



St. Michael's Hospital Avera
410 W 16th Avenue
Tyndall, SD 57066

4-16-2014

Facility Development
(605) 322-7803
Avera McKennan - Plaza II
1325 S. Cliff Ave
Sioux Falls, SD 57117

ARCHITECT

I hereby certify that this plan, specification, and/or report was prepared by me or under my direct supervision and that I am a duly Licensed Architect under the laws of the State of South Dakota.

Print Name: Garrett Peters

Signature: 

Registration #: 8536

Date: April 16, 2014



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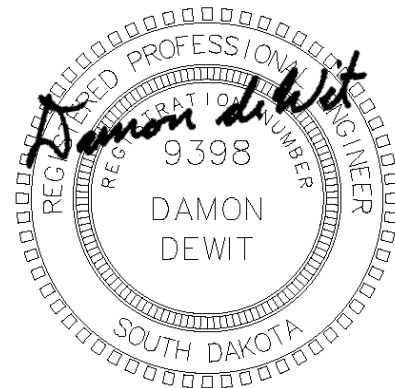
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PROJECT: AVERA ST. MICHAELS
TYNDALL, SOUTH DAKOTA

ACEI PROJECT NO.: 113047

DATE: April 16, 2014

Project Manual sections prepared by or under the supervision of Damon deWit, Reg. No. 9398 include all sections of Division 21-22-23.



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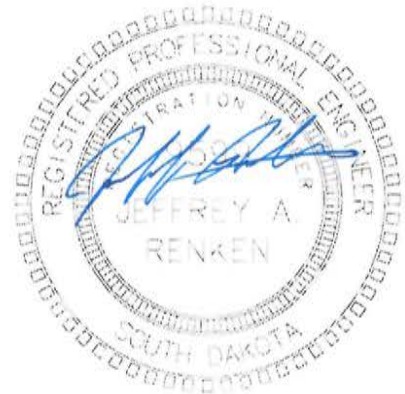
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PROJECT: AVERA ST. MICHAELS
TYNDALL, SOUTH DAKOTA

ACEI PROJECT NO.: 113047

DATE: April 16, 2014

Project Manual sections prepared by or under the supervision of Jeffrey A. Renken, Reg. No.9599, include all sections of Division 26.



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Project: St. Michael's Hospital Avera Patient Wing Addition

Owner: St. Michael's Hospital Avera
410 W 16th Avenue
Tyndall, SD 57066

Bids for the construction work for the project named above will be received by Jacob Bunde on behalf of the St. Michael's Hospital Avera on **5-06-2014 before 3:00** Central Standard Time, in accordance with Construction Documents prepared by:

Avera Health
Jacob Bunde, Facility Architect
1325 S. Cliff Ave
Sioux Falls, SD 57117
605-322-7802

The Drawings and other contract documents may be examined at the following places:

Avera Doctors Plaza II
1325 S. Cliff Ave
Sioux Falls, SD 57117

Copies and/or PDF disc may be obtained by:

Contacting Jacob Bunde jacob.bunde@avera.org

The Owner reserves the right to waive any informality or to reject any or all bids and to accept a bid, which in the Owner's judgment is in the Owner's best interest.

Bids shall be submitted in writing using the Bid Form contained in the specifications. FAX bids will be accepted at Avera McKennan Hospital (605)322-7832 up to the time of bidding and will be held in confidence. Such bids must be verified in writing within 72 hours after the bid time to be valid.

Bidders shall carefully examine entire contents of Contract Documents prepared for the work to become thoroughly familiar with all requirements. Bidders shall visit the construction site to obtain first-hand knowledge of existing conditions, including existing utilities and services, obstacles, which may be encountered, and all other conditions relative to the work to be performed. Contractors shall not receive extra payments for conditions that can be determined by examining the site and the contract documents.

No bidder may withdraw his bid within 30 days after the actual date of the opening thereof.

END OF SECTION

1. CONTRACTOR'S LICENSE

Subject to the provisions of South Dakota state law (____), bidders must hold a valid South Dakota Contractor's License of the proper class. Such license shall have been in effect for at least ten (10) days prior to the scheduled bid opening. License shall be valid for the highest amount of the Bidder's total bid combination, including all alternates. Any bid submitted without this information properly included (according to the Invitation for Bids) may be rejected without further consideration.

2. PROJECT REPRESENTATIVES

The Owner/Architect:

Avera
Jacob Bunde, Facility Architect
1325 S. Cliff Ave
Sioux Falls, SD 571117
605-322-7802

3. SUBSTITUTIONS

To obtain approval to use unspecified products, bidder shall submit in writing. Any products that are approved for use in the Work according to this provision will be identified in an Addendum.

4. EXAMINATION OF DRAWINGS, SPECIFICATIONS AND SITE OF WORK

Bidders shall carefully examine all bidding documents, Drawings (including Addenda) and the construction site to obtain first-hand knowledge of existing conditions.

5. INTERPRETATION OR CORRECTION OF BIDDING DOCUMENTS

Bidder shall examine the site and local conditions, and shall promptly report errors, inconsistencies, or ambiguities to the Architect.

Bidders and sub-bidders who required clarifications or interpretations of the documents shall make a written request, email, or FAX to the Architect sufficiently in advance of the bid date to allow for written interpretations.

6. ADDENDA

Direct all questions about the work to the Architect. Written replies will be issued to all prime bidders of record as Addenda, and shall become part of the Work. The Owner, Architect and/or Engineers will not be bound by nor responsible for oral clarifications. Questions received within 48 hours before bid opening may not be answered.

7. BID PREPARATION

Bids shall be submitted on one unaltered copy, identical to the form included with the bid documents. All blanks shall be filled in by typewriter or legible writing. Sums shall be expressed as numbers and words. The amount written in words shall govern.

8. SUBMISSION OF BIDS/REQUIRED EXHIBITS

Bid envelope contents:

- a. One complete copy of the Bid Form
- b. Signatures
- c. Copy of Contractor's License or Certificate of Renewal.

Bidders may withdraw bids at any time before bid opening.

9. EQUAL EMPLOYMENT OPPORTUNITY

It is the policy of the Owner to employ personnel without discrimination.

10. REJECTION OF BIDS

Owner reserves the right to reject any or all bids.

The Owner reserves the right to disqualify any bid upon evidence of collusion or other unlawful practices by the bidder.

11. ACCEPTANCE OF BIDS (CONTRACT AWARD)

It is the intent of the Owner to award Contracts to the responsible bidder with the best value within the allowable budget, on the basis of a combination of base and alternate bids which give the most complete desired project. At the Owner's option, requested alternate bid work may be incorporated in the Contract.

The Owner reserves the right to accept any bid, and to reject any or all bids for good cause, or to negotiate Contract terms with the chosen bidders when such is deemed by the owner to be in its best interest.

Each bidder shall be prepared, if so requested by the Owner, to present evidence of qualifications and financial ability to carry out the terms of the Contract.

12. EXECUTION OF AGREEMENT

Form of the Contract will be **AVERA HEALTH CONSTRUCTION CONTRACT (00-5300)(Copy Attached)**.

13. NOTICE TO PROCEED

Successful bidders will have access to the project site immediately upon Notice to Proceed.

END OF SECTION

TO: Avera McKennan
Attn: Nate Vollmuth
1325 S. Cliff Ave
Sioux Falls, SD 57104

Pursuant to and in compliance with the Notice to Bid and the proposed Contract Documents relating to the work of:

Project: _____

Including Addenda numbered: _____, _____, _____, _____, _____, _____

The undersigned, having become thoroughly familiar with the terms and conditions of the proposed Contract Documents and with local conditions affecting the performance and costs of the work at the place where the work is to be completed, and having fully inspected the site in all particulars, hereby proposed and agrees to fully perform the work within the time stated and in strict accordance with the proposed Contract Documents, including furnishing any and all labor and materials and to do all of the work required to construct and complete said work in accordance with the Contract Documents, for the sum of money stated in this Bid Form.

I understand that the Owner reserves the right to reject this bid, but that this bid shall remain open and not be withdrawn for a period of thirty (30) days from the date prescribed for its opening.

Bidder agrees to perform all work identified on the Drawings, to abide by Conditions of the Contract, and further to coordinate work of all sub-contractors for the total sum of:

_____ Dollars
(\$_____)

ALTERNATES:

Proposed amounts for Alternates stated hereafter include net changes from Base Bid, as set forth above:

Alternate #1: _____

VOLUNTARY COST-SAVINGS ALTERNATES:

We have listed below voluntary cost-savings alternates the Owner may wish to consider. We understand that these items may be used in the determination of the successful low bidder and agree to provide the indicated work as described for the cost reductions indicated.

(please attached a separate page)

AGREEMENT:

Bidder agrees to commence work under this Contract on or before a date specified in the written Notice to Proceed by the Owner and to fully complete the Bid Package Work according to the Construction Schedule.

CORPORATION/COMPANY:

BY:

POSITION:

ADDRESS:

CITY, STATE, ZIP

TELEPHONE:

FAX:

EMAIL:

END OF SECTION

1.1 PROJECT INFORMATION

- A Name: _____
- B Location: _____
- C Owner: _____
- D Architect: _____

1.2 SCOPE OF WORK

- A Scope: _____

- B Contract Type: (see attached)
- C Timeline: _____

END OF SECTION

PART 1 – GENERAL

1.1 DEFINITIONS

- A. An Alternate is an amount proposed by Bidders and stated on Bid Form for certain construction activities or contract adjustments that may be added to or deducted from Base Bid amount if Owner decides to accept a corresponding change in either amount of construction to be completed, or in products, materials, equipment, system, or installation methods described in Contract Documents.
- B. Each Alternate is described in abbreviated language, recognizing that Drawings and Specification Sections document work to be added to or omitted from basic requirements of Contract Documents in event Owner elects to accept the Alternate.

PART 2 – SCHEDULE OF ALTERNATES

- 1. xxxxxxx
 - a. (Add/Deduct)

END OF SECTION

1.1 SUMMARY

- A. Each contractor shall participate in coordination requirements.

1.2 PROJECT MEETING and PROGRESS MEETINGS

- A. Bi-weekly meetings will be held at _____

1.3 PRE-CONSTRUCTION CONFERENCE

- A. Attendees: Authorized representatives of Owner, Architect, and their consultants; Contractor and its superintendent; major subcontractors; suppliers; and other concerned parties shall attend the conference.
- B. Agenda: Discuss items of significance that could affect progress, including the following:
 - a. Tentative construction schedule
 - b. Phasing
 - c. Critical work sequencing and long-lead items
 - d. Designation of key personnel and their duties: Sign In Sheet
 - e. Procedures for processing field decisions and Change Orders
 - f. Procedures for testing and inspecting.
 - g. Office, work, and storage areas
 - h. First aid
 - i. Security
 - j. Progress cleaning
 - k. Working hours
 - l. Review of Contract
 - m. Submittal of Shop Drawings
 - n. Application for Payment
 - o. Substantial Completion Date: _____
 - p. PCRA
 - q. Infection Control
 - r. Staging Area
 - s. Contractor Parking
 - t. Dumpster location
 - u. Temporary Facilities
 - v. Smoking on site
- C. The agenda should be produced by the general contractor and distributed to all parties listed above.

END OF SECTION

- A. Contractor's Construction Schedule: Updated bi-weekly
- B. Daily Construction Reports: Submit one copy at monthly intervals
- C. Material Location Reports: Submit one copy at monthly intervals.
- D. Field Condition Reports: Submit one copy at time of discovery of differing conditions
- E. Special Reports: Submit one copy at time of unusual event.

END OF SECTION

CONSTRUCTION PROGRESS SCHEDULE

- A. Submit construction timeline within (10) days of award of bid.

PROPOSED PRODUCT LIST

- A. Within (15) days after award of bid, submit complete list of major products proposed for use.

SHOP DRAWINGS

- A. Submit to Owner/Architect a copy of Shop Drawings for all major products to be approved.
- B. Owner/Architect will returned to Contractor with modifications if necessary within (5) days.

PRODUCT DATA

- A. The Contractor is required to maintain copies of all product data on site.
- B. Copies or original product data sheets to be turned over to Owner/Architect at Final Completion.

- A. 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.
- B. Manufacturer Qualifications: A firm experienced in manufacturing products or systems similar to those indicated for this Project and with a record of successful in-service performance.
- C. Fabricator Qualifications: A firm experienced in producing products similar to those indicated for this Project and with a record of successful in-service performance.
- D. 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.
- E. 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: Requirement for specialists shall not supersede building codes and regulations governing the Work.
- F. 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.
- 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
- H. Manufacturer's Field Services: Where indicated, engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including service connections.

END OF SECTION

- A. Punchlist preparation: Submit one copy of list. Include name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
- B. Provide final cleaning. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations.
- C. Complete the cleaning operations before requesting inspection for certification of Substantial Completion for entire Project or for a portion of Project.

END OF SECTION

- A. Final Submittal: Submit 2 copies of each manual in final form at least 7 days before final inspection.
- B. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, assemble and coordinate information furnished by representatives and prepare manuals.
- C. Manuals to Submit:
 - General Manuals
 - Emergency Manuals
 - Operations Manuals
 - Product Maintenance Manuals
 - Systems and Equipment Maintenance Manuals
- D. Provide Manuals in 3-Ring Binder and digital copy

END OF SECTION

- A. Record Drawings: Submit one set of marked-up Record Prints.
- B. Record Specifications: Submit one copy of Project's Specifications, including addenda and contract modifications.
- C. Record Product Data: Submit one copy of each Product Data submittal.
- D. Assemble miscellaneous records required by other Specification Sections for miscellaneous record keeping and submittals in connection with actual performance of the Work. Bind or file miscellaneous records and identify each, ready for continued use and reference.

END OF SECTION

- A. Coordinate instruction schedule with Owner's operations. Adjust schedule as required to minimize disrupting Owner's operations.
- B. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
- C. Coordinate content of training sessions with content of approved emergency, operation, and maintenance manuals.
- D. Program Structure:
 - Fire-protection systems, including fire alarm and fire-extinguishing systems
 - Heat generation, including feedwater equipment, pumps, and water distribution piping
 - Refrigeration systems, including condensers, pumps, and distribution piping
 - HVAC systems, including air-handling equipment and air distribution system
 - HVAC instrumentation and controls
 - Electrical service and distribution, including transformers, switchboards, panelboards, and motor controls
 - Packaged engine generators, including transfer switches
 - Lighting equipment and controls
 - Communication systems, including voice and data, and television equipment
- E. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

END OF SECTION

PREMIER PURCHASING PARTNERS, LP GROUP PURCHASING AGREEMENTS

A. Section includes administrative and procedural requirements for utilization of products and materials purchased under the Premier Purchasing Partners, LP; a group purchasing organization (GPO) of which *Avera* is an Owner / Member.

B. DEFINITIONS

1. GPO Agreements: agreements negotiated by the Premier Purchasing Partners, LP on behalf of its Member Institutions including *Avera*, with selected Contracted Materials Suppliers and Service Providers for Member Institutions' projects .
2. Terms and Conditions (including pricing tiers as defined in the agreements) of the Premier Agreements with Contracted Materials Suppliers and Service Providers shall be extended to the Member Institutions including *Avera* for incorporation into the identified projects.
3. Premier Construction Agreements: list of Contracted Suppliers and Service Providers used in construction projects (see the attached Premier Construction Agreements for *Avera* for products included in this project).

C. PROCEDURES

1. *Avera* has identified those Suppliers and Service Providers of Premier Construction Agreements available to their project.
2. Premier working with *Avera* has notified the Contracted Materials Suppliers at a National Level, sharing information about the project describing scope and schedule for the project.
3. The National Level representatives for the Contracted Materials Suppliers and Services Providers have made the appropriate distributors and suppliers who will bid on this project aware of the GPO Agreements with Premier and will support their efforts to win the bid for their respective materials or services. Premier Contracted Materials Suppliers has made Premier and *Avera* aware of who the local authorized representatives are to ensure that the Premier pricing is extended to the contracting community for the this project
4. Contractors seeking a price proposal from a Premier Contracted Supplier will need to reference the Premier Contract Number (PP-FA__) for each materials contract in order to receive the Premier pricing for this project. The contracting parties will need to reference the Premier Entity Number () to receive credit for the purchase. See the attached Premier Construction Agreements list for the Contracted Suppliers.
5. Within 8 calendar weeks of the award of the construction contract, *Avera* will require that the selected Contractors make *Avera* aware of which GPO Agreements are being utilized as a part of this project. The Contractors shall provide *Avera* specific procurement information about the amount of Premier Contracted Materials Suppliers goods and services that are included in their

proposal including; Purchase Order Number, Date, Amount and Issuing party, along with a targeted installation date. This information shall be submitted to *Avera* on the Premier Contract Reporting Template

6. *Avera* shall notify Premier, Inc. of which Construction Agreements will be incorporated into the project.
7. Premier, Inc. will confirm the sale of the Construction goods and services with the Contracted Materials Suppliers.

D RELATED DOCUMENTS

1. Drawings and General Conditions of the Contract
2. Premier Construction Agreements List
3. Premier Contract Reporting Template

LIENS:

Neither the final payment, retained percentage, nor any other payments shall become due until the Contractor, when requested by the Owner, shall deliver to the Owner a complete release of all liens, financial obligations or claims from himself/herself, subcontractors, or other agents acting on his/her behalf in connection with the work, arising out of the work, and an affidavit that so far as he/she has knowledge or information, the releases include all the labor and material for which a lien could be filed. If any lien remains unsatisfied after all payments are made, the Contractor shall refund to the Owner all moneys that the latter may be compelled to pay in discharging such a lien, including all costs and a reasonable attorney's fee.

MEDICARE ACCESS TO RECORDS:

In accordance with 42 U.S.C. 1395x(v)(I)(i) & (ii), until the expiration of four (4) years after the furnishing of services under the agreement, the vendor shall make available, upon written request by the Secretary, U.S. Department of Health and Human Services or upon request by the U.S. Comptroller General, or any of their duly authorized representatives, the contract, books, documents, and records of vendor that are necessary to certify the nature and extent of costs of any agreement between vendor and the owner.

DISINFECTION OF POTABLE WATER SYSTEM
FOR AVERA HEALTHCARE FACILITIES

Reference: 2009 Uniform Plumbing Code, Section 609.9

Facility _____ City _____

1. Was the piping system flushed with potable water until no dirty water appears at every outlet? 609.9.1 YES NO

2. Were cautionary signs posted at all entrances and fixtures during the procedure and shutoff valves tagged? YES NO

3. Was the system filled with water-chlorine solution containing at least 50 parts per million of chlorine and valved off and allowed to stand for 24 hours? 609.9.2 YES NO

OR

Was the system filled with water-chlorine solution containing at least 200 parts per million of chlorine and valved off and allowed to stand for 3 hours? 609.9.2 YES NO

4. What method was used to ensure the level of chlorine was achieved at every fixture location? (i.e. Chlorine test strips, chlorine test kit, etc.) _____

5. Following the standing time, was the system flushed with potable water until chlorine levels are near supply water levels (less than 4 parts per million)? 609.9.3 YES NO

6. The disinfection process shall be repeated if it is shown by bacteriological examination that contamination persists in the system. City of Sioux Falls Public Health Laboratory at 521 North Main Ave. conducts these tests. YES NO

7. When was the system disinfected? Date _____ Time _____
When was the system flushed of chlorine solution? Date _____ Time _____
Who conducted the disinfection? _____ Flushing? _____
Testing witnessed by: _____, Avera McKennan employee

8. Please print name of person completing report? _____
Signature _____ Phone # _____
Name of Firm _____ Phone # _____

9. Provide copy of documentation to SD Dept. of Health Fax #773-6667, Avera McKennan Facilities Services Fax #322-7401, Project Mechanical Engineer _____, and Project General Contractor _____.

See attached plan of plumbing system, valves, fixture locations and bacteriological test.

SECTION 04-2000 - UNIT MASONRY**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Concrete unit masonry.
- B. Brick unit masonry.
- C. Masonry mortar and grout.

1.02 RELATED WORK

- A. Section 03-4515 – Precast Architectural Concrete Panels: Precast panels to receive cast in brick facing.
- B. Section 05-1200 - Structural Steel Framing: Steel anchors embedded in masonry.
- C. Section 05-5000 - Metal Fabrications: Metal items embedded in masonry.

1.03 SUBMITTALS

- A. Manufacturer's Product Data for each type of masonry unit and accessory.
- B. 4 Samples of face brick and 2 Samples of each color of mortar, showing the full range of color and texture to be expected in the Work. Approved Samples shall be the standard for appearance and quality of installed work.
- C. Mortar and grout design mix, required environmental conditions, and admixture limitations.
- D. Mortar test reports showing conformance to ASTM C270.
- E. Grout test reports showing conformance to ASTM C476.
- F. Manufacturer's certification that each product complies with Specifications.
- G. Provide full shop drawings for caulk joints and sealants in the wall assemblies. Show location of the joints.

1.04 QUALITY ASSURANCE

- A. Installer: Company specializing in masonry construction with 5 years experience.
- B. Before any brick is laid, the Architect will select 10 facing brick units from brick at the job site for testing.
- C. Deliver Samples to the testing laboratory for testing to determine compliance with Specifications. Laboratory tests shall include:
 - 1. ASTM C67 for brick.
 - 2. ASTM C780 for mortar.

- 3. ASTM C1019 for grout.

- D. If brick is found to be not in compliance, additional brick will be selected by the Architect and tested at the Contractor's expense.
- E. Failure of the second series of tests shall be cause for rejection of the batches tested. Remove rejected brick from the site.
- F. Use test results to adjust mortar mix design to obtain optimum bond.
- G. Use accessory materials recommended by manufacturer of primary materials.
- H. Verify compatibility of products.
- I. Comply with Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) "Architectural Sheet Metal Manual" standards for fabrication and installation of metal flashing.

1.05 MOCK-UPS

- A. Provide a wall mock-up for each combination of exposed unit masonry work and back-up construction, minimum 6 feet long by 6 feet high. Locate on site where directed.
- B. Mock-ups shall include sealant and other items that will be built into the masonry represented by each mock-up. Retain mock-ups during construction as the standard for remaining masonry work. Protect with weather resistant membrane.
- C. Demolish and remove mock-ups when directed by the Architect.

1.06 PRE-INSTALLATION MEETING

- A. Convene 7 days before beginning masonry work at the site.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Prevent intermixture of aggregates with earth or foreign materials.
- B. Protect Type I concrete masonry units from precipitation.
- C. Use preblended mortar manufacturer's dispensing equipment for storage and dispensing of preblended mortar mixture.

1.08 SITE CONDITIONS

- A. Maintain materials and surrounding air temperature to minimum 50 degrees F before, during, and 48 hours after completion of masonry work.
- B. When ambient temperature is expected to fall below 40 degrees F, comply with International Masonry Industry All-Weather Council "Recommended

Practices and Guide Specifications for Cold Weather Masonry Construction.”

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Portland cement: ASTM C150, Type I.
- B. Lime: ASTM C207, Type S.

2.02 MANUFACTURED UNITS

- A. Special units: Provide special shapes for lintels, corners, jambs, sash, control joints, headers, bonding, and other special conditions.

2.03 CONCRETE MASONRY UNITS (CMU)

- A. Acceptable manufacturers:
 - 1. Aggregate Industries, Eagan, MN.
 - 2. Amcon Block and Precast, Inc., St. Cloud, MN.
 - 3. Anchor Block Company, North St. Paul, MN.
 - 4. County Materials Corporation, Marathon, WI.
- B. Curing method exposed units: Autoclave, steam, or CO₂.
- C. Load bearing units: ASTM C90-99, Type I, hollow, normal weight.
- D. Non load-bearing: ASTM C129, hollow, normal weight.
- E. Concrete building brick: ASTM C55, Grade N, Type I.
- F. Packaging, Type I units: Factory shrink-wrapped to protect from precipitation.

2.04 BRICK (BR)

- A. Acceptable suppliers:
 - 1. Belden Brick, Canton, OH.
 - 2. Endicott Clay Products, Fairbury, NE.
 - 3. Hebron Brick.
 - 4. Minnesota Brick & Tile, Bloomington, MN.
 - 5. Ochs Brick & Stone, North St. Paul, MN.
 - 6. Other as approved.
- B. Standard: Design is based on the following brick. Indicated products are the standard for appearance and performance.
 - 1. BR-1, full brick units: ASTM C216, Grade SW, Type FBS, 3-5/8 inches by 2-1/4 inches by 7-5/8 inches. Match existing brick on buildings ADP1 and East Inpatient Tower.

- 2. BR-2, brick units cast into precast panel face: ASTM C1088, Exterior Grade, Type TBX, 3-5/8 inches by 2-1/4 inches by 7-5/8 inches. Match existing brick on buildings ADP1 and East Inpatient Tower.

2.05 MORTAR AND GROUT

- A. Mortar mix: ASTM C270, cement-lime or mortar cement, proportion specification.
 - 1. Portland cement: Natural color or white.
 - 2. Aggregate: ASTM C144, except for joints less than 1/4 inch use aggregate graded with 100 percent passing No. 16 sieve.
- B. Colored mortar: Premixed colored masonry cements, using natural and synthetic iron oxides and chromium oxides for color, color as selected. Tamms or approved.
- C. Grout: ASTM C476. Fine grout in grout spaces less than 2 inches in horizontal direction, coarse grout elsewhere.
- D. Mortar mixes, interior: Proportion method.
 - 1. Load-bearing: Type N.
 - 2. Non-load-bearing: Type O or Type N.
 - 3. Below grade: Type M.
- E. Mortar mixes, exterior: Proportion method.
 - 1. Above-grade: Type N or Type S.
 - 2. Below grade and ground contact: Type M.
- F. Grout mix: 3,000 psi strength at 28 days; 7 inches to 8 inches slump.

2.06 REINFORCING AND TIES

- A. Acceptable manufacturers:
 - 1. Dur-O-Wal, Aurora, IL.
 - 2. Heckmann, Melrose Park, IL.
 - 3. Hohman & Barnard, Hauppauge, NY.
- B. Standard: Where specific model numbers are indicated, the named product shall be the standard for design and performance.
- C. Condition: Free of loose rust, scale, oil, and other coating that would reduce bond.
- D. Finish, exterior walls: Hot-dip galvanized after fabrication, ASTM A153, Class B.
- E. Finish, other interior walls: Mill galvanized, ASTM A641, Class 1, 0.40 ounce coating.
- F. Plain reinforcing bars: ASTM A615, Grade 60, deformed.
- G. Reinforcing bar bends and hooks: ACI standard 90 degree or 180 degree unless otherwise indicated.

- H. Deformed wire: ASTM A496, zinc coating per ASTM A153.
- I. Welded wire fabric: ASTM A185.
- J. Interior composite wall reinforcing: ASTM A82 9 gauge steel wire ladder.
- K. Exterior cavity wall reinforcing: ASTM A82, 9 gauge steel wire ladder, adjustable 0.1875 inch eye-and-pintle units where wythes do not align.
- L. Masonry veneer ties: 2-piece assembly allowing differential vertical or horizontal movement between veneer and framing; maximum deformation or play 0.05 inch under 100 pounds load in either compression or tension; 0.1875 inch ties with 1-1/2 inches embedment in masonry veneer.
- M. Flexible anchors for intersecting walls: 2 inches by 5 inches by 1/4 inch mesh, 23 gauge hardware cloth, ASTM A116, Class 3 galvanized.
- N. Rigid anchors for intersecting walls: 1/4 inch by 1-1/4 inches by 28 inches galvanized tie bars, 2 inches right angle bend in each end.
- O. Anchorage to structural steel: Triangular loops of 6 gauge steel wire ties anchored to 1/4 inch wire rods or clip angles welded to structure. Dur-O-Wal Flex-O-Lok.
- P. Anchorage to metal studs: Triangular loops of 6 gauge steel wire anchored with 4 inches adjustable stud plate anchors through sheathing to steel studs.
- Q. Anchorage to concrete: Dovetail anchors inserted in anchor slots cast in concrete.

2.07 THERMAL AND MOISTURE CONTROL PRODUCTS

- A. Cavity insulation: Extruded polystyrene, ASTM C578, Type IV. Dow Styrofoam, Minnesota Diversified Certifoam, U.C. Industries Foamular.
- B. Building membrane: As specified in Section 07-2510.
- C. Membrane flashing: Peel & stick membrane, 8 mil plastic bonded to bitumen or butyl, 40 mil total. Carlisle CCW-705 TWF, Grace Perm-A-Barrier Wall Flashing, Meadows SealTight Air Shield, Polyguard 401, SafSeal 6634.
- D. Termination bar: Type 304 stainless steel, minimum dimensions 1 inch wide by 1/16 thick. Predrilled 12 inches o.c., within 2 inches of each end.
- E. Metal flashing: 26 gauge soft stainless steel, unpolished finish; hemmed approximately 3/16 inch. Maximum available lengths to minimize joints.

- F. Weeps: 1/4 inch round rope, 50 percent cotton.
- G. Mortar trap: High density polyethylene or nylon mesh, 10 inches high by full horizontal depth of cavity. Mortar Net USA "Mortar Net"; Polytite "MortarStop".

2.08 ACCESSORIES

- A. Expansion joint strips: ASTM D1056, Grade RE41E1; pre-molded, flexible cellular neoprene rubber filler strips; compressible to 35 percent.
- B. Control joint strips: ASTM D2000, Designation 2AA-805, styrene butadiene rubber, or ASTM D2287, General Purpose Grade, Designation PVC-63506, polyvinyl chloride; designed to fit sash block and to maintain lateral stability in masonry.
- C. Building paper: No. 15 asphalt saturated felt.
- D. Cleaning solutions: Non-acidic, not harmful to masonry work or adjacent materials.

PART 3 - EXECUTION

3.01 GENERAL

- A. Coordinate placement of metal anchors furnished to other Sections.
- B. Provide temporary bracing during installation of masonry work. Maintain in place until building structure provides permanent bracing.
- C. Do not apply uniform floor or roof loads to masonry until it has cured for 24 hours. Do not apply concentrated construction loads to masonry until it has cured for 72 hours.
- D. Cover top of walls with waterproof sheeting at end of each day's work. Keep tops of wall covered until permanently covered with roofing or coping. Extend covering 24 inches down each face; secure in position.
- E. Promptly remove grout or mortar from masonry or concrete to be left exposed. Prevent accumulation of mortar on sills, ledges, and projections.
- F. Do not lay masonry units that are wet or frozen. Remove ice or snow from masonry bed by carefully applying heat until top surface is dry to the touch.
- G. Replace masonry damaged by freezing.

3.02 MORTAR AND GROUT

- A. Mix cementitious materials and aggregates with the minimum amount of water consistent with workability.

- B. Measure materials by volume or weight. Do not measure by shovel.
- C. Do not use contaminated or deteriorated cementitious materials or aggregates.
- D. Do not use mortar that has begun to set or is more than 2 hours old. Retemper within that time only as required to restore workability. Do not retemper colored mortar.
- E. Do not add calcium chloride, antifreeze liquids, salts, or other substances not specified.

3.03 INSTALLATION

- A. Lay first row of unit masonry on full bed of mortar.
- B. Provide cleanout holes in first course of all cores to be grouted. After pour, close cleanout holes.
- C. Build in chases, recesses, conduits, sleeves, and other items required by other Sections. Solidly embed anchors, lintels, reinforcing, door frames, and similar items.
- D. Lay out work in advance for accurate spacing of surface bond pattern, for uniform joint widths, and to properly locate openings, control joints, returns, and offsets. Avoid use of less than half-size units.
- E. Maintain continuity of cores that are to be reinforced and grouted. Keep these cavities free of mortar.
- F. Cut masonry units with a motor-driven masonry saw. Use full units without cutting wherever possible.

3.04 COURSING

- A. Maintain uniform course dimensions.
- B. Lay concrete masonry units in running bond, with 1 unit and 1 mortar joint to equal 8 inches.
- C. Lay brick units in running bond, with 3 brick units and 3 mortar joints to equal 8 inches.

3.05 PLACING AND BONDING

- A. Install solid masonry units for anchoring equipment requiring solid units for anchorage. Lay in full bed of mortar, with full head joints, uniformly jointed with other work.
- B. Lay hollow masonry units with face shell bedding on head and bed joints.
- C. Buttering corners of joints or excessive furrowing of mortar joints is not permitted.
- D. Remove excess mortar as masonry work progresses.
- E. Interlock intersections and external corners.

- F. Do not shift or tap masonry units after mortar has achieved initial set. Where adjustment must be made, remove mortar and replace.
- G. Cut masonry units with straight, clean, unchipped edges.
- H. Cut joints flush where ceramic tile, quarry tile, or resilient base tile is scheduled.
- I. Isolate masonry partitions from vertical structural framing members with a control joint unless otherwise indicated.
- J. Isolate top joint of masonry partitions from horizontal structural framing members and slabs or decks with compressible joint filler.
- K. When stopping work step back 1/2 masonry unit in each course, do not tooth.

3.06 LINTELS AND REINFORCING

- A. Install reinforced unit masonry lintels over openings larger than 12 inches where steel or precast concrete lintels are not indicated. Refer to structural Drawings for reinforcing. Provide 8 inches minimum bearing on each side of opening. Reinforce with two #5 bars. Fill with grout.
- B. Allow masonry lintels to attain specified strength before removing temporary supports.
- C. Support and secure reinforcing bars to prevent displacement. Maintain position within 1/2 inch of dimensioned position.
- D. Place vertical reinforcing before grouting. Do not exceed 48 inches pour height.
- E. Fully embed wall reinforcing. Place reinforcing in alternate courses, lap ends 6 inches minimum; provide continuity at corners by cutting, bending, and lapping as recommended by the manufacturer.
- F. Place and consolidate grout fill without displacing reinforcing.
- G. Lap splices minimum 24 bar diameters.
- H. At bearing locations, fill masonry cores with grout for a minimum 12 inches either side of opening.

3.07 THERMAL AND MOISTURE CONTROL PRODUCTS

- A. Install through-wall flashing where indicated, and at shelf angles, lintels, ledges, and other obstructions to downward flow of water. Clean substrates and remove projections that might puncture flashing. Extend flashing 4 inches into masonry at each end.
- B. Extend flashing from outer face of brick through veneer, turn up minimum 8 inches, seal to back-up.

Use a termination bar at top edge of membrane flashing.

- C. Lap end joints 6 inches and seal watertight.
- D. Install end dams at terminations and change in plane of flashing.
- E. Bend outer 1/4 inch of metal flashing down at 45 degree angle to form continuous drip.
- F. Install weeps in the head joints of the same course of masonry bedded in the flashing mortar at 16 inches o.c. maximum. Minimum of 18 inches double back cotton rope secured at top ends.
- G. Install insulation with tight joints, tight against masonry. Maintain clear air space. Secure in place with mechanical insulation clip at each tie as required to hold insulation tight against backup.
- H. Install continuous mortar trap at bottom of cavity, and above each opening.
- I. Apply membrane flashing joint seal to joints that are not mortared-in on exterior of masonry back-up behind brick.
- J. Provide cleared drainage plane or cavity within wall assembly, formed to carry all moisture out through weep holes

3.08 MORTAR JOINTS

- A. Cut joints flush on walls to be concealed.
- B. Rake out joints for caulk or sealants.
- C. Strike joints flush on surfaces facing the interior of cavity-walls, and where waterproofing, dampproofing, or vapor retarder are to be applied.
- D. Tool exposed joints concave with a non-staining metal jointing tool. Where dampproofing or waterproofing is to be applied, tool joints flush.
- E. Work grout to eliminate voids. Do not displace reinforcement when grouting. Grout in hollow metal door frames as masonry work progresses.

3.09 REINFORCEMENT AND ANCHORAGES - SINGLE WYTHE MASONRY

- A. Install horizontal joint reinforcement 16 inches o.c.
- B. Place masonry joint reinforcement in first and second horizontal joints above and below openings. Extend minimum 16 inches each side of opening.
- C. Place joint reinforcement continuous in first and second joint below top of walls.
- D. Lap joint reinforcement ends minimum 6 inches. Extend minimum 16 inches each side of openings.
- E. Reinforce joint corners and intersections with strap anchors 16 inches o.c.

3.10 MASONRY VENEER TIES

- A. Provide ties as indicated and as required by applicable regulations. Where not indicated, provide as follows.
 1. Minimum by area: 1 metal tie per 2.67 square feet of wall area.
 2. Maximum horizontal spacing: 32 inches.
 3. Maximum vertical spacing: 18 inches.
 4. Openings: Maximum 36 inches o.c. around perimeter, within 12 inches of opening.
 5. Additional ties as required by ACI 530.
- B. Stagger tie locations in alternate courses.

3.11 ENGINEERED MASONRY

- A. Lay masonry units with core cells vertically aligned clear of mortar and unobstructed.
- B. Place mortar in masonry unit bed joints back 1/4 inch from edge of unit grout spaces, bevel back and upward. Permit mortar to cure 7 days before placing grout.
- C. Reinforce masonry unit cores with reinforcement bars and grout.
- D. Retain vertical reinforcement in position at top and bottom of cells and at intervals not exceeding 192 bar diameters. If necessary, use bar positioners to hold the bars securely in place prior to grouting.
- E. Wet masonry unit surfaces in contact with grout just prior to grout placement.
- F. Grout spaces less than 2 inches in width with fine grout using low lift grouting techniques. Grout spaces 2 inches or greater in width with course grout using high or low lift grouting techniques.
- G. When grouting is stopped for more than 1 hour, terminate grout 1-1/2 inches below top of upper masonry unit to form a positive key for subsequent grout placement.
- H. Low lift grouting: Place first lift of grout to a height of 16 inches and rod for grout consolidation. Place subsequent lifts in 8 inch increments and rod for grout consolidation.
- I. High lift grouting:
 1. Provide clean-out opening 4 inches high at the bottom of each cell to be grouted by cutting 1 face shell of masonry unit.
 2. In double wythe walls, omit every second masonry unit in 1 of the wythes for clean out and cell inspection purposes.
 3. In double wythe walls, construct vertical grout barriers or dams between the masonry

- wythes, with masonry units every 30 feet maximum.
4. Clean out masonry cells and cavities with high pressure water spray. Permit complete water drainage.
 5. Request the Architect/engineer to inspect the cells. Allow 5 days advance notice of inspection.
 6. After cleaning and cell inspection, seal openings with masonry units.
 7. Pump grout into spaces. Maintain water content in grout to intended slump without aggregate segregation.
 8. Limit grout lift to 48 inches and rod for grout consolidation. Wait 30 to 60 minutes before placing next lift.

3.12 CONTROL JOINTS

- A. Construct control joints where indicated on the Drawings. If not indicated:
 1. Locate exterior vertical control joints at 20 feet o.c. maximum, interior vertical control joints at 30 feet o.c. maximum. Provide vertical control joints at 1 side of each lintel, and 4 feet maximum from each corner.
 2. Locate exterior horizontal control joints at 20 feet o.c. maximum, with soft joints at each shelf angle and at top of wall.
- B. Do not continue horizontal joint reinforcement through control joints.
- C. Form control joints in concrete masonry units with a sheet building paper bond breaker, fitted to 1 side of the hollow contour end units. Fill the resultant elliptical core with grout fill. Rake joint at exposed unit faces for placement of backer rod and sealant.
- D. Install preformed control joint device in continuous lengths. Seal butt and corner joints in accordance with manufacturer's instructions.

3.13 BUILT-IN WORK

- A. As work progresses, build in wood nailing strips, anchor bolts, plates, and other items furnished under other Sections.
- B. Build in items plumb and level.
- C. Do not build in organic materials subject to deterioration.

3.14 CONSTRUCTION TOLERANCES

- A. Variation from alignment of plan location: 1/4 inch in 10 feet, 1/2 inch in 20 feet; 3/4 inch in 40 feet or more.

- B. Variation from alignment of pilasters: 1/4 inch.
- C. Variation from plumb: 1/4 inch in 10 feet; 3/8 inch in 20 feet, 1/2 inch maximum.
- D. Variation from cross-sectional dimension: Minus 1/4 inch to plus 3/8 inch.
- E. Variation from level coursing: 1/8 inch in 3 feet, 1/4 inch in 10 feet; 1/2 inch in 30 feet; 3/4 inch in 40 feet or more.
- F. Variation between faces of adjacent units: 1/16 inch.
- G. Variation of joint thickness: 1/8 inch in 3 feet, non-cumulative.

3.15 POINTING AND CLEANING

- A. Enlarge voids and holes other than weep holes while tooling joints, and completely fill with mortar. Point-up joints, including adjacent work, to provide a neat, uniform appearance, prepared for application of sealants.
- B. After mortar is set and cured, remove large mortar particles by hand with wooden paddles and non-metallic scrape hoes or chisels. Clean concrete unit masonry to comply with masonry manufacturer's directions and applicable NCMA "Tek" bulletins. Do not use acid, metal scrapers, or abrasives to clean glazed units.

END OF SECTION

- A. Delivery and Storage: Stack lumber flat with spacers beneath and between each bundle to provide air circulation. Protect lumber from weather by covering with waterproof sheeting, securely anchored. Provide for air circulation around stacks and under coverings.
- B. DIMENSION LUMBER FRAMING: Construction or No. 2 grade and any of the following species:
 - Hem-fir (north); NLGA.
 - Mixed southern pine; SPIB
 - Northern species; NLGA.
- C. EQUIPMENT BACKING PANELS: Plywood at ¾" thickness min.

END OF SECTION

SUBMITTALS

- A. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.

COORDINATION

- A. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of Work specified in other Sections to ensure that interior architectural woodwork can be supported and installed as indicated.

FABRICATORS

- A. Available Fabricators: Subject to compliance with requirements, fabricators offering interior architectural woodwork that may be incorporated into the Work include, but are not limited to, the following:
 1. Pine Valley
 2. JMJ
 3. Malony
 4. Creative Surfaces

PLASTIC LAMINATE CABINETS

- A. Grade: Custom.
- B. Cabinet Construction: Flush overlay.
- C. Reveal Dimension: 1/4 inch.
- D. Materials
 - a. (PL1) Plastic Laminate: Color and Pattern: _____

CABINET HARDWARE AND ACCESSORIES

- A. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, 135 degrees of opening, self-closing.
- B. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.
 - a. All locations
- C. Catches: Magnetic catches, BHMA A156.9, B03141.
- D. Adjustable Shelves: Knape & Vogt, 82 series heavy-duty with 182 series heavy-duty designer brackets.
- E. Shelf Rests: BHMA A156.9, B04013; metal.
- F. Drawer Slides BHMA A156.9, B05091:
 - a. Box Drawer Slides: Grade 1; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
 - b. File Drawer Slides: Grade 1HD-100; for drawers more than 6 inches (150 mm) high or 24 inches (600 mm) wide.
- G. Door Locks: BHMA A156.11, E07121
 - a. All sink bases
- H. Grommets for Cable Passage through Countertops: 2-inch (51-mm) OD, molded-plastic grommets and matching plastic caps with slot for wire passage.

PLASTIC LAMINATE COUNTERTOPS

- A. Grade: Custom
- B. Materials:
 - a. (PL2) Plastic Laminate: Color and Pattern: _____

SOLID-SURFACING-MATERIAL

- A. Grade: Custom
- B. Solid-Surfacing-Material Thickness: 1/2 inch
- C. Install integral sink bowls in countertops in shop.
- D. Drill holes in countertops for plumbing fittings and soap dispensers in shop.
- E. Materials:
 - a. (SSM) Solid Surfacing Materials: Color and Pattern: _____
 - b. (SSW) Solid Surface Window Sills: Color and Pattern: _____

CLOSET AND UTILITY SHELVEING

- A. Grade: Economy
- B. Shelf Material: 3/4-inch (19-mm) thermo-set decorative panel with PVC or polyester edge banding.

COUNTERTOP BRACKET

- A. (BR1) 21x15 inches, by A & M Hardware, Inc. (or approved equal)
- B. (BR2) 12x8 inches, by A & M Hardware, Inc. (or approved equal)

INSTALLATION

- A. All countertops shall be sealed to adjacent surfaces with a bead of silicone
- B. Countertops shall be fully supported with base cabinets or a countertop bracket
- C. Countertop corners shall have a radius of a minimum of 1/8"

END OF SECTION

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. Manufactured Products:
 - a. Manufactured reglets and counterflashing.
- 2. Formed Products:
 - a. Formed roof drainage sheet metal fabrications.
 - b. Formed low-slope roof sheet metal fabrications.
 - c. Formed wall sheet metal fabrications.

B. Related Sections:

- 1. Division 06 Section "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
- 2. Division 07 Section "Metal Wall Panels" for installing sheet metal flashing and trim integral with roofing.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies as indicated 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. Fabricate and install roof edge flashing and copings capable of resisting the following forces according to recommendations in FMG Loss Prevention Data Sheet 1-49:
 - 1. Wind Zone 1: For velocity pressures of 10 to 20 lbf/sq. ft. (0.48 to 0.96 kPa): 40-lbf/sq. ft. (1.92-kPa) perimeter uplift force, 60-lbf/sq. ft. (2.87-kPa) corner uplift force, and 20-lbf/sq. ft. (0.96-kPa) outward force.
- C. Thermal Movements: Provide sheet metal flashing and trim that allows for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C)] material surfaces.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each manufactured product and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of sheet metal flashing and trim, including plans, elevations, expansion-joint locations, and keyed details. Distinguish between shop- and field-assembled work. Include the following:
 - 1. Identification of material, thickness, weight, and finish for each item and location in Project.
 - 2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.

3. Details for joining, supporting, and securing sheet metal flashing and trim, including layout of fasteners, cleats, clips, and other attachments. Include pattern of seams.
 4. Details of termination points and assemblies, including fixed points.
 5. Details of expansion joints and expansion-joint covers, including showing direction of expansion and contraction.
 6. Details of edge conditions, including eaves, ridges, valleys, rakes, crickets, and counterflashings as applicable.
 7. Details of special conditions.
- C. Samples for Initial Selection: For each type of sheet metal flashing, trim, and accessory indicated with factory-applied color finishes involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Sheet Metal Flashing: 12 inches (300 mm) long by actual width of unit, including finished seam and in required profile. Include fasteners, cleats, clips, closures, and other attachments.
 2. Trim, Metal Closures, Expansion Joints, Joint Intersections, and Miscellaneous Fabrications: 12 inches (300 mm) long and in required profile. Include fasteners and other exposed accessories.
 3. Accessories and Miscellaneous Materials: Full-size Sample.
 4. Anodized Aluminum Samples: Samples to show full range to be expected for each color required.
- E. Qualification Data: For qualified fabricator.
- F. Maintenance Data: For sheet metal flashing, trim, and accessories to include in maintenance manuals.
- G. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that 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. For copings and roof edge flashings that are **SPRI ES-1 tested** and **FM Approvals** approved, shop shall be listed as able to fabricate required details as tested and approved.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual" unless more stringent requirements are specified or shown on Drawings.
- C. Preinstallation Conference: Conduct conference at Project site.
1. Meet with Owner, Architect, Owner's insurer if applicable, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, unit skylights, and roof-mounted equipment.
 2. Review methods and procedures related to sheet metal flashing and trim.
 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 4. Review special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect sheet metal flashing.
 5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage. Store sheet metal flashing and trim materials away from uncured concrete and masonry.

- B. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to the extent necessary for the period of sheet metal flashing and trim installation.

1.7 WARRANTY

- A. Special Warranty on Finishes: Manufacturer's standard form in which 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. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCEREQUIREMENTS

- 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 SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. FM Approvals Listing: Manufacture and install copings and roof edge flashings that are listed in FM Approvals' "RoofNav" and approved for windstorm classification, Class 1-90. Identify materials with name of fabricator and design approved by FM Approvals.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 SHEET METALS

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying a strippable, temporary protective film before shipping.
- B. Metallic-Coated Steel Sheet: Restricted flatness steel sheet, metallic coated by the hot-dip process and pre-painted by the coil-coating process to comply with ASTM A 755/A 755M.
 - 1. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation; structural quality.
 - 2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40 (Class AZM150 coating designation, Grade 275); structural quality.
 - 3. Surface: Smooth, flat.
 - 4. Exposed Coil-Coated Finish:
 - a. Two-Coat Fluoropolymer: AAMA 621. 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.

- b. Mica Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish with suspended mica flakes 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.
 - c. FEVE Fluoropolymer: AAMA 621. Two-coat fluoropolymer finish containing 100 percent fluorinated ethylene vinyl ether resin in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
5. Color: Champagne Metallic or approved equal to matching metal wall panels.
 6. Concealed Finish: Pre-treat with 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 (0.013 mm).

2.3 UNDERLAYMENT MATERIALS

- A. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, non-perforated.
- B. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: ASTM D 1970; stable after testing at 240 deg F (116 deg C).
 2. Low-Temperature Flexibility: ASTM D 1970; passes after testing at minus 20 deg F (29 deg C).
 3. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Carlisle Coatings & Waterproofing Inc.; CCW WIP 300HT.
 - b. Grace Construction Products, a unit of W. R. Grace & Co.; Ultra.
 - c. Henry Company; Blueskin PE200 HT.
 - d. Metal-Fab Manufacturing, LLC; MetShield.
 - e. Owens Corning; WeatherLock Metal High Temperature Underlayment.
 - f. Prior approved equal.
- C. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation and 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.
 - 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. Fasteners for Zinc-Coated (Galvanized) or Aluminum-Zinc Alloy-Coated Steel Sheet: Hot-dip galvanized steel according to ASTM A 153/A 153M or ASTM F 2329 or Series 300 stainless steel.

- C. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
- D. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane polymer sealant; low modulus; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- E. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- F. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.5 MANUFACTURED SHEET METAL FLASHING AND TRIM

- A. Roof Edge Metal System: FM Global 1-90 approved system compliant with roofing assembly manufacturer.
 - 1. Basis-of-Design:
 - a. Style: Firestone, UNA-Edge CO and UNA-Edge GS or approved equal with roofing assembly.
 - b. Material: Galvanized steel 24 ga. minimum.
 - c. Fascia Bar Height: 4" minimum.
 - d. Lengths: 8' min to 12' max.
 - e. Color: Champagne Metallic
- B. Reglets: Units of type, material, and profile indicated, formed to provide secure interlocking of separate reglet and counterflashing pieces, and compatible with flashing indicated with interlocking counterflashing on exterior face, of same metal as reglet.
 - 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. Cheney Flashing Company.
 - b. Fry Reglet Corporation.
 - c. Heckmann Building Products Inc.
 - d. Hickman, W. P. Company.
 - e. Hohmann & Barnard, Inc.; STF Sawtooth Flashing.
 - f. Keystone Flashing Company, Inc.
 - g. National Sheet Metal Systems, Inc.
 - h. Sandell Manufacturing Company, Inc.
 - i. Prior Approved Equal.
 - 2. Material: Galvanized steel, 0.022 inch (0.56 mm) thick.
 - 3. Surface-Mounted Type: Provide with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 - 4. Masonry Type: Provide with offset top flange for embedment in masonry mortar joint.
 - 5. Accessories:
 - a. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where Drawings show reglet without metal counterflashing.
 - b. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.
 - 6. Finish: With manufacturer's standard color coating as selected by Architect.

2.6 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, geometry,

metal thickness, and other characteristics of item indicated. Fabricate items at the shop to greatest extent possible.

1. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
 2. Obtain field measurements for accurate fit before shop fabrication.
 3. Form sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces exposed to view.
- B. Fabrication Tolerances: Fabricate sheet metal flashing and trim that is capable of installation to a tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.
- C. Sealed Joints: Form non-expansion but movable joints in metal to accommodate elastomeric sealant.
- D. Expansion Provisions: Where lapped expansion provisions cannot be used, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with butyl sealant concealed within joints.
- E. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
- F. Fabricate cleats and attachment devices of sizes as recommended by SMACNA's "Architectural Sheet Metal Manual" for application, but not less than thickness of metal being secured.
- G. Seams: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with elastomeric sealant unless otherwise recommended by sealant manufacturer for intended use. Rivet joints where necessary for strength.
- H. Do not use graphite pencils to mark metal surfaces.

2.7 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 10-foot- (3-m-) 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, seal, and solder or weld watertight.
1. Coping Profile: As indicated on drawings.
 2. Joint Style: Butt, with 6-inch- (150-mm-) wide, exposed cover plates.
 3. Fabricate from the following materials:
 - a. Galvanized Steel: [0.040 inch (1.02 mm)] <Insert thickness> thick.
 - b. Aluminum-Zinc Alloy-Coated Steel: [0.040 inch (1.02 mm)] <Insert thickness> thick.
- B. Roof to Roof Edge Flashing (Gravel Stop) and Fascia Cap Transition Expansion-Joint Cover: Fabricate from the following materials:
1. Galvanized Steel: 0.034 inch (0.86 mm) thick.
 2. Aluminum-Zinc Alloy-Coated Steel: 0.034 inch (0.86 mm) thick.
- C. Base Flashing: Fabricate from the following materials:
1. Galvanized Steel: 0.028 inch (0.71 mm) thick.
 2. Aluminum-Zinc Alloy-Coated Steel: 0.028 inch (0.71 mm) thick.
- D. Counterflashing: Fabricate from the following materials:
- 1.
 2. Galvanized Steel: 0.022 inch (0.56 mm) thick.

3. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.

E. Flashing Receivers: Fabricate from the following materials:

1. Galvanized Steel: 0.022 inch (0.56 mm) thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.

2.8 WALL SHEET METAL FABRICATIONS

A. Opening Flashings in Frame Construction: Fabricate head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings. Form head and sill flashing with 2-inch- (50-mm-) high, end dams. Fabricate from the following materials:

1. Galvanized Steel: 0.022 inch (0.56 mm) thick.
2. Aluminum-Zinc Alloy-Coated Steel: 0.022 inch (0.56 mm) thick.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of the Work.

1. Verify compliance with requirements for installation tolerances of substrates.
2. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

B. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.

C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

A. General: Install underlayment as indicated on Drawings.

B. Polyethylene Sheet: Install polyethylene sheet with adhesive for anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped and taped joints of not less than 2 inches (50 mm).

C. Felt Underlayment: Install felt underlayment with adhesive for temporary anchorage to minimize use of mechanical fasteners under sheet metal flashing and trim. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

D. Self-Adhering Sheet Underlayment: Install self-adhering sheet underlayment, wrinkle free. Apply primer if required by underlayment manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation; use primer rather than nails for installing underlayment at low temperatures. Apply in shingle fashion to shed water, with end laps of not less than 6 inches (150 mm) staggered 24 inches (600 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.

3.3 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, solder, welding rods, 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 and levels indicated. Provide uniform, neat seams with minimum exposure of solder, 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 (300 mm) apart. Anchor each cleat with two fasteners. Bend tabs over fasteners.
 4. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
 5. Install sealant tape where indicated.
 6. Torch cutting of sheet metal flashing and trim is not permitted.
 7. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by SMACNA.
1. Coat back side of uncoated aluminum sheet metal flashing and trim with bituminous coating where flashing and trim will contact wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene sheet.
- C. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet (3 m) with no joints allowed within 24 inches (600 mm) of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with sealant concealed within joints.
- D. Fastener Sizes: Use fasteners of sizes that will penetrate wood sheathing not less than 1-1/4 inches (32 mm) for nails and not less than 3/4 inch (19 mm) for wood screws.
- E. Seal joints as shown and as required for watertight construction.
1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch (25 mm) into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F (4 deg C).
 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."
- F. Rivets: Rivet joints in uncoated aluminum where indicated and where necessary for strength.

3.4 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, set units true to line, and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.
- B. Roof Edge Metal Flashing System: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate at 16-inch (400-mm) centers.
- C. Copings: Anchor to resist uplift and outward forces according to recommendations in FMG Loss Prevention Data Sheet 1-49 for specified wind zone and as indicated.
1. Interlock exterior bottom edge of coping with continuous cleat anchored to substrate at 16-inch (400-mm) centers.

2. Anchor interior leg of coping with screw fasteners and washers at 24-inch (600-mm) centers.
- D. Pipe or Post Counterflashing: Install counterflashing umbrella with close-fitting collar with top edge flared for elastomeric sealant, extending a minimum of 4 inches (100 mm) 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 (100 mm) over base flashing. Lap counterflashing joints a minimum of 4 inches (100 mm) and bed with sealant. Secure in a waterproof manner by means of interlocking folded seam or blind rivets and sealant.
- 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.

3.5 WALL FLASHING INSTALLATION

- A. General: Install sheet metal wall flashing to intercept and exclude penetrating moisture according to SMACNA recommendations and as 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 Division 04 Section "Unit Masonry and Stone Masonry."
- C. Opening Flashings in Frame Construction: Install continuous head, sill, jamb, and similar flashings to extend 4 inches (100 mm) beyond wall openings.

3.6 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align sheet metal flashing and trim within installed tolerance of 1/4 inch in 20 feet (6 mm in 6 m) on slope and location lines as indicated and within 1/8-inch (3-mm) offset of adjoining faces and of alignment of matching profiles.

3.7 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. On completion of installation, remove unused materials and clean finished surfaces. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 076200

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. Modified bituminous sheet waterproofing.

- B. Related Sections:

- 1. Division 07 Section "Thermal Insulation" for foam-plastic board foundation insulation.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, and tested physical and performance properties of waterproofing.
- 2. Include manufacturer's written instructions for evaluating, preparing, and treating substrate.

- B. Samples: For each exposed product and for each color and texture specified, including the following products:

- 1. **8-by-8-inch** square of waterproofing and flashing sheet.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by waterproofing manufacturer.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Apply waterproofing within the range of ambient and substrate temperatures recommended by waterproofing manufacturer. Do not apply waterproofing to a damp or wet substrate.

- 1. Do not apply waterproofing in snow, rain, fog, or mist.

- B. Maintain adequate ventilation during preparation and application of waterproofing materials.

1.6 WARRANTY

- A. Manufacturer's Warranty: Manufacturer's standard materials-only warranty in which manufacturer agrees to furnish replacement waterproofing material for waterproofing that does not comply with requirements or that fails to remain watertight within specified warranty period.

- 1. Warranty Period: Five years from date of Substantial Completion.

- B. Installer's Special Warranty: Provide installation warranty signed by Installer, covering Work of this Section, for warranty period of two years.

- 1. Warranty includes removing and reinstalling protection board, drainage panels and insulation.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Source Limitations for Waterproofing System: Obtain waterproofing materials, protection course, and molded-sheet drainage panels from single source from single manufacturer.

2.2 MODIFIED BITUMINOUS SHEET WATERPROOFING

- A. Modified Bituminous Sheet: Minimum **60-mil** nominal thickness, self-adhering sheet consisting of **56 mils** of rubberized asphalt laminated on one side to a **4-mil-** thick, polyethylene-film reinforcement, and

with release liner on adhesive side; formulated for application with primer or surface conditioner that complies with VOC limits of authorities having jurisdiction.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. American Hydrotech, Inc.; VM75.
 - b. Carlisle Coatings & Waterproofing Inc.; CCW MiraDRI 860/861.
 - c. Grace, W. R., & Co. - Conn.; Bituthene 4000.
 - d. Meadows, W. R., Inc.; SealTight Mel-Rol.
2. Physical Properties:
 - a. Tensile Strength, Membrane: 250 psi minimum; ASTM D 412, Die C, modified.
 - b. Ultimate Elongation: 300 percent minimum; ASTM D 412, Die C, modified.
 - c. Low-Temperature Flexibility: Pass at minus 20 deg F ; ASTM D 1970.
 - d. Crack Cycling: Unaffected after 100 cycles of 1/8-inch movement; ASTM C 836.
 - e. Puncture Resistance: 40 lbf minimum; ASTM E 154.
 - f. Water Absorption: 0.2 percent weight-gain maximum after 48-hour immersion at 70 deg F ; ASTM D 570.
 - g. Water Vapor Permeance: 0.05 perms maximum; ASTM E 96/E 96M, Water Method.
 - h. Hydrostatic-Head Resistance: 200 feet minimum; ASTM D 5385.
3. Sheet Strips: Self-adhering, rubberized-asphalt strips of same material and thickness as sheet waterproofing.

2.3 AUXILIARY MATERIALS

- A. General: Furnish auxiliary materials recommended by waterproofing manufacturer for intended use and compatible with sheet waterproofing.
- B. Primer: Liquid waterborne primer recommended for substrate by sheet-waterproofing material manufacturer.
- C. Surface Conditioner: Liquid, waterborne surface conditioner recommended for substrate by sheet-waterproofing material manufacturer.
- D. Liquid Membrane: Elastomeric, two-component liquid, cold fluid applied, of trowel grade or low viscosity.
- E. Substrate Patching Membrane: Low-viscosity, two-component, modified asphalt coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the waterproofing.
 1. Verify that concrete has cured and aged for minimum time period recommended in writing by waterproofing manufacturer.
 2. Verify that substrate is visibly dry and within the moisture limits recommended in writing by manufacturer. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 3. Verify that compacted subgrade is dry, smooth, sound, and ready to receive waterproofing sheet.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrates according to manufacturer's written instructions. Provide clean, dust-free, and dry substrates for waterproofing application.
- B. Mask off adjoining surfaces not receiving waterproofing 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.
- E. Prepare, fill, prime, and treat joints and cracks in substrates. Remove dust and dirt from joints and cracks according to ASTM D 4258.
 - 1. Install sheet strips of width according to manufacturer's written instructions and center over treated construction and contraction joints and cracks exceeding a width of **1/16 inch**.
- F. Corners: Prepare, prime, and treat inside and outside corners according to ASTM D 6135.
 - 1. Install membrane strips centered over vertical inside corners. Install **3/4-inch** fillets of liquid membrane on horizontal inside corners and as follows:
 - a. At footing-to-wall intersections, extend liquid membrane in each direction from corner or install membrane strip centered over corner.
 - b. At plaza-deck-to-wall intersections, extend liquid membrane or sheet strips onto deck waterproofing and to finished height of sheet flashing.
- G. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through waterproofing and at drains and protrusions according to ASTM D 6135.

3.3 MODIFIED BITUMINOUS SHEET-WATERPROOFING APPLICATION

- A. Install modified bituminous sheets according to waterproofing manufacturer's written instructions and recommendations in ASTM D 6135.
- B. Apply primer to substrates at required rate and allow it to dry. Limit priming to areas that will be covered by sheet waterproofing in same day. Reprime areas exposed for more than 24 hours.
- C. Apply and firmly adhere sheets over area to receive waterproofing. Accurately align sheets and maintain uniform **2-1/2-inch-** minimum lap widths and end laps. Overlap and seal seams, and stagger end laps to ensure watertight installation.
 - 1. When ambient and substrate temperatures range between **25 and 40 deg F** , install self-adhering, modified bituminous sheets produced for low-temperature application. Do not use low-temperature sheets if ambient or substrate temperature is higher than **60 deg F** .
- D. Horizontal Application: Apply sheets from low to high points of decks to ensure that laps shed water.
- E. Apply continuous sheets over already-installed sheet strips, bridging substrate cracks, construction, and contraction joints.
- F. Seal edges of sheet-waterproofing terminations with mastic.
- G. Install sheet-waterproofing and auxiliary materials to tie into adjacent waterproofing.
- H. Repair tears, voids, and lapped seams in waterproofing not complying with requirements. Slit and flatten fishmouths and blisters. Patch with sheet waterproofing extending **6 inches** beyond repaired areas in all directions.
- I. Immediately install foam-plastic board foundation insulation/protection course with butted joints over waterproofing membrane.

3.4 FIELD QUALITY CONTROL

- A. Engage a site representative qualified by waterproofing membrane manufacturer to inspect substrate conditions, surface preparation, membrane application, flashings, protection, and drainage components, and to furnish reports to Architect.

3.5 PROTECTION, REPAIR, AND CLEANING

- A. Do not permit foot or vehicular traffic on unprotected membrane.
- B. Protect waterproofing from damage and wear during remainder of construction period.

- C. Protect installed board insulation from damage due to UV light, harmful weather exposures, physical abuse, and other causes. Provide temporary coverings where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.
- D. Correct deficiencies in or remove waterproofing that does not comply with requirements; repair substrates, reapply waterproofing, and repair sheet flashings.
- E. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 071326

Bold and italics are items revised, added or changed.

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. Foam-plastic board insulation.
2. Glass-fiber board insulation.
3. Mineral-wool board insulation.
4. Glass-fiber blanket insulation.
5. Mineral-wool blanket insulation.
- ~~6. Spray-applied cellulosic insulation.~~
7. Spray polyurethane foam insulation (*basis-of-design at exterior walls*).
8. Vapor retarders.

B. Related Sections:

1. Division 07 Section(s) "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing", and "Thermoplastic Polyolefin (TPO) Roofing" for insulation specified as part of roofing construction.
2. Division 07 Section "Fire-Resistive Joint Systems" for insulation installed as part of a perimeter fire-resistive joint system.
3. Division 09 Section(s) "Gypsum Board Shaft Wall Assemblies" for installation in wood- and metal-framed assemblies of insulation specified by referencing this Section.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.4 QUALITY ASSURANCE

- A. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.

PART 2 - PRODUCTS

2.1 FOAM-PLASTIC BOARD INSULATION

- A. Extruded-Polystyrene Board Insulation: ASTM C 578, of type and minimum compressive strength indicated below, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
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. DiversiFoam Products; Certifoam 40.
 - b. Dow Chemical Company (The); Perimate DI-A, Floormate 500-A.
 - c. Owens Corning; Foamular 400
 - d. Pactiv Building Products; GreenGuard XPS
 - e. Prior approved equal.
 2. Type VI, 40 psi (276 kPa).
- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.2 GLASS-FIBER BOARD INSULATION

- 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. CertainTeed Corporation.
 2. Johns Manville.
 3. Knauf Insulation.
 4. Owens Corning.
 5. Prior approved equal.
- A. Foil-Faced, Flexible Glass-Fiber Board Insulation (Cavity Wall –*Contractor's Option*) : ASTM C 612, Type IA or ASTM C 553, Types I, II, and III; faced on one side with foil-scrim-kraft vapor retarder; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84.
1. Nominal density of not less than 1.5 lb/cu. ft. (24 kg/cu. m) or more than 1.7 lb/cu. ft. (27 kg/cu. m), thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
- B. Sustainability Requirements: Provide glass-fiber board insulation as follows:
1. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

2.3 MINERAL-WOOL BOARD INSULATION

- 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. Fibrex Insulations Inc.
 2. Isolatek International.
 3. Owens Corning.
 4. Roxul Inc.
 5. Thermafiber.
 6. Prior approved equal.
- B. Unfaced, Mineral-Wool Board Insulation: ASTM C 612; with maximum flame-spread and smoke-developed indexes of 15 and zero, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.
1. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).
 2. Fiber Color: Darkened, where indicated.

- C. Foil-Faced, Mineral-Wool Board Insulation (*Spandrel*): ASTM C 612; faced on one side with foil-scrim or foil-scrim-polyethylene vapor retarder; with maximum flame-spread and smoke-developed indexes of 25 and 5, respectively, per ASTM E 84.

- 1. Nominal density of 4 lb/cu. ft. (64 kg/cu. m), Types IA and IB, thermal resistivity of 4 deg F x h x sq. ft./Btu x in. at 75 deg F (27.7 K x m/W at 24 deg C).

2.4 GLASS-FIBER BLANKET INSULATION

- 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. CertainTeed Corporation.
- 2. Guardian Building Products, Inc.
- 3. Johns Manville.
- 4. Knauf Insulation.
- 5. Owens Corning.
- 6. Prior approved equal.

- B. Unfaced, Glass-Fiber Blanket Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

- C. Sustainability Requirements: Provide glass-fiber blanket insulation as follows:

- 1. Free of Formaldehyde: Insulation manufactured with 100 percent acrylic binders and no formaldehyde.
- 2. Low Emitting: Insulation tested according to ASTM D 5116 and shown to emit less than 0.05-ppm formaldehyde.

2.5 SPRAY POLYURETHANE FOAM INSULATION (*Base Bid in Lieu of Foil Faced Flexible Board Insulation at Exterior Walls*)

- A. Closed-Cell Polyurethane Foam Insulation: ICC-ES Acceptance Criteria AC377, with maximum flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.

- 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. Demilec (USA), LLC, ph. (817) 640-4900.
 - b. Prior approved equal.
- 2. Product: Subject to compliance with requirements, provide the following:
 - a. Heatlok Soy 200 Spray-Applied Polyurethane Foam Insulation; 3.25" minimum to 3.4" maximum thickness.
 - b. Prior approved equal.
- 3. Minimum density of 2.0 lb/cu. ft. (32 kg/cu. m), thermal resistivity of 7.4 deg F x h x sq. ft./Btu x in. at 75 deg F (43 K x m/W at 24 deg C).

2.6 VAPOR RETARDERS (*Contractor's Option with Board Insulation Only*)

- A. Polyethylene Vapor Retarders: ASTM D 4397, 10 mils (0.25 mm) thick, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- C. Vapor-Retarder Fasteners: Pancake-head, self-tapping steel drill screws; with fender washers.

- D. Single-Component Nonsag Urethane Sealant: ASTM C 920, Type I, Grade NS, Class 25, Use NT related to exposure, and Use O related to vapor-barrier-related substrates.
- E. Adhesive for Vapor Retarders: Product recommended by vapor-retarder manufacturer and has demonstrated capability to bond vapor retarders securely to substrates indicated.

2.7 INSULATION FASTENERS

- A. Adhesively Attached, Angle-Shaped, Spindle-Type Anchors: Angle welded to projecting spindle; capable of holding insulation of specified thickness securely in position indicated with self-locking washer in place.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Gemco; 90-Degree Insulation Hangers.
 - b. Prior approved equal.
 - 2. Angle: Formed from 0.030-inch- (0.762-mm-) thick, perforated, galvanized carbon-steel sheet with each leg 2 inches (50 mm) square.
 - 3. Spindle: Copper-coated, low-carbon steel; fully annealed; 0.105 inch (2.67 mm) in diameter; length to suit depth of insulation indicated.
- B. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGM Industries, Inc.; TACTOO Adhesive.
 - b. Gemco; Tuff Bond Hanger Adhesive.
 - c. Prior approved equal.
- C. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick galvanized-steel sheet, with beveled edge for increased stiffness, sized as required to hold insulation securely in place, but not less than 1-1/2 inches (38 mm) square or in diameter.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGM Industries, Inc.; RC150.
 - b. Gemco; Dome-Cap or R-150.
 - c. Prior approved equal.
 - 2. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in the following locations:
 - a. Ceiling plenums.
- D. Insulation Standoff: Spacer fabricated from galvanized mild-steel sheet for fitting over spindle of insulation anchor to maintain air space of 1 inch (25 mm) between face of insulation and substrate to which anchor is attached.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Gemco; Clutch Clip.
 - b. Prior approved equal.
- E. Anchor Adhesive: Product with demonstrated capability to bond insulation anchors securely to substrates indicated without damaging insulation, fasteners, and substrates.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:

- a. AGM Industries, Inc.; TACTOO Adhesive.
- b. Gemco; Tuff Bond Hanger Adhesive.
- c. Prior approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or vapor retarders, including removing projections capable of puncturing vapor retarders, or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

E. Provide spray-applied polyurethane foam insulation as basis-of-design at precast concrete exterior walls. It is a "Contractor's Option" to utilize foil faced fiberglass flexible board insulation, stand offs, vapor barrier, etc.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

- A. On vertical footing and foundation wall surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 1. If not otherwise indicated, extend insulation a minimum of 48 inches below exterior grade line unless indicated otherwise.
- B. On horizontal surfaces under slabs, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units.
 1. If not otherwise indicated, extend insulation a minimum of 24 inches (610 mm) in from exterior walls.
 2. Install below slab on-grade at all locations where radiant in-floor heating is indicated.

3.4 INSTALLATION OF CAVITY-WALL INSULATION

- A. ***Spray-Applied Polyurethane Foam Insulation: Install in accordance with manufacturer's published installation instructions, applicable codes, and ICC-ES reports with an approved installer. Maximum thickness 3.4 inches with a minimum average thickness of not less than 3.0 inches (R=22.2). Do not apply insulation until installation of windows, misc. exterior opening, pipes, ducts, conduits, wiring, and electrical outlets in walls is complete.***
 1. ***Approved Installer: Ymker Insulation, Contact –Ed Ymker, Sioux City, IA, ph. (702) 395-0668***
- B. Foam-Plastic Board Insulation (***Contractor's Option***): Install pads of adhesive spaced approximately 24 inches (610 mm) o.c. both ways on inside face, and as recommended by manufacturer. Fit courses of insulation between wall ties and other obstructions, with edges butted tightly in both directions. Press units firmly against inside substrates.

1. Supplement adhesive attachment of insulation by securing boards with two-piece wall ties designed for this purpose and specified in Division 04 Section "Unit Masonry."

3.5 INSTALLATION OF INSULATION FOR FRAMED CONSTRUCTION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units.
- B. Foam-Plastic Board Insulation: Seal joints between units by applying adhesive, mastic, or sealant to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation with adhesive, mastic, or sealant as recommended by insulation manufacturer.
- C. Glass-Fiber or Mineral-Wool Blanket Insulation: Install in cavities formed by framing members according to the following requirements:
 1. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 2. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 3. Maintain 3-inch (76-mm) clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 4. For metal-framed wall cavities where cavity heights exceed 96 inches (2438 mm), support unfaced blankets mechanically and support faced blankets by taping flanges of insulation to flanges of metal studs.
 5. Vapor-Retarder-Faced Blankets: Tape joints and ruptures in vapor-retarder facings, and seal each continuous area of insulation to ensure airtight installation.
 - a. Exterior Walls: Set units with facing placed toward interior of construction or as indicated on Drawings.
- D. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 1. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.

3.6 INSTALLATION OF INSULATION IN CEILINGS FOR SOUND ATTENUATION

- A. Where glass-fiber blankets are indicated for sound attenuation above ceilings, install blanket insulation over entire ceiling area in thicknesses indicated. Extend insulation 48 inches (1219 mm) up either side of partitions.

3.7 INSTALLATION OF INSULATION FOR CONCRETE SUBSTRATES

- A. Install board insulation on concrete substrates by adhesively attached, spindle-type insulation anchors as follows:
 1. Fasten insulation anchors to concrete substrates with insulation anchor adhesive according to anchor manufacturer's written instructions. Space anchors according to insulation manufacturer's written instructions for insulation type, thickness, and application indicated.
 2. Apply insulation standoffs to each spindle to create cavity width indicated between concrete substrate and insulation.
 3. After adhesive has dried, install board insulation by pressing insulation into position over spindles and securing it tightly in place with insulation-retaining washers, taking care not to compress insulation below indicated thickness.
 4. Where insulation will not be covered by other building materials, apply capped washers to tips of spindles.

3.8 INSTALLATION OF CURTAIN-WALL INSULATION

- A. Install board insulation in curtain-wall construction where indicated on Drawings according to curtain-wall manufacturer's written instructions.
 - 1. Hold insulation in place by securing metal clips and straps or integral pockets within window frames, spaced at intervals recommended in writing by insulation manufacturer to hold insulation securely in place without touching spandrel glass. Maintain cavity width of dimension indicated between insulation and glass.
 - 2. Install insulation where it contacts perimeter fire-containment system to prevent insulation from bowing under pressure from perimeter fire-containment system.

3.9 INSTALLATION OF VAPOR RETARDERS (*Contractor's Option with Fiberglass Insulation*)

- A. Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
- B. Seal vertical joints in vapor retarders over framing by lapping no fewer than two studs.
 - 1. Before installing vapor retarders, apply urethane sealant to flanges of metal framing including runner tracks, metal studs, and framing around door and window openings. Seal overlapping joints in vapor retarders with vapor-retarder tape according to vapor-retarder manufacturer's written instructions. Seal butt joints with vapor-retarder tape. Locate all joints over framing members or other solid substrates.
 - 2. Firmly attach vapor retarders to metal framing and solid substrates with vapor-retarder fasteners as recommended by vapor-retarder manufacturer.
- C. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- D. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.

3.10 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

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. Adhered thermoplastic polyolefin (TPO) roofing system.
2. Vapor retarder.
3. Roof insulation.

- B. Section includes the installation of insulation strips in ribs of roof deck. Insulation strips are furnished under Section 053100 "Steel Decking."

C. Related Requirements:

1. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking; and for wood-based, structural-use roof deck panels.
2. Section 072100 "Thermal Insulation" for insulation beneath the roof deck.
3. Section 076200 "Sheet Metal Flashing and Trim" for metal roof edge system, flashings and counterflashings.
4. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
5. Storm Drainage Piping Specialties for roof drains – see plan sheets.

1.3 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.

1.4 PREINSTALLATION MEETINGS

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

1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 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, including:

1. Base flashings and membrane terminations.
2. Tapered insulation, including slopes.
3. Roof plan showing orientation of steel roof deck and orientation of roofing, fastening spacings, and patterns for mechanically fastened roofing.
4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer that is **UL and FM Global approved** listed for roofing system identical to that used for this Project.
- B. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.9 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 1. Special warranty includes roofing, base flashings, roof insulation, fasteners, cover boards, roofing accessories, and other components of roofing system.
 2. Warranty Period: 15 years from date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roofing, base flashing, roof insulation, fasteners, cover boards, substrate boards, vapor retarders, roof pavers, and walkway products, for the following warranty period:
 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
1. Carlisle SynTec Incorporated.
 2. Cooley Engineered Membranes.
 3. Custom Seal Roofing.
 4. Firestone Building Products.
 5. Flex Roofing Systems.
 6. GAF Materials Corporation.
 7. GenFlex Roofing Systems.
 8. Johns Manville.
 9. Mule-Hide Products Co., Inc.
 10. Versico Incorporated.
 11. Prior approved equal.
- B. Source Limitations: Obtain roofing components including for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
 2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- C. FM Global Listing: Roofing, base flashings, and component materials shall comply with requirements in FM Global 4450 or FM Global 4470 as part of a built-up roofing system, and shall be listed in FM Global's "RoofNav" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
1. Fire/Windstorm Classification: Class 1A-90.
 2. Hail-Resistance Rating: MH.
- 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.

2.3 TPO ROOFING

- A. Fabric-Reinforced TPO Sheet: ASTM D 6878, internally fabric- or scrim-reinforced, uniform, flexible fabric-backed TPO sheet.
1. Thickness: 60 mils (1.5 mm) nominal.
 2. Exposed Face Color: White.

2.4 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.

1. Liquid-type auxiliary materials shall comply with VOC limits of authorities having jurisdiction.
2. Adhesives and sealants that are not on the exterior side of weather barrier shall comply with the following limits for VOC content:
 - a. Plastic Foam Adhesives: 50 g/L.
 - b. Gypsum Board and Panel Adhesives: 50 g/L.
 - c. Multipurpose Construction Adhesives: 70 g/L.
 - d. Fiberglass Adhesives: 80 g/L.
 - e. Single-Ply Roof Membrane Adhesives: 250 g/L.
 - f. Single-Ply Roof Membrane Sealants: 450 g/L.
 - g. Nonmembrane Roof Sealants: 300 g/L.
 - h. Sealant Primers for Nonporous Substrates: 250 g/L.
 - i. Sealant Primers for Porous Substrates: 775 g/L.
 - j. Other Adhesives and Sealants: 250 g/L.
- B. Sheet Flashing: Manufacturer's standard unreinforced TPO sheet flashing, 55 mils (1.4 mm) thick, minimum, of same color as TPO sheet.
- C. Bonding Adhesive: Manufacturer's standard, water based.
- D. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch (25 by 3 mm) thick; with anchors.
- E. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roofing to substrate, and acceptable to roofing system manufacturer.
- 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 other accessories.

2.5 VAPOR RETARDER

- A. Polyethylene Film: ASTM D 4397, 6 mils (0.15 mm) thick, minimum, with maximum permeance rating of 0.13 perm (7.5 ng/Pa x s x sq. m).
 1. Adhesive: Manufacturer's standard lap adhesive, FM Global approved for vapor-retarder application.

2.6 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by TPO roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated and that produce FM Global-approved roof insulation.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2 felt or glass-fiber mat facer on both major surfaces.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches (1:48) unless otherwise indicated.
- D. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.7 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.

- C. Insulation Adhesive: Insulation manufacturer's recommended adhesive formulated to attach roof insulation to substrate or to another insulation layer as follows:
 - 1. Modified asphaltic, asbestos-free, cold-applied adhesive.
 - 2. Bead-applied, low-rise, one-component or multicomponent urethane adhesive.
 - 3. Full-spread spray-applied, low-rise, two-component urethane adhesive.
- D. Cover Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate, 1/2 inch (13 mm) thick
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. CertainTeed Corporation; GlasRoc Sheathing, GlasRoc Sheathing Type X.
 - b. Georgia-Pacific Corporation; Dens Deck, Dens Deck DuraGuard, Dens Deck Prime.
 - c. National Gypsum Company; Gold Bond eXP Extended Exposure Sheathing.
 - d. Temple-Inland, Inc; GreenGlass Exterior Sheathing.
 - e. USG Corporation; Securock Glass Mat Roof Board.
 - f. Prior approved equal.
- E. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

2.8 WALKWAYS

- A. Flexible Walkways: Factory-formed, nonporous, heavy-duty, slip-resisting, surface-textured walkway rolls, approximately 3/16 inch (5 mm) thick and acceptable to roofing system manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
 - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
 - 4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
 - 5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Install insulation strips according to acoustical roof deck manufacturer's written instructions.

3.3 VAPOR-RETARDER INSTALLATION

- A. Polyethylene Film: Loosely lay polyethylene-film vapor retarder in a single layer over area to receive vapor retarder, side and end lapping each sheet a minimum of 2 inches (50 mm) and 6 inches (150 mm), respectively. Continuously seal side and end laps with adhesive.
- B. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

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 and insulation manufacturer's written instructions for installing roof insulation.
- C. Install tapered insulation under area of roofing to conform to slopes indicated.
- D. Install insulation under area of roofing to achieve required thickness. Where overall insulation thickness is 2.7 inches (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.
 - 1. Where installing composite and noncomposite insulation in two or more layers, install noncomposite board insulation for bottom layer and intermediate layers, if applicable, and install composite board insulation for top layer.
- E. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- F. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch (6 mm) with insulation.
 - 1. Cut and fit insulation within 1/4 inch (6 mm) of nailers, projections, and penetrations.
- G. 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 in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
 - 2. Fasten insulation to resist uplift pressure at corners, perimeter, and field of roof.
- H. Install cover boards 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 (150 mm) in each direction. Loosely butt cover boards together and fasten to roof deck.
 - 1. Fasten cover boards according to requirements in FM Global's "RoofNav" for specified Windstorm Resistance Classification.
 - 2. Fasten cover boards to resist uplift pressure at corners, perimeter, and field of roof.

3.5 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.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- C. Accurately align roofing, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.

- D. 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.
- E. In addition to adhering, mechanically fasten roofing securely at terminations, penetrations, and perimeter of roofing.
- F. Apply roofing with side laps shingled with slope of roof deck where possible.
- G. 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.
- H. Spread sealant bed over deck-drain flange at roof drains, and securely seal roofing in place with clamping ring.

3.6 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.

3.7 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.

3.8 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion.
- B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.9 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.

3.10 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: <Insert name of Owner>.
2. Address: <Insert address>.
3. Building Name/Type: <Insert information>.
4. Address: <Insert address>.
5. Area of Work: <Insert information>.
6. Acceptance Date: _____.
7. Warranty Period: <Insert time>.
8. Expiration Date: _____.

- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,

- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.

- D. This Warranty is made subject to the following terms and conditions:

1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding **72 mph (m/sec)**>;
 - c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of roofing; and
 - g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded

basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.

6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____,

1. Authorized Signature: _____
2. Name: _____
3. Title: _____

END OF SECTION 075423

SECTION 077200 - ROOF 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. Roof hatches.
- B. Related Sections:
 - 1. Section 055000 "Metal Fabrications" for metal vertical ladders, ships' ladders, and stairs for access to roof hatches.
 - 2. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, roof expansion-joint covers, and miscellaneous sheet metal trim and accessories.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Shop Drawings: For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- C. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Roof plans, drawn to scale, and coordinating penetrations and roof-mounted items. Show the following:
 - 1. Size and location of roof accessories specified in this Section.
 - 2. Method of attaching roof accessories to roof or building structure.
 - 3. Other roof-mounted items including mechanical and electrical equipment, ductwork, piping, and conduit.
 - 4. Required clearances.
- B. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For roof accessories to include in operation and maintenance manuals.

1.7 COORDINATION

- A. Coordinate layout and installation of roof accessories with interfacing and adjoining construction to provide a leakproof, weathertight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.8 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation and mill phosphatized for field painting where indicated.
 - 1. Mill-Phosphatized Finish: Manufacturer's standard for field painting.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
 - 1. Mill Finish: As manufactured.
- C. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.
- E. Steel Tube: ASTM A 500, round tube.
- F. Galvanized-Steel Tube: ASTM A 500, round tube, hot-dip galvanized according to ASTM A 123/A 123M.
- G. Steel Pipe: ASTM A 53/A 53M, galvanized.

2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, thickness as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Underlayment:
 - 1. Felt: ASTM D 226, Type II (No. 30), asphalt-saturated organic felt, nonperforated.

2. Polyethylene Sheet: 6-mil- (0.15-mm-) thick polyethylene sheet complying with ASTM D 4397.
 3. Slip Sheet: Building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum, rosin sized.
- F. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened.
1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 3. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- G. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- H. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane, silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- I. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- J. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 ROOF HATCH

- A. Roof Hatches: Metal roof-hatch units with lids and insulated single walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, integral metal cant, thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
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. AES Industries, Inc.
 - b. Babcock-Davis.
 - c. Bilco Company (The).
 - d. Bristolite Skylights.
 - e. Custom Solution Roof and Metal Products.
 - f. Dur-Red Products.
 - g. Hi Pro International, Inc.
 - h. J. L. Industries, Inc.
 - i. Metallic Products Corp.
 - j. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
 - k. Naturalite Skylight Systems; Vistawall Group (The).
 - l. Nystrom.
 - m. O'Keeffe's Inc.
 - n. Pate Company (The).
 - o. Precision Ladders, LLC.
 - p. prior approved equal.
- B. Type and Size: Single-leaf lid, 30 by 60 inches (750 by 1524 mm) .
- C. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.
- D. Hatch Material: Aluminum sheet, 0.090 inch (2.28 mm) thick.
1. Finish: Mill Finish: As manufactured

E. Hardware Stainless-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.

1. Provide two-point latch on lids larger than 84 inches (2130 mm).
2. Provide remote-control operation.

2.4 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.
1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Underlayment: Where installing roof accessories directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet, or install a course of polyethylene sheet.
 3. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Roof-Hatch Installation:
1. Install roof hatch so top surface of hatch curb is level.
 2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 3. Attach safety railing system to roof-hatch curb.
 4. Attach ladder-assist post according to manufacturer's written instructions.

3.3 REPAIR AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing according to ASTM A 780.

- B. Touch up factory-primed surfaces with compatible primer ready for field painting according to Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."
- C. Clean exposed surfaces according to manufacturer's written instructions.
- D. Clean off excess sealants.
- E. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 07-8400 - FIRESTOPPING**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Firestop sealers.
- B. Fire safing insulation.

1.02 SYSTEM DESCRIPTION

- A. Each firestop system to seal holes and voids in fire rated construction.
- B. Each system to be listed in by UL or Warnock Hersey, and tested per ASTM E814, with hourly rating equal to the assembly being penetrated.
- C. The installed product shall be stable, unaffected by freezing, humidity, or water.
- D. The installed system shall be easily re-entered and repaired without special tools.

1.03 SUBMITTALS

- A. Manufacturer's Product Data for each material used.
- B. Evidence of manufacturer's training and approval of installer.
- C. Schedule of firestop conditions, specific UL or Warnock Hersey listing, and other code acceptance information for each condition and assembly. Submit within 10 days after Notice to Proceed or award of Contract, whichever is earlier.
- D. Shop Drawings for each combination of wall construction and penetration. For each condition, indicate:
 - 1. Material, shape, and movement of penetrating object.
 - 2. Materials in assembly being penetrated.
 - 3. Type and quantity of firestop materials and accessories.
 - 4. UL system number in current edition of Fire Resistance Directory.
- E. Sample of labels.

1.04 QUALITY ASSURANCE

- A. The installer shall have received training from the product manufacturer, and be approved in writing by the manufacturer.
- B. Provide a mock-up of each assembly. Each mock-up to be accepted by the building code official. Accepted assemblies shall be the standard for remaining assemblies of the same type.

- C. Systems for top-of-wall joints and other moving joints to be listed for dynamic joints with movement capabilities to match joint movement.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Labels shall state name of manufacturer, product description, and UL listing.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Acceptable manufacturers:
 1. 3M, St. Paul, MN.
 2. Hilti, Inc., Tulsa, OK.
 3. Nelson Firestop Products, Tulsa, OK.
 4. Rectorseal, Houston, TX.
 5. Specified Technologies, Somerville, NJ.
 6. Tremco, Beachwood, OH.
 7. W. R. Grace & Co., Columbia, MD.
 8. Other as approved.

2.02 FIRESTOP

- A. Materials: Caulk, spray, pipe wrap, composite sheet, restricting collar, galvanized steel sleeve, moldable putty, foam, mineral wool, and backing as required for each condition by UL listed design.

2.03 FIRE SAFING INSULATION AND ACCESSORIES

- A. Safing insulation: Semi-rigid boards designed for use as fire safing, ASTM C612, Classes 1 and 2; nominal density 4.0 pcf; passing ASTM E136 for combustion characteristics; R value 4.0 at 75 degrees F.
- B. Caulk: Recommended by safing insulation manufacturer for sealing joint between safing insulation and edge of floor slab.
- C. Safing clips: Galvanized steel, approved by safing insulation manufacturer.
- D. Labels: Durable, 5 inches by 3 inches, with the words "Firestop System - Do Not Disturb", and identification of the manufacturer, system design number, installer, and date of installation, in non-fading, waterproof ink.

PART 3 - EXECUTION**3.01 INSTALLATION**

- A. Install materials according to manufacturer's installation instructions for specific conditions of use and UL listing.

- B. Where penetration is through construction that contains voids, including metal framed assemblies and hollow concrete masonry units, install firestop on both sides of assembly.
- C. Install safing at openings between edge of slab and exterior wall panels.

- D. Remove excess material from exposed surfaces.
- E. Provide labels for each firestop assembly.

END OF SECTION

SECTION 07-9200 - JOINT SEALANTS**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Joint sealant, cleaners, primers, bond breakers, and backers.

1.02 RELATED WORK

- A. Section 07-9201 - Joint Sealant Schedule.
- B. Section 08-4003 - Aluminum Entrance, Windows, and Curtain Wall: Glazing sealants.

1.03 SUBMITTALS

- A. Manufacturer's Product Data, including performance test data sheets for each product.
- B. Manufacturer's compatibility and adhesion test reports for each combination of sealant and substrate.
- C. Full range of color Samples for each exposed product for selection by the Architect.

1.04 QUALITY ASSURANCE

- A. Failure to maintain airtight and watertight seals within limitations of wear and aging shall be recognized as failure of materials or installation.
- B. If requested, submit substrate materials to sealant manufacturer for laboratory testing of adhesion and compatibility with secondary seals. Testing shall not be required if joint sealant manufacturer submits acceptable test results based on previous testing of same joint sealant, substrate, and condition of use found in this Work.

1.05 PRECONSTRUCTION FIELD-ADHESION TESTING AND MOCKUPS, EXTERIOR JOINTS

- A. Notify the Architect 7 days in advance of times when test joints will be installed.
- B. Conduct tests in the presence of the Architect and the joint sealant manufacturer's technical representative.
- C. Before installing exterior sealants, field-test each combination of exterior sealant and substrate for adhesion.
 - 1. Install joint sealants in 72 inches long joints using same materials and methods specified. Allow sealants to cure fully before testing, 14 days minimum.
 - 2. Make knife cuts from one side of joint to the other, followed by 2 cuts approximately 2 inches long at sides of joint and meeting

cross cut at one end. Place a mark 1 inch from cross-cut end of piece.

- 3. Use fingers to grasp 2 inch piece of sealant between cross-cut end and 1 inch mark; pull firmly at a 90 degree angle or more in direction of side cuts while holding a ruler along side of sealant. Pull sealant out of joint to the distance recommended by sealant manufacturer for testing adhesive capability, but not less than maximum movement capability in extension; hold this position for 10 seconds.
- 4. For joints with dissimilar substrates, check adhesion to each substrate separately. Do this by extending cut along one side, checking adhesion to opposite side, and then repeating this procedure for opposite side.
- D. Note whether sealant in joint connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include pull distance used to test each type of product and joint substrate. For sealants that fail adhesively, follow manufacturer's recommended procedures to improve performance, and retest.
- E. Evaluation of field-adhesion test results: Sealants not exhibiting adhesive failure from testing shall be considered satisfactory, subject to compliance with Specifications. Do not use sealants that fail to adhere to joint substrates during testing.
- F. In addition to field testing, the Architect will also review installed sealant for aesthetic effects and final approval of sealant color.

1.06 PRECONSTRUCTION STAIN TESTING

- A. Perform stain testing of natural stone, masonry, and other porous substrates indicated to be used in the Work. Obtain actual samples of materials proposed for use and test to determine if permanent discoloration of porous surfaces will occur from direct contact with sealants. Perform stain testing in conformance with ASTM C1248 and as follows:
 - 1. Notify the Architect 5 days before beginning test.
 - 2. Arrange for manufacturer's field technical representative to be present during examination of test results.
 - 3. Cut substrate to provide flat surface for application of sealant.
 - 4. Separate substrate materials by removable shims to create 1/2 by 1/2 by 3 inches joint.
 - 5. Fill joint with sealant, tool, and allow to cure for 21 days at room temperature.

6. After curing, remove shims, compress joint to 1/4 inch width, and place in an oven at 158 degrees F for 14 days.
7. Remove sample and allow to cool to room temperature.
8. Examine sample to determine presence of discoloration or change in appearance in any way to exposed surfaces.
9. After visual inspection, cut sample in half to determine presence of discoloration or change in appearance in any way into the sample itself at the adhesive bond line and presence of bleeding into the area around the adhesive bond line.
10. Record results in stain test log.
11. Do not install sealants that show evidence of staining substrates.

1.07 DELIVERY AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with factory labels stating manufacturer, product name and designation, color, expiration times for unopened shelf life, pot life, curing time, and mixing instructions.

1.08 WARRANTY

- A. Furnish manufacturer's 20-year non-staining warranty for sealants in contact with stone or other porous materials. Submit samples as required by manufacturer, and comply with manufacturer's instructions and details required for warranty.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Acceptable manufacturers:
 1. Bostik Findley, Inc., Middleton, MA.
 2. Dow Corning Corp., Midland, MI.
 3. General Electric, Cleveland, OH.
 4. Mameco International, Inc. Tremco, Beachwood, OH.
 5. Sika Corporation, Lyndhurst, NJ.
 6. Sonneborn, Degussa Building Systems, Shakopee, MN.
 7. Tremco, Inc. Sealant/Weatherproofing Division, Beachwood, OH.
 8. Other as approved.

2.02 SEALANT

- A. Performance: Non-staining, non-shrinking, non-drying, non-migrating, permanently elastic; recommended by sealant manufacturer for

conditions of service, based on field experience and laboratory testing. Where given choice of 1 part or 2 part product, use the one with optimum performance for conditions of use.

- B. Compatibility: Listed or recommended by manufacturer for substrate and conditions of use.
- C. Color: As selected.
- D. SNT-1: ASTM C834, 1 part acrylic-latex; mildew resistant, paintable; recommended for exposed interior applications with joint movement of plus or minus 7.5 percent. Foam sealants are not acceptable.
- E. SNT-2: ASTM C920, Type S, Grade NS, Class 25, air-curing, mildew resistant silicone rubber.
- F. SNT-3: ASTM C920, Type S or M, Grade NS, Class 50, silicone. Non-staining to stone per ASTM C1248.
 1. Dow Corning 756 SMS Silicone Building Sealant.
 2. GE Silpruf NB SCS9000.
 3. Tremco Spectrem 3 Construction Grade Silicone Sealant.
- G. SNT-4: ASTM C920, Type S or M, Grade NS, Class 25, silicone.
- H. SNT-5: ASTM C920, Type S, Grade NS, Class 50, silicone.
- I. SNT-6: ASTM C920, Type S or M, Grade P, Class 25, polyurethane, rated for traffic.
- J. SNT-7: ASTM C920, Type S or M, Grade P, Class 25, polyurethane.

2.03 JOINT SEALANT BACKING

- A. General: Preformed, compressible, gas and water non-absorbent, non-extruding, low compression set. Size, shape, and density as recommended by manufacturer to control sealant depth and provide optimum sealant performance.
- B. Backer rod:
 1. Vertical joints: Non-outgassing polyurethane or polyolefin foam. ASTM C1330, Type B or Type O.
 - a. Backer Rod Mfg. Co. "Denver Foam".
 - b. Nomaco "Sof Rod".
 - c. Other as approved.
 2. Horizontal joints: Closed cell polyethylene foam. ASTM C1330, Type C.

2.04 PRECOMPRESSED JOINT FILLER

- A. Precompressed joint seal: Open-cell, high density, polyurethane foam, impregnated with water-based, stabilized, acrylics crosslinked ethylene vinyl acetate (EVA).
- B. Prefinished joint seal: Open-cell, high density, polyurethane foam, impregnated with water-based, stabilized, acrylics crosslinked ethylene vinyl acetate (EVA), with integral silicone face. Color as selected.
- C. Depth: As recommended by manufacturer for conditions of use.
- D. Exposed exterior walls: Emseal "Colorseal", color as selected.
- E. Concealed exterior walls: Emseal "25V".

2.05 MISCELLANEOUS

- A. Cleaners, primers, bond breakers, masking tape: Recommended by sealant manufacturer for conditions of use.

PART 3 - EXECUTION**3.01 PREPARATION**

- A. Clean joints immediately before beginning installation. Joint surfaces to be sound, smooth, clean, dry, and free of contaminants.
- B. Prime joint surfaces using primer recommended by sealant manufacturer for substrate. Confine primer to areas of joint sealer bond. Exception: Do not prime surfaces when manufacturer's adhesion tests indicate better bond is achieved without primer.
- C. Do not use materials stored beyond recommended shelf life, or materials that have been opened or mixed beyond manufacturer's recommended period of use.

3.02 INSTALLATION

- A. Install when temperatures are in lower third of range recommended by manufacturer when possible.
- B. Install joint fillers to support joint sealant with cross-sections and locations that will produce optimum performance of the completed joint. Do not twist, tear, stretch, or puncture joint fillers, or leave gaps at ends of pieces. Use only dry materials.
- C. Apply bond breaker tape to prevent 3-sided bonding.
- D. Install joint sealant in a uniform, continuous ribbon, without gaps or air pockets, completely wetting joint surfaces. Cross section and depth to be as

recommended by manufacturer to provide optimum performance.

- E. Tool non-sag sealants immediately after installation to form smooth, continuous, slightly concave surface. Do not use tooling agents that discolor sealants or adjacent surfaces, or that are not approved by sealant manufacturer. Do not feather-edge sealant.

3.03 FIELD QUALITY CONTROL, EXTERIOR JOINTS

- A. Field-test joint sealant adhesion to joint surfaces in exterior substrates in the presence of the Architect.
- B. Perform 1 test for each 1,000 feet of joint length of each type, using method described in this Section under Preconstruction Adhesion Testing. Perform minimum 1 test per floor, per elevation, for each type of joint sealant.
- C. Inspect joints for complete fill, absence of voids, and joint configuration. Record results in a field adhesion test log. Indicate compliance or non-compliance.
- D. Inspect tested joints and report the following:
 1. Whether sealants in joints connected to pulled-out portion failed to adhere to joint substrates or tore cohesively. Include data on pull distance used to test each type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field- adhesion hand-pull test criteria.
 2. Whether sealants filled joint cavities and are free from voids.
 3. Whether sealant dimensions and configurations comply with specified requirements.
- E. Record test results in a field adhesion test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
- F. Repair sealants pulled from test area by applying new sealants following same procedures used to originally seal joints. Ensure that original sealant surfaces are clean and new sealant contacts original sealant.
- G. Sealants not exhibiting adhesive failure from testing, or noncompliance with other indicated requirements, shall be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other

requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.04 PROTECTION AND CLEANING

- A. Cut out and remove joints that are damaged at time of Substantial Completion, and replace with new

materials to produce repairs indistinguishable from original work.

- B. Clean adjacent surfaces of excess sealant as work progresses.

END OF SECTION

QUALITY ASSURANCE

- A. Source Limitations: Obtain hollow metal work from single source from single manufacturer.
- B. Fire-Rated, Borrowed-Light Frame 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.

PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

MANUFACTURERS

- A. 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. Amweld Building Products, LLC.
 - b. Benchmark; a division of Therma-Tru Corporation.
 - c. Ceco Door Products; an Assa Abloy Group company.
 - d. Curries Company; an Assa Abloy Group company.
 - e. Steelcraft; an Ingersoll-Rand company.
 - f. Prior approved equal.

STANDARD HOLLOW METAL FRAMES

- A. Exterior Frames: Fabricated from metallic-coated steel sheet.
 - a. Fabricate frames with mitered or coped corners.
 - b. Fabricate frames as full profile welded unless otherwise indicated.
 - c. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
- B. Interior Frames: Fabricated from cold-rolled steel sheet unless metallic-coated sheet is indicated.
 - a. Fabricate frames with mitered or coped corners.
 - b. Fabricate frames as full profile welded unless otherwise indicated.
 - c. Frames for Level 3 Steel Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
 - d. Frames for Wood Doors: 0.053-inch- (1.3-mm-) thick steel sheet.
 - e. Frames for Borrowed Lights: 0.053-inch- (1.3-mm-) thick steel sheet or same as adjacent door frame.

END OF SECTION

SUBMITTALS

- A. Preliminary Finish Samples: Full range of standard factory finishes
- B. Shop Drawings:
 - a. Door schedule showing locations, types, sizes, thickness, grade, undercuts, cutouts, label requirements and the hardware.
 - b. Door elevations showing the location and size of cutouts for the lite kits and louvers.

MANUFACTURERS

- A. Acceptable manufactures:
 - a. Algoma Hardwoods
 - b. Acrovyn – Construction Specialties
 - c. VT Industries
 - d. Eggers Industries
 - e. Graham
 - f. Marshfield Door Systems, Inc.
 - g. Or Equal

DOOR CONSTRUCTION

- A. General: 5-ply, 1 ¾ inches thick, interior flush wood, bonded, solid core, ANSI/WDMA I.S. 1-A Premium Grade.
- B. Non-rated and 20 minutes doors:
 - a. Core: Bonded particle core
 - b. Stiles: Laminated with veneer edge-banded to match face veneer over structural composite lumber backers, glued to core.
 - c. Rails: Mill option hardwood or SCL, top and bottom
- C. Doors with greater than 20 minute rating:
 - a. Core: Bonded non-combustible fire resistive material, containing no asbestos
 - b. Stiles: Laminated with veneer edge-banded, to match veneer over mineral composite, glued to core.
 - c. Rails: Mineral composite as required by rated assembly
- D. Intumescent gasket: Recessed into door edge, concealed by wood veneer
- E. Transom and side panels: Same laminated plastic veneer as door in same opening.

FINISHES

- A. PLAM1: _____
- B. PLAM2: _____

END OF SECTION

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. Exterior and interior storefront framing.
- 2. Exterior and interior manual-swing entrance doors and door-frame units.

B. Related Requirements:

- 1. Section 084229.13 "Folding Automatic Entrances" for coordinating finish among aluminum fenestration units.
- 2. Section 084229.23 "Sliding Automatic Entrances" for coordinating finish among aluminum fenestration units.
- 3. Section 084413 "Glazed Aluminum Curtain Walls" for coordinating finish among aluminum fenestration units.
- 4. Section 085113 "Aluminum Windows" for coordinating finish among aluminum fenestration units.
- 5. Section 088000 "Glazing" for glazing.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

B. Shop Drawings: For aluminum-framed entrances and storefronts. Include plans, elevations, sections, full-size details, and attachments to other work.

- 1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
- 2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.

- 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.

C. Samples: For each type of exposed finish required, in manufacturer's standard sizes.

D. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship 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 created by wind and thermal and structural movements.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - d. Water penetration through fixed glazing and framing areas.
 - e. Failure of operating components.
 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
1. Aluminum-framed entrances and storefronts 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.
- B. Energy Performance: Certify and label energy performance according to NFRC as follows:
1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than **0.45 Btu/sq. ft. x h x deg F** as determined according to NFRC 100.
 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.40 as determined according to NFRC 200.
 3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 45 as determined according to NFRC 500.
- C. 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.**
 2. **Kawneer North America.**
 3. **Manko Window Systems, Inc.**
 4. **Oldcastle BuildingEnvelope.**
 5. **Tubelite.**
 6. **United States Aluminum.**
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing and accessories, from single manufacturer.

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. Framing Member Size: 2 inches wide x 4-1/2 inches deep.
 2. Construction:
 - a. Exterior Storefront Framing: Thermally broken.
 - b. Interior Storefront Framing: Nonthermal.
 3. Glazing System: Retained mechanically with gaskets on four sides.
 4. Glazing Plane: Front.
 5. Fabrication Method: Field-fabricated stick system.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
- D. Materials:
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: **ASTM B 209**.
 - b. Extruded Bars, Rods, Profiles, and Tubes: **ASTM B 221**.
 - 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.

2.4 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual-swing operation.
1. Door Construction: **2- to 2-1/4-inch** overall thickness, with minimum **0.125-inch**-thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
 2. Door Design: Medium stile; **3-1/2-inch** nominal width.
 3. Glazing Stops and Gaskets: Beveled, snap-on, extruded-aluminum stops and preformed gaskets.
 - a. Provide nonremovable glazing stops on outside of door.

2.5 ENTRANCE DOOR HARDWARE

- A. Entrance Door Hardware: Hardware not specified in this Section is specified in Section 087100 "Door Hardware."

2.6 GLAZING

- A. Glazing: Comply with Section 088000 "Glazing."
- B. Glazing Gaskets: Manufacturer's standard sealed-corner pressure-glazing system of black, resilient elastomeric glazing gaskets, setting blocks, and shims or spacers.

2.7 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 2. Reinforce members as required to receive fastener threads.

- B. Anchors: Three-way adjustable anchors with minimum adjustment of **1 inch** that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for **30-mil** thickness per coat.

2.8 FABRICATION

- A. Form or extrude aluminum shapes before finishing.
- B. 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. Physical and thermal isolation of glazing from framing members.
 - 4. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 5. Provisions for field replacement of glazing from interior.
 - 6. 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. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- E. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- F. Entrance Doors: Reinforce doors as required for installing entrance door hardware.
 - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 - 2. At exterior doors, provide weather sweeps applied to door bottoms.
- G. Entrance Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
- H. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

- A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.
 - 1. Color: Medium Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, 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. Prepare surfaces that are in contact with structural sealant according to sealant manufacturer's written instructions to ensure compatibility and adhesion. Preparation includes, but is not limited to, cleaning and priming surfaces.

3.3 INSTALLATION

A. General:

1. Comply with manufacturer's written instructions.
2. Do not install damaged components.
3. Fit joints to produce hairline joints free of burrs and distortion.
4. Rigidly secure nonmovement joints.
5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
6. Seal perimeter and other 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 materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.

C. Set continuous sill members and flashing in full sealant bed as specified in Section 079200 "Joint Sealants" to produce weathertight installation.

D. Install components plumb and true in alignment with established lines and grades.

E. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.

F. Install glazing as specified in Section 088000 "Glazing."

G. Install weatherseal sealant according to Section 079200 "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer.

H. Entrance Doors: Install doors to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to entrance door hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.

3.4 ERECTION TOLERANCES

A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:

1. Plumb: **1/8 inch in 10 feet; 1/4 inch in 40 feet.**
2. Level: **1/8 inch in 20 feet; 1/4 inch in 40 feet.**
3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to **1/2 inch** wide, limit offset from true alignment to **1/16 inch.**
 - b. Where surfaces are separated by reveal or protruding element from **1/2 to 1 inch** wide, limit offset from true alignment to **1/8 inch.**
 - c. Where surfaces are separated by reveal or protruding element of **1 inch** wide or more, limit offset from true alignment to **1/4 inch.**
4. Location: Limit variation from plane to **1/8 inch in 12 feet; 1/2 inch** over total length.

3.5 MAINTENANCE SERVICE

A. Entrance Door Hardware:

1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

END OF SECTION 084113

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 aluminum windows for exterior locations.
- B. Related Requirements:
 - 1. Section 084113 "Aluminum-Framed Entrances and Storefronts" for coordinating finish among aluminum fenestration units.
 - 2. Section 084229.13 "Folding Automatic Entrances" for coordinating finish among aluminum fenestration units.
 - 3. Section 084229.23 "Sliding Automatic Entrances" for coordinating finish among aluminum fenestration units.
 - 4. Section 084413 "Glazed Aluminum Curtain Walls" for coordinating finish among aluminum fenestration units.
 - 5. Section 088000 "Glazing" for glazing.

1.3 REFERENCE

- A. Refer to AAMA/WDMA/CSA 101/I.S.2/A440 for a complete list of references and industry standards.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review and discuss the finishing of aluminum windows that is required to be coordinated with the finishing of other aluminum work for color and finish matching.
 - 3. Review, discuss, and coordinate the interrelationship of aluminum windows with other exterior wall components. Include provisions for anchorage, flashing, sealing perimeters, and protecting finishes.
 - 4. Review and discuss the sequence of work required to construct a watertight and weathertight exterior building envelope.
 - 5. Inspect and discuss the condition of substrate and other preparatory work performed by other trades.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, glazing and fabrication methods, dimensions of individual components and profiles, hardware, and finishes for aluminum windows.
- B. Shop Drawings: Include plans, elevations, sections, hardware, accessories, insect screens, operational clearances, and details of installation, including anchor, flashing, and sealant installation.
- C. Samples for Verification: For aluminum windows and components required, showing full range of color variations for finishes.
- D. Product Schedule: For aluminum windows. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

- A. Sample Warranties: For manufacturer's warranties.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A manufacturer capable of fabricating aluminum windows that meet or exceed performance requirements indicated and of documenting this performance by test reports, and calculations.

- B. Installer Qualifications: An installer acceptable to aluminum window manufacturer for installation of units required for this Project. Upon request, the window manufacturer shall provide written confirmation that the installer is authorized to install window products to be used on this project.

1.8 DELIVERY, STORAGE AND HANDLING

A. Packing, Shipping, Handling and Unloading

- 1. Materials will be packed, loaded, shipped, unloaded, stored and protected in accordance with AAMA CW-10.

1.9 WARRANTY

A. Aluminum Window Warranty

- 1. Products: Submit a written warranty, executed by the window manufacturer, for a period of 10 years from the date of manufacture, against defective materials or workmanship, including substantial non-compliance with applicable specification requirements and industry standards, which result in premature failure of the windows, finish, factory-glazed glass, or parts, outside of normal wear.
- 2. In the event that windows or components are found defective, manufacturer will repair or provide replacements without charge at manufacturer's option.
- 3. Warranty for all components must be direct from the manufacturer (non pass-through) and non pro-rated for the entire term. Warranty must be assignable to the non-residential owner, and transferable to subsequent owners through its length.

B. Installation: Submit a written warranty, executed by the window installer, for a period of 5 years from the date of substantial completion, against defective materials or workmanship, including substantial non-compliance with applicable specification requirements, which result in premature failure.

- 1. In the event that installation of windows or components is found to be defective, installer will repair or provide replacements without charge at the installer's option.

PART 2 - PRODUCTS

2.1 WINDOW PERFORMANCE REQUIREMENTS

A. Product Standard: Comply with AAMA/WDMA/CSA 101/I.S.2/A440 for definitions and minimum standards of performance, materials, components, accessories, and fabrication unless more stringent requirements are indicated.

- 1. Window Certification: AMMA certified with label attached to each window.

B. Design Wind Loads

- 1. The design wind pressure for the project will be:
 - a. Per local building codes
- 2. All structural components, including meeting rails, mullions and anchors shall be designed accordingly, complying with deflection and stress requirements of Paragraph 1.03.B.

C. Air, Water and Structural Performance Requirements

- 1. When tested in accordance with cited test procedures, windows shall meet or exceed the following performance criteria, as well as those indicated in AAMA/WDMA/CSA 101/I.S.2/A440 for Architectural AW Performance Class windows, Performance Grade 100 (AW100) unless otherwise noted herein.
 - a. Test units shall not be smaller in either width or height than the "Gateway Test Size" specified in AAMA/WDMA/CSA 101/I.S.2/A440 for AW Performance Class.
 - b. "Downsize" testing to meet Optional Performance Class requirements specified herein shall not be permitted.
 - c. Test units shall employ manufacturer's standard sealing, lock spacing and anchorage.
- 2. Air Test Performance Requirements

- a. Air infiltration maximum 0.1 cfm per square foot at 6.24 psf pressure differential when tested in accord with ASTM E283.
3. Water Test Performance Requirements
 - a. No uncontrolled water leakage at 15.00 psf static pressure differential, with water application rate of 5 gallons/hr/sq ft when tested in accord with both ASTM E331 and ASTM E547. Static water test shall be repeated after application of design test pressures. (Performance can vary with hardware package selected.)
4. Structural Test Performance Requirements
 - a. Uniform Load Deflection Test
 - 1) No deflection of any unsupported span L of test unit (framing rails, muntins, mullions, etc.) in excess of L/175 at both a positive and negative load of 100 psf (design test pressure) when tested in accord with ASTM E330.
 - b. Uniform Load Structural Test
 - 1) Unit to be tested at 1.5 x design test pressure, both positive and negative, acting normal to plane of wall in accord with ASTM E330.
 - 2) No glass breakage; permanent damage to fasteners, hardware parts, or anchors; damage to make windows inoperable; or permanent deformation of any main frame or ventilator member in excess of 0.2% of its clear span.
- D. Condensation Resistance and Thermal Transmittance Performance Requirements
 1. Perform thermal tests in accordance with NFRC 102 and AAMA 1503, or provide finite element computer thermal modeling and calculations per NFRC 100 or AAMA 507, using DOE/LBL THERM 5.2 and WINDOWS 5.2 software.
 - a. Thermal Transmittance (U-Factor) for the overall curtainwall vision area and adjacent framing shall be less than or equal to 0.45 BTU/hr-ft²-°F.
 - b. Condensation Resistance Factor (CRF) requirements: CRF minimum 68 (Frame) and CRF minimum 67 (Glass).
 - c. Solar Heat Gain Coefficient (SHGC) for the overall curtainwall vision area and adjacent framing shall not exceed 0.40.

2.2 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Wausau Window and Wall Systems – 4250i-XLT INvent Series Fixed Windows with extended thermal separation, or comparable product by one of the following:
 1. EFCO Corporation.
 2. Kawneer North America.
 3. Manko Window Systems, Inc.
 4. Oldcastle, Inc.
 5. Tubelite.
 6. United States Aluminum.
- B. Source Limitations: Obtain aluminum windows from single source from single manufacturer.

2.3 MATERIALS

- A. Aluminum Framing Members
 1. Extruded aluminum billet, 6063-T5 or T6 alloy for primary components; 6063-T5 or T6, 6005-T5, 6105-T5 or 6061-T6 for structural components; all meeting the requirements of ASTM B221.
 2. Aluminum sheet alloy 5005-H32 (for anodic finishing), or alloy 3003-H14 (for painted or unfinished sheet) meeting the requirements of ASTM B209.
 3. Principal window frame will be a minimum 0.125" in thickness at hardware mounting locations.
 4. Extruded or formed trim components will be a minimum 0.060" in thickness.
 5. Frame depth 4 7/8" minimum.

2.4 COMPONENTS

A. Hardware

1. All steel components including attachment fasteners to be stainless steel except as noted.
2. Extruded aluminum components 6063-T5 or -T6.
3. Thermo-plastic or thermo-set plastic caps, housings and other components to be injection-molded nylon, extruded PVC, or other suitable compound.

B. Sealants

1. All sealants shall comply with applicable provisions of AAMA 800 and/or Federal Specifications FS-TT-001 and 002 Series.
2. Frame joinery sealants shall be suitable for application specified and as tested and approved by window manufacturer.

C. Glass

1. Provide in accordance with Section 088000.
2. Sealed insulated glass shall be tested and certified in accord with ASTM E2190.

D. Glazing

1. Provide in general accordance with Section 088000.
2. Glazing method shall be in general accordance with the GANA Glazing Manual for specified glass type, or as approved by the glass fabricator.

E. Glazing Materials

1. Setting Blocks/Edge Blocking: Provide in sizes and locations recommended by GANA Glazing Manual. Setting blocks used in conjunction with soft-coat low-e glass shall be silicone.
2. Back-bedding tapes, expanded cellular glazing tapes, toe beads, heel beads and cap beads shall meet the requirements of applicable specifications cited in AAMA 800.
3. Glazing gaskets shall be non-shrinking, weather-resistant, and compatible with all materials in contact.
4. Structural silicone sealant where used shall meet the requirements of ASTM C1184.
5. Spacer tape in continuous contact with structural silicone shall be tested for compatibility and approved by the sealant manufacturer for the intended application.
6. Gaskets in continuous contact with structural silicone shall be extruded silicone or compatible material.

F. Steel Components

1. Provide steel reinforcements as necessary to meet the performance requirements of 1.03.
2. Concealed steel anchors and reinforcing shall be factory painted after fabrication with TGIC powder coating, or rust-inhibitive primer complying with Federal Specification TT-P-645B.

G. Muntins:

1. Provide muntin grids as shown on architectural drawings.
2. Finish to match window frames.

H. Receptors:

1. Provide extruded aluminum receptors to receive windows, as shown on architectural drawings.
2. Finish to match window frames.

2.5 FABRICATION

A. General:

1. Finish, fabricate and shop assemble frame and sash ventilator members into complete windows under the responsibility of one manufacturer.
2. No bolts, screws or fastenings shall impair independent frame movement, or bridge the thermal barrier, unless such bridging was also present in thermal test units and thermal models.
3. Fabricate to allow for thermal movement of materials when subjected to a temperature differential from -30 • F to +180 • F.

B. Frames:

1. Cope and mechanically fasten each corner, or miter and weld each corner; then seal weather tight.
2. Make provisions for continuity of frame joinery seals at extrusion webs.

C. Glass Drainage: (field glazed units only)

1. Provision shall be made to insure that water will not accumulate and remain in contact with the perimeter area of sealed insulated glass.

D. Thermal Break Construction:

1. Continuous extruded polyamide with 25% glass fiber reinforcing, mechanically crimped into cross-knurled cavities.
2. Minimum thermal separation: 5/8".
3. Quality assurance records must be maintained and available as requested.

2.6 FINISHES

A. Color Anodic Finish: AAMA 611, AA-M12C22A42/A44, Class I, 0.018 mm or thicker.

1. Color: Medium Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine openings, substrates, structural support, anchorage, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Verify rough opening dimensions, levelness of sill plate, and operational clearances.
- C. Examine wall flashings, vapor retarders, water and weather barriers, and other built-in components to ensure weathertight window installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Erection of Aluminum Windows

1. Install all windows with skilled workers in accordance with approved shop drawings, installation instructions, specifications, and the AAMA Commercial Window and Door Installation Manual.
2. Aluminum that is not organically coated shall be insulated from direct contact with steel, masonry, concrete or other dissimilar metals by bituminous paint, rust-inhibiting primer, non-conductive shims or other suitable insulating material.

3.3 ADJUSTING, CLEANING, AND PROTECTION

- A. Clean exposed surfaces immediately after installing windows. Avoid damaging protective coatings and finishes. Remove excess sealants, glazing materials, dirt, and other substances.
 1. Keep protective films and coverings in place until final cleaning.
- B. Remove and replace glass that has been broken, chipped, cracked, abraded, or damaged during construction period.
- C. Protect window surfaces from contact with contaminating substances resulting from construction operations. If contaminating substances do contact window surfaces, remove contaminants immediately according to manufacturer's written instructions.

END OF SECTION 085113

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TYNDALL, SD

DOOR #	HDW GROUP
101	1
101-1	2
102	1
102-1	2
103	1
103-1	2
104	1
104-1	2
105	1
105-1	2
106	1
106-1	2
107	1
107-1	2
108	1
108-1	2
109	1
109-1	2
110	1
110-1	2
111	1
111-1	2
111-2	1
112	4
112-1	2
113	5
113-1	6
114	7
115	8
116	9
117	10
118	11
119-1	18
119-2	12
124	13
125	14
126	14
201	19
202	20
203	16
204	17
207	15

Hardware Set 1

Each to receive:

3	EA	Hinge	T4A3786 4.5" x 4.5" US26D	MK
1	EA	Hospital Latch	28 115 US26D	SA
1	EA	Armor Plate	AP50 34" x 40" US32D	BU
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -18'	NG
1	EA	Edge Guard	304 34" US32D	BU

Hardware Set 2

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Privacy Lock	8265 LNL US26D	SA
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -17'	NG

Hardware Set 3

Each to receive:

3	EA	Hinge	T4A3786 4.5" x 4.5" US26D	MK
1	EA	Hospital Latch	28 115 US26D	SA
1	EA	Armor Plate	AP50 34" x 38" US32D	BU
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -18'	NG
1	EA	Edge Guard	304 34" US32D	BU

Hardware Set 4

Each to receive:

3	EA	Hinge	T4A3786 4.5" x 4.5" US26D	MK
1	EA	Hospital Latch	28 115 US26D	SA
1	EA	Armor Plate	AP50 34" x 46" US32D	BU
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -18'	NG
1	EA	Edge Guard	304 34" US32D	BU

Hardware Set 5

Each to receive:

3	EA	Hinge	T4A3786 4.5" x 4.5" US26D	MK
1	EA	Passage Latch	8215 LNL US26D	SA
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -18'	NG

Hardware Set 6

Each to receive:

6	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
2	EA	Flush Bolt	FB458 626	IV
1	EA	Classroom Lock	8237 LNL US26D	SA
2	EA	Overhead Stop	454S 652	GJ

Hardware Set 7

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Classroom Lock	8237 LNL US26D	SA
1	EA	Overhead Stop	454S 652	GJ
1	EA	Surface Closer	DA 351 UO EN	SA
1	EA	Armor Plate	AP50 34" x 34" US32D	BU
1	EA	Gasketing	5050B -17'	NG
1	EA	Edge Guard	304 34" US32D	BU

Hardware Set 8

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Storeroom/Closet Lock	8204 LNL US26D	SA
1	EA	Surface Closer	DA 351 UO EN	SA
1	EA	Armor Plate	AP50 34" x 34" US32D	BU
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -17'	NG
1	EA	Edge Guard	304 34" US32D	BU

Hardware Set 9

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Dormitory/Exit Lock	8225 LNL US26D	SA
1	EA	Electric Strike	1006CDB 630	HS
1	EA	Door Operator	4631 STD AL	LC
1	EA	Kick Plate	KP50 10" x 34" US32D	BU
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -17'	NG
1	EA	Gasketing	160SA -36" X 84"	NG
1	EA	Door Bottom	225N- 36"	NG
2	EA	Actuator	8310-813	LC

Hardware Set 10

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Dormitory/Exit Lock	8225 LNL US26D	SA
1	EA	Electric Strike	1006CDB 630	HS
1	EA	Door Operator	4642 REG AL	LC
1	EA	Kick Plate	KP50 10" x 34" US32D	BU
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -17'	NG
1	EA	Gasketing	160SA -36" X 84"	NG
1	EA	Door Bottom	225N- 36"	NG
2	EA	Actuator	8310-813	LC

Hardware Set 11

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Access Control Mortise Lock	KP8278 LNL US26D	SA
1	EA	Surface Closer	DA 351 UO EN	SA
1	EA	Armor Plate	AP50 34" x 34" US32D	BU
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -17'	NG
1	EA	Edge Guard	304 34" US32D	BU

Hardware Set 12

Each to receive:

8	EA	Hinge	T4A3786 4.5" x 4.5" US26D	MK
2	EA	Surface Vert Rod Exit	12 8710 US32D	SA
2	EA	Surface Closer	351 UO EN	SA
2	EA	Kick Plate	KP50 10" x 46" US32D	BU
2	EA	Electromagnetic Holder	998 689	RF
1	EA	Gasketing	5050B -23'	NG
1	EA	Gasketing	5070B -8'	NG

Hardware Set 13

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Storeroom/Closet Lock	8204 LNL US26D	SA
1	EA	Surface Closer	351 UO EN	SA
1	EA	Kick Plate	KP50 10" x 34" US32D	BU
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -17'	NG

Hardware Set 14

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Storeroom/Closet Lock	8204 LNL US26D	SA
1	EA	Overhead Stop	454S 652	GJ

Hardware Set 15

Each to receive:

3	EA	Hinge	TA2714 4.5" x 4.5" US26D	MK
1	EA	Classroom Lock	8237 LNL US26D	SA
1	EA	Wall Stop	WS406CCV 630	IV
1	EA	Gasketing	5050B -17'	NG

Hardware Set 16

Each to receive:

3	EA	Hinge	T4A3386 x NRP 4.5" x 4.5" US26D	MK
1	EA	Rim Exit Device	8804 862 US32D	SA
1	EA	Surface Closer	351 PS EN	SA
1	EA	Kick Plate	KP50 10" x 34" US32D	BU
1	EA	Threshold	425E -36"	NG
1	EA	Gasketing	160SA -36" X 84"	NG
1	EA	Sweep	200NA -36"	NG

Hardware Set 17

Each to receive:

3	EA	Hinge	T4A3386 x NRP 4.5" x 4.5" US26D	MK
1	EA	Dormitory/Exit Lock	8225 LNL US26D	SA
1	EA	Surface Closer	351 PS EN	SA
1	EA	Kick Plate	KP50 10" x 34" US32D	BU
1	EA	Threshold	425E -36"	NG
1	EA	Gasketing	160SA -36" X 84"	NG
1	EA	Sweep	200NA -36"	NG

Hardware Set 18

Each to receive:

1	EA	Continuous Hinge	FM300 7'0 630	MR
1	EA	Rim Exit Device	AD8510 US32D	SA
1	EA	Surface Closer	351 PS EN	SA
1	EA	Drop Plate	351D EN	SA
1	EA	Threshold	425E -48"	NG

SWEEP AND WEATHERSTRIP FURNISHED BY DOOR SUPPLIER.

Hardware Set 19

Each to receive:

1	EA	Continuous Hinge	FM300 7'0 630	MR
1	EA	Rim Exit Device	AD8504 862 US32D	SA
1	EA	Door Operator	4642 REG AL	LC
1	EA	Threshold	425E -36"	NG
1	EA	Actuator	8310-3857TW	LC

SWEEP AND WEATHERSTRIP FURNISHED BY DOOR SUPPLIER.

Hardware Set 20

Each to receive:

1	EA	Continuous Hinge	FM300 7'0 630	MR
1	EA	Push Bar & Pull	422 x 26C US32D	BU
1	EA	Door Operator	4642 REG AL	LC
1	EA	Actuator	8310-3857TW	LC

SECTION 087100 - DOOR HARDWARE

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. Commercial door hardware for the following:
 - a. Swinging doors.
- B. Related Sections include the following:
 - 1. Division 08 Section "Hollow Metal Doors and Frames" for astragals provided as part of fire-rated labeled assemblies and for door silencers provided as part of hollow-metal frames.
 - 2. Division 08 Section "Flush Wood Doors" for astragals provided as part of fire-rated labeled assemblies.
 - 3. Division 26 Sections for connections to electrical power system and for low-voltage wiring work.
 - 4. Division 28 Section "Fire Detection and Alarm" for connections to building fire alarm system.

1.3 SUBMITTALS

- A. Product Data: Include construction and installation details, material descriptions, dimensions of individual components and profiles, and finishes.
- B. Qualification Data: For Architectural Hardware Consultant.
- C. Maintenance Data: For each type of door hardware to include in maintenance manuals. Include final hardware and keying schedule.
- D. Warranty: Special warranty specified in this Section.
- E. Other Action Submittals:
 - 1. Door Hardware Sets: Prepared by or under the supervision of Architectural Hardware Consultant, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final door hardware sets with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.

- a. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule." Double space entries, and number and date each page.
 - b. Format: Use same scheduling sequence and format and use same door numbers as in the Contract Documents.
 - c. Content: Include the following information:
 - 1) Identification number, location, hand, fire rating, and material of each door and frame.
 - 2) Type, style, function, size, quantity, and finish of each door hardware item. Include description and function of each lockset and exit device.
 - 3) Complete designations of every item required for each door or opening including name and manufacturer.
 - 4) Fastenings and other pertinent information.
 - 5) Location of each door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - 6) Explanation of abbreviations, symbols, and codes contained in schedule.
 - 7) Mounting locations for door hardware.
 - 8) Door and frame sizes and materials.
 - d. Submittal Sequence: Submit the final door hardware sets at earliest possible date, particularly where approval of the door hardware sets must precede fabrication of other work that is critical in Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the door hardware sets.
2. Keying Schedule: Prepared by or under the supervision of Architectural Hardware Consultant, detailing Owner's final keying instructions for locks. Include schematic keying diagram and index each key set to unique door designations.

1.4 QUALITY ASSURANCE

- A. Architectural Hardware Consultant Qualifications: A person who is currently certified by DHI as an Architectural Hardware Consultant and 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.
- B. Source Limitations: Obtain each type and variety of door hardware from a single manufacturer, unless otherwise indicated.
- C. 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 ratings indicated, based on testing according to UBC Standard 7-2.
- D. Keying Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." In addition to Owner, Contractor, and Architect, conference participants shall also include Installer's Architectural Hardware Consultant. Incorporate keying conference decisions into final keying schedule after reviewing door hardware keying system including, but not limited to, the following:

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up for door hardware delivered to Project site.
- B. Tag each item or package separately with identification related to the final door hardware sets, and include basic installation instructions, templates, and necessary fasteners with each item or package.

1.6 COORDINATION

- A. Templates: Distribute door hardware templates for doors, frames, and other work specified to be factory prepared for installing door hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing door hardware to comply with indicated requirements.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of door hardware that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including excessive deflection, cracking, or breakage.
 - b. Faulty operation of operators and door hardware.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering and use.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in this Section and door hardware sets indicated in Part 3 "Door Hardware Sets" Article.
 - 1. Door Hardware Sets: Provide quantity, item, size, finish or color indicated, and named manufacturers' products.

- B. Designations: Requirements for design, grade, function, finish, size, and other distinctive qualities of each type of door hardware are indicated in Part 3 "Door Hardware Sets" Article. Products are identified by using door hardware designations, as follows:
1. Named Manufacturers' Products: Manufacturer and product designation are listed for each door hardware type required for the purpose of establishing minimum requirements. Manufacturers' names are abbreviated in Part 3 "Door Hardware Sets" Article.
- C. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 HINGES, GENERAL

- A. Quantity: Provide the following, unless otherwise indicated:
1. Two Hinges: For doors with heights up to 60 inches (1524 mm).
 2. Three Hinges: For doors with heights 61 to 90 inches (1549 to 2286 mm).
 3. Four Hinges: For doors with heights 91 to 120 inches (2311 to 3048 mm).
 4. For doors with heights more than 120 inches (3048 mm), provide 4 hinges, plus 1 hinge for every 30 inches (750 mm) of door height greater than 120 inches (3048 mm).
- B. Template Requirements: Except for hinges and pivots to be installed entirely (both leaves) into wood doors and frames, provide only template-produced units.
- C. Hinge Weight: Unless otherwise indicated, provide the following:
1. Entrance Doors: Heavy-weight hinges.
 2. All Doors: Antifriction-bearing hinges.
 3. Interior Doors 36" or less: Standard-weight hinges.
 4. Interior Doors over 36": Heavy-weight hinges.
- D. Hinge Base Metal: As indicated in the Door Hardware Schedule at the end of Part 3.
- E. Hinge Options: Where indicated in door hardware sets or on Drawings:
1. Nonremovable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for outswinging exterior doors.
 2. Corners: Square.
- F. Fasteners: Comply with the following:
1. Machine Screws: For metal doors and frames. Install into drilled and tapped holes.
 2. Wood Screws: For wood doors and frames.
 3. Threaded-to-the-Head Wood Screws: For fire-rated wood doors.

2.3 HINGES

- A. Butts and Hinges: BHMA A156.1.
- B. Template Hinge Dimensions: BHMA A156.7.
- C. Available Manufacturers:
 - 1. Hager Companies (HAG).
 - 2. McKinney Products Company; an ASSA ABLOY Group company (MCK).
 - 3. Stanley Commercial Hardware; Div. of The Stanley Works (STH).

2.4 CONTINUOUS HINGES

- A. General: Minimum 0.120-inch- (3.0-mm-) thick, hinge leaves with minimum overall width of 4 inches (102 mm); fabricated to full height of door and frame and to template screw locations; with components finished after milling and drilling are complete.
 - 1. Fire Pins: Steel pins to hold labeled fire doors in place if required by tested listing.
- B. Continuous, Barrel-Type Hinges: Hinge with knuckles formed around a pin that extends entire length of hinge.
 - 1. Base Metal for Exterior Hinges: Stainless steel.
 - 2. Available Manufacturers:
 - a. Hager Companies (HAG).
 - b. Markar Architectural Products, Inc.; a Subsidiary of Adams Rite Manufacturing Co. (MP).
 - c. McKinney Products Company; an ASSA ABLOY Group company (MCK).
 - d. Stanley Commercial Hardware; Div. of The Stanley Works (STH).

2.5 LOCKS AND LATCHES, GENERAL

- A. Accessibility Requirements: Where indicated to comply with accessibility requirements, comply with [the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
- B. Latches and Locks for Means of Egress Doors: Comply with NFPA 101. Latches shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
- C. Lock Trim:
 - 1. Lockset Designs: Provide design indicated in Door Hardware sets or, if sets are provided by another manufacturer, provide designs that match those designated.

- D. Lock Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Bored Locks: Minimum 1/2-inch (13-mm) latchbolt throw.
 - 2. Mortise Locks: Minimum 3/4-inch (19-mm) latchbolt throw.
 - 3. Deadbolts: Minimum 1-inch (25-mm) bolt throw.
- E. Backset: 2-3/4 inches (70 mm), unless otherwise indicated.
- F. Strikes: Manufacturer's standard strike with strike box for each latchbolt or lock bolt, with curved lip extended to protect frame, finished to match door hardware set.

2.6 LOCKS AND LATCHES

- A. Lock Functions: Function numbers and descriptions indicated in door hardware sets comply with the following:
 - 1. Bored Locks: BHMA A156.2.
 - 2. Mortise Locks: BHMA A156.13.
- B. Bored Locks: BHMA A156.2; Series 4000.
 - 1. Available Manufacturers:
 - a. Corbin Russwin Architectural Hardware; an ASSA ABLOY Group company (CR).
 - b. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).
 - c. Glynn Johnson; an Ingersoll-Rand Company (GJ).
- C. Mortise Locks: Stamped steel case with steel or brass parts; BHMA A156.13; Series 1000.
 - 1. Available Manufacturers:
 - a. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).

2.7 DOOR BOLTS

- A. Bolt Throw: Comply with testing requirements for length of bolts required for labeled fire doors, and as follows:
 - 1. Mortise Flush Bolts: Minimum 3/4-inch (19-mm) throw.
- B. Manual Flush Bolts: BHMA A156.16, Grade 1 unless Grade 2 is indicated; designed for mortising into door edge.
 - 1. Available Manufacturers:
 - a. Door Controls International (DCI).
 - b. Hager Companies (HAG).
 - c. IVES Hardware; an Ingersoll-Rand Company (IVS).

- d. Trimco (TBM).

2.8 EXIT DEVICES

- A. Exit Devices: BHMA A156.3, Grade 1 unless Grade 2 is indicated.
- B. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 - 1. Provide operating devices that do not require tight grasping, pinching, or twisting of the wrist and that operate with a force of not more than 5 lbf (22 N).
- C. Exit Devices for Means of Egress Doors: Comply with NFPA 101. Exit devices shall not require more than 15 lbf (67 N) to release the latch. Locks shall not require use of a key, tool, or special knowledge for operation.
- D. Panic Exit Devices: Listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for panic protection, based on testing according to UL 305.
- E. Fire Exit Devices: Devices complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire and panic protection, based on testing according to UL 305 and NFPA 252.
- F. Through Bolts: For exit devices and trim on metal doors, non-fire-rated wood doors and fire-rated wood doors.
 - 1. Available Manufacturers:
 - a. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).

2.9 LOCK CYLINDERS

- A. Standard Lock Cylinders: BHMA A156.5.
- B. Cylinders: Manufacturer's standard tumbler type, constructed from brass or bronze, stainless steel, or nickel silver, and complying with the following:
 - 1. Number of Pins: Seven.
 - 2. Mortise Type: Threaded cylinders with rings and straight- or clover-type cam.
 - 3. Rim Type: Cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 4. Bored-Lock Type: Cylinders with tailpieces to suit locks.
 - a. High-Security Grade: BHMA A156.5, Grade 1A, listed and labeled as complying with pick- and drill-resistant testing requirements in UL 437 (Suffix A).

- C. Permanent Cores: Manufacturer's standard; finish face to match lockset; complying with the following:
 - 1. Interchangeable Cores: Core insert, removable by use of a special key; usable with other manufacturers' cylinders.
 - 2. Removable Cores: Core insert, removable by use of a special key; for use only with core manufacturer's cylinder and door hardware.
- D. Manufacturer: Same manufacturer as for locks and latches.

2.10 KEYING

- A. Keying System: Factory registered, complying with guidelines in BHMA A156.28, Appendix A. Incorporate decisions made in keying conference, and as follows:
 - 1. Existing System: Master key or grand master key locks to Owner's existing system.
- B. Keys: Nickel silver.
 - 1. Stamping: Permanently inscribe each key with a visual key control number and include the following notation:
 - a. Notation: "DO NOT DUPLICATE."
 - 2. Quantity: In addition to two (2) keys for each lock, provide the following:
 - a. Master Keys: Five.
 - b. Grand Master Keys: Five.
 - c. Great-Grand Master Keys: Five.

2.11 ELECTRIC STRIKES

- A. Standard: BHMA A156.31, Grade 1 unless Grade 2 is indicated.
- B. General: Use fail-secure electric strikes with fire-rated devices.
- C. Available Manufacturers:
 - 1. Folger Adam Security Inc.; an ASSA ABLOY Group company (FAS).
 - 2. H.E.S.; an ASSA ABLOY Group company (HES).
 - 3. Von Duprin; an Ingersoll-Rand Company (VD).

2.12 OPERATING TRIM

- A. Standard: BHMA A156.6 and as indicated in Door Hardware sets.
- B. Materials: Fabricate as indicated in Door Hardware sets.
- C. Available Manufacturers:
 - 1. Burns Manufacturing Incorporated (BM).
 - 2. Hager Companies (HAG).

3. Hiawatha, Inc. (HIA).
4. IVES Hardware; an Ingersoll-Rand Company (IVS).
5. Trimco (TBM).

2.13 CLOSERS

- A. Accessibility Requirements: Where handles, pulls, latches, locks, and other operating devices are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 1. Comply with the following maximum opening-force requirements:
 - a. Interior, Non-Fire-Rated Hinged Doors: 5 lbf (22.2 N) applied perpendicular to door.
 - b. Fire Doors: Minimum opening force allowable by authorities having jurisdiction.
- B. Door Closers for Means of Egress Doors: Comply with NFPA 101. Door closers shall not require more than 30 lbf (133 N) to set door in motion and not more than 15 lbf (67 N) to open door to minimum required width.
- C. Size of Units: Unless otherwise indicated, comply with manufacturer's written recommendations for size of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Provide factory-sized closers, adjustable to meet field conditions and requirements for opening force.
- D. Surface Closers: BHMA A156.4, Grade 1 unless Grade 2 is indicated Provide type of arm required for closer to be located on non-public side of door, unless otherwise indicated.
 1. Available Manufacturers:
 - a. SARGENT Manufacturing Company; an ASSA ABLOY Group company (SGT).

2.14 PROTECTIVE TRIM UNITS

- A. Size: 2 inches less than door width on push side, by height specified in door hardware sets.
- B. Fasteners: Manufacturer's standard machine or self-tapping screws.
- C. Metal Protective Trim Units: BHMA A156.6; beveled top and 2 sides; fabricated from material indicated in door hardware sets.
 1. Available Manufacturers:
 - a. Burns Manufacturing Incorporated (BM).
 - b. Hager Companies (HAG).
 - c. Hiawatha, Inc. (HIA).
 - d. IVES Hardware; an Ingersoll-Rand Company (IVS).

- e. Trimco (TBM).

2.15 STOPS AND HOLDERS

- A. Stops and Bumpers: BHMA A156.16, Grade 1 unless Grade 2 is indicated.
 - 1. Provide floor stops for doors unless wall or other type stops are scheduled or indicated. Do not mount floor stops where they will impede traffic. Where floor or wall stops are not appropriate, provide overhead holders.
- B. Silencers for Metal Door Frames: BHMA A156.16, Grade 1; neoprene or rubber, minimum diameter 1/2 inch (13 mm); fabricated for drilled-in application to frame.
- C. Available Manufacturers:
 - 1. Hager Companies (HAG).
 - 2. IVES Hardware; an Ingersoll-Rand Company (IVS).
 - 3. Trimco (TBM).

2.16 DOOR GASKETING

- A. Standard: BHMA A156.22.
- B. General: Provide continuous weather-strip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated or scheduled. Provide noncorrosive fasteners for exterior applications and elsewhere as indicated.
 - 1. Perimeter Gasketing: Apply to head and jamb, forming seal between door and frame.
 - 2. Meeting Stile Gasketing: Fasten to meeting stiles, forming seal when doors are closed.
 - 3. Door Bottoms: Apply to bottom of door, forming seal with threshold when door is closed.
- C. Air Leakage: Not to exceed 0.50 cfm per foot (0.000774 cu. m/s per m) of crack length for gasketing other than for smoke control, as tested according to ASTM E 283.
- D. Smoke-Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke-control ratings indicated, based on testing according to UL 1784.
 - 1. Provide smoke-labeled gasketing on 20-minute-rated doors and on smoke-labeled doors.
- E. Fire-Labeled Gasketing: 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 UBC Standard 7-2.
- F. Gasketing Materials: ASTM D 2000 and AAMA 701/702.
- G. Available Manufacturers:

1. Hager Companies (HAG).
2. National Guard Products (NGP).
3. Pemko Manufacturing Co. (PEM).
4. Reese Enterprises (RE).

2.17 THRESHOLDS

- A. Standard: BHMA A156.21.
- B. Accessibility Requirements: Where thresholds are indicated to comply with accessibility requirements, comply with the U.S. Architectural & Transportation Barriers Compliance Board's "Americans with Disabilities Act (ADA), Accessibility Guidelines for Buildings and Facilities (ADAAG)."
 1. Bevel raised thresholds with a slope of not more than 1:2. Provide thresholds not more than 1/2 inch (13 mm) high.
- C. Thresholds for Means of Egress Doors: Comply with NFPA 101. Maximum 1/2 inch (13 mm) high.
- D. Available Manufacturers:
 1. Hager Companies (HAG).
 2. National Guard Products (NGP).
 3. Pemko Manufacturing Co. (PEM).
 4. Reese Enterprises (RE).

2.18 FABRICATION

- A. Manufacturer's Nameplate: Do not provide products that have manufacturer's name or trade name displayed in a visible location except in conjunction with required fire-rated labels and as otherwise approved by Architect.
 1. Manufacturer's identification is permitted on rim of lock cylinders only.
- B. Base Metals: Produce door hardware units of base metal, fabricated by forming method indicated, using manufacturer's standard metal alloy, composition, temper, and hardness. Furnish metals of a quality equal to or greater than that of specified door hardware units and BHMA A156.18. Do not furnish manufacturer's standard materials or forming methods if different from specified standard.
- C. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to commercially recognized industry standards for application intended, except aluminum fasteners are not permitted. Provide Phillips flat-head screws with finished heads to match surface of door hardware, unless otherwise indicated.

1. Concealed Fasteners: For door hardware units that are exposed when door is closed, except for units already specified with concealed fasteners. Do not use through bolts for installation where bolt head or nut on opposite face is exposed unless it is the only means of securely attaching the door hardware. Where through bolts are used on hollow door and frame construction, provide sleeves for each through bolt.
2. Steel Machine or Wood Screws: For the following fire-rated applications:
 - a. Mortise hinges to doors.
 - b. Strike plates to frames.
 - c. Closers to doors and frames.
3. Steel Through Bolts: For the following fire-rated applications unless door blocking is provided:
 - a. Surface hinges to doors.
 - b. Closers to doors and frames.
 - c. Surface-mounted exit devices.
4. Spacers or Sex Bolts: For through bolting of hollow-metal doors.
5. Fasteners for Wood Doors: Comply with requirements in DHI WDHS.2, "Recommended Fasteners for Wood Doors."

2.19 FINISHES

- A. Standard: BHMA A156.18, as indicated in door hardware sets.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine doors and frames, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Examine roughing-in for electrical power systems to verify actual locations of wiring connections before electrified door hardware installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Steel Doors and Frames: Comply with DHI A115 Series.
 - 1. Surface-Applied Door Hardware: Drill and tap doors and frames according to ANSI A250.6.
- B. Wood Doors: Comply with DHI A115-W Series.

3.3 INSTALLATION

- A. Mounting Heights: Mount door hardware units at heights indicated as follows unless otherwise indicated or required to comply with governing regulations.
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."
 - 2. Custom Steel Doors and Frames: DHI's "Recommended Locations for Builders' Hardware for Custom Steel Doors and Frames."
 - 3. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
- B. Install each door hardware item to comply with manufacturer's written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 09 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
 - 1. Set units level, plumb, and true to line and location. Adjust and reinforce attachment substrates as necessary for proper installation and operation.
 - 2. Drill and countersink units that are not factory prepared for anchorage fasteners. Space fasteners and anchors according to industry standards.

3.4 ADJUSTING

- 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. Electric Strikes: Adjust horizontal and vertical alignment of keeper to properly engage lock bolt.
 - 2. Door Closers: Unless otherwise required by authorities having jurisdiction, adjust sweep period so that, from an open position of 70 degrees, the door will take at least 3 seconds to move to a point 3 inches (75 mm) from the latch, measured to the leading edge of the door.
- B. Occupancy Adjustment: Approximately six months after date of Substantial Completion, Installer shall examine and readjust, including adjusting operating forces, each item of door hardware as necessary to ensure function of doors, door hardware, and electrified door hardware.

3.5 CLEANING AND PROTECTION

- A. Clean adjacent surfaces soiled by door hardware installation.
- B. Clean operating items as necessary to restore proper function and finish.
- C. Provide final protection and maintain conditions that ensure that door hardware is without damage or deterioration at time of Substantial Completion.

3.6 DOOR HARDWARE SETS

END OF SECTION 087100

SECTION 088000 - GLAZING

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. Glass for doors, interior borrowed lites, storefront framing, and glazed curtain walls.
- 2. Glazing sealants and accessories.

- B. Related Requirements:

- 1. Section 088813 "Fire-Resistant Glazing."

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

- B. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.

- C. IBC: International Building Code.

- D. Interspace: Space between lites of an insulating-glass unit.

1.4 COORDINATION

- A. Coordinate glazing channel dimensions to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

1.5 PREINSTALLATION MEETINGS

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

- 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
- 2. Review temporary protection requirements for glazing during and after installation.

1.6 ACTION SUBMITTALS

- A. Product Data: For each type of product.

- B. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.

- 1. Coated glass.
- 2. Insulating glass.

- C. Glazing Accessory Samples: For sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.

- D. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

- E. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.7 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, manufacturers of insulating-glass units with sputter-coated, low-E coatings, and sealant testing agency.
- B. Product Certificates: For glass.
- C. Product Test Reports: For tinted glass, coated glass, insulating glass, and glazing sealants, for tests performed by a qualified testing agency.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Sample Warranties: For special warranties.

1.8 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
- B. Comply with insulating-glass manufacturer's written instructions for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.10 FIELD CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or are below 40 deg F (4.4 deg C).

1.11 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: **10** years from date of Substantial Completion.

- B. **Manufacturer's Special Warranty for Laminated Glass:** Manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. **Warranty Period: 10 years** from date of Substantial Completion.

- C. **Manufacturer's Special Warranty for Insulating Glass:** Manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. **Warranty Period: 10 years** from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. **Basis-of-Design Glass Product:** Subject to compliance with requirements, provide product indicated in glass schedules or comparable product by one of the following:
 - 1. Guardian Industries Corp.; SuperNeutral 68 SunGuard Low-E (basis-of-design)
 - 2. PPG Industries, Inc.; SolarBan 60 Low-E
 - 3. Prior approved equal.

- B. **Source Limitations for Glass:** Obtain from single source from single manufacturer for each glass type.

- C. **Source Limitations for Glazing Accessories:** Obtain from single source from single manufacturer for each product and installation method.

2.2 PERFORMANCEREQUIREMENTS

- A. **General:** Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.

- B. **Delegated Design:** Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design glazing.

- C. **Structural Performance:** Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.
 - 1. **Design Wind Pressures:** As indicated on Drawings.
 - 2. **Design Wind Pressures:** Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.
 - a. **Wind Design Data:** As indicated on Drawings.
 - b. **Basic Wind Speed:** 90 mph (40 m/s).
 - c. **Importance Factor:** 1.15.
 - d. **Exposure Category:** C.

 - 3. **Thickness of Patterned Glass:** Base design of patterned glass on thickness at thinnest part of the glass.

4. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
 5. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- D. Safety Glazing: Where safety glazing is indicated, provide glazing that complies with 16 CFR 1201, Category II.
- E. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6 mm thick unless noted otherwise.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.
1. GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."
 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- B. Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction, or, manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- C. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
- D. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.
1. Minimum Glass Thickness for Exterior Lites: 6 mm unless noted otherwise.
 2. Thickness of Tinted Glass: Provide same thickness for each tint color indicated throughout Project.
- E. Strength: Where annealed float glass is indicated, provide annealed float glass, heat-strengthened float glass, or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened float glass is indicated, provide heat-strengthened float glass or fully tempered float glass as needed to comply with "Performance Requirements" Article. Where fully tempered float glass is indicated, provide fully tempered float glass.

2.4 GLASS PRODUCTS

- A. Clear Annealed Float Glass: ASTM C 1036, Type I, Class 1 (clear), Quality-Q3.
- B. Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.

1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- C. Heat-Strengthened Float Glass: ASTM C 1048, Kind HS (heat strengthened), Type I, Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear) or Class 2 (tinted) as indicated, Quality-Q3.
 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
- D. Ceramic-Coated Spandrel Glass: ASTM C 1048, Type I, Condition B, Quality-Q3.

2.5 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190.
 1. Sealing System: Dual seal, with manufacturer's standard primary and secondary sealants.
 2. Spacer: Thermally broken aluminum, nonmetallic laminate, or nonmetallic tube.
 3. Desiccant: Molecular sieve or silica gel, or a blend of both.

2.6 GLAZING SEALANTS

- A. General:
 1. Compatibility: Compatible with one another and with other materials they contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Field-applied sealants shall have a VOC content of not more than 250 g/L.
 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 1199 or 899.
 - b. GE Advanced Materials - Silicones; UltraGlaze SSG4000 or UltraGlaze SSG4000AC.
 - c. Polymeric Systems, Inc.; PSI-631.
 - d. Tremco Incorporated; Proglaze SSG or Tremsil 600.
 - e. Prior approved equal.
- C. Glazing Sealant: Acid-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 25, Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; General Purpose Sealant or 999-A.
 - b. GE Advanced Materials - Silicones; Contractors SCS1000 or Construction SCS1200.
 - c. Polymeric Systems, Inc.; PSI-601.
 - d. Tremco Incorporated; Proglaze or Tremsil 200.
 - e. Prior approved equal.

2.7 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; 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 Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 - 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 - 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, with 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, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of 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).

2.9 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
 - 1. Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - a. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.
- 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.
- C. Grind smooth and polish exposed glass edges and corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:

1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.
2. Presence and functioning of weep systems.
3. Minimum required face and edge clearances.
4. Effective sealing between joints of glass-framing members.

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

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving glass immediately before glazing. Remove coatings not firmly bonded to substrates.
- B. Examine glazing units to locate exterior and interior surfaces. Label or mark units as needed so that exterior and interior surfaces are readily identifiable. Do not use materials that leave visible marks in the completed Work.

3.3 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.
- B. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass includes glass with edge damage or other imperfections that, when installed, could weaken glass, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- F. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- H. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- J. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- K. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first, then to jambs. Cover horizontal framing joints by applying tapes to jambs, then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks, and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks, and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Immediately after installation remove nonpermanent labels and clean surfaces.

- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer. Remove and replace glass that cannot be cleaned without damage to coatings.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.8 MONOLITHIC GLASS SCHEDULE

- A. Glass Type [**GL-3**]: Clear float glass.
 - 1. Minimum Thickness: 6 mm.
- B. Glass Type [**GL-4**]: Clear heat-strengthened or fully tempered float glass.
 - 1. Minimum Thickness: 6 mm.
 - 2. Safety glazing required.

3.9 INSULATING GLASS SCHEDULE

- A. Glass Type [**GL-1**]: Low-E-coated, clear insulating glass.
 - 1. Basis-of-Design Product: Guardian Industries, Corp; SunGuard Super Neutral 68
 - 2. Overall Unit Thickness: 1 inch (25 mm).
 - 3. Minimum Thickness of Each Glass Lite: 6 mm.
 - 4. Outdoor Lite: Annealed, Heat-strengthened, or Fully Tempered float glass.
 - 5. Interspace Content: Argon.
 - 6. Indoor Lite: Annealed.
 - 7. Low-E Coating: Pyrolytic or sputtered on second or third surface.
 - 8. Winter Nighttime U-Factor: .25 maximum.
 - 9. Summer Daytime U-Factor: .28 maximum.
 - 10. Visible Light Transmittance: 58 percent minimum.
 - 11. Solar Heat Gain Coefficient: .35 maximum.
 - 12. Safety glazing required.
- B. Glass Type [**GL-2**]: Low-E-coated, clear insulating glass, indoor lite heat strengthened.
 - 1. Basis-of-Design Product: Guardian Industries, Corp; SunGuard Super Neutral 68
 - 2. Overall Unit Thickness: 1 inch (25 mm).
 - 3. Minimum Thickness of Each Glass Lite: 6 mm.
 - 4. Outdoor Lite: Annealed, Heat-strengthened, or Fully Tempered float glass.
 - 5. Interspace Content: Argon.
 - 6. Indoor Lite: Fully tempered float glass.
 - 7. Low-E Coating: Pyrolytic or sputtered on second or third surface.
 - 8. Winter Nighttime U-Factor: .25 maximum.
 - 9. Summer Daytime U-Factor: .28 maximum.
 - 10. Visible Light Transmittance: 58 percent minimum.
 - 11. Solar Heat Gain Coefficient: .35 maximum.
 - 12. Safety glazing required.
- C. Glass Type [**GL-11**]: Ceramic-coated, tinted insulating spandrel glass.
 - 1. Basis-of-Design Product: Guardian Industries, Corp; SunGuard Super Neutral 68.
 - 2. Overall Unit Thickness: 1 inch (25 mm).
 - 3. Minimum Thickness of Each Glass Lite: 6 mm.
 - 4. Outdoor Lite: Annealed, Heat-strengthened or Fully tempered float glass.
 - 5. Tint Color: As selected by Architect from manufacturer's full range.
 - 6. Interspace Content: Argon.

7. Indoor Lite: Heat-strengthened or fully tempered float glass.
8. Opaque Coating Location: Fourth surface.
9. Opaque Coating Color: As selected by Architect from manufacturer's full range.
10. Winter Nighttime U-Factor: .25 maximum.
11. Summer Daytime U-Factor: .28 maximum.

END OF SECTION 088000

FINISH SPECIFICATIONS TYNDALL, SD						
CODE	MATERIAL	MANUFACTURER	STYLE	COLOR	NUMBER	COMMENTS
AC11	ACCOUSTICAL TILE	ARMSTRONG	CIRRUS	WHITE		
AC12	SEALED/CLEANABLE ACCOUSTICAL TILE	USG	CLIMAPLUS	WHITE	584	REGULAR EDGE
GYP1	GYP/UM BOARD CEILING - SMOOTH SURFACE, 1 COAT PRIMER, 2 FINISH COATS					
	WALL					
P1	SMOOTH, 1 COAT PRIMER, 2 FINISH COATS	SHERWIN WILLIAMS				
P2	SMOOTH, 1 COAT PRIMER, 2 FINISH COATS	SHERWIN WILLIAMS				
P3	SMOOTH, 1 COAT PRIMER, 2 FINISH COATS	SHERWIN WILLIAMS				
P4	SMOOTH, 1 COAT PRIMER, 2 FINISH COATS	SHERWIN WILLIAMS				
EPX1	EPOXY PAINT, 1 COAT PRIMER, 2 FINISH COATS	SHERWIN WILLIAMS				
EPX2	EPOXY PAINT, 1 COAT PRIMER, 2 FINISH COATS	SHERWIN WILLIAMS				
WC1	VINYL WALL COVERING - TYPE 2 ONLY	SYMPHONY	RRABODY			PATIENT ROOM HEADWALLS ONLY
WC2	VINYL WALL COVERING - TYPE 2 ONLY	MD&ESQUIRE	FREY			CHAPEL ONLY
WC3	VINYL WALL COVERING - TYPE 2 ONLY	NATIONAL WALL COVERING	NANNING STRIPE			NURSE STATION ONLY
WP1	SHEET WALL PROTECTION	CS AGRUVYN	040 SHEET	SUEDE TEXTURE		BUTT JOINTS TOGETHER; NO VERTICAL TRIM
BG1	BUMPER GUARD	CS AGRUVYN	SCR-50			
CG1	CORNER GUARD	CS AGRUVYN	SM20- FULL HEIGHT			
OWT1	CERAMIC WALL TILE - GROUT COLOR NOTED IN COMMENTS - 12X24	AMERICAN OLEAN	DANYA			HORIZONTAL INSTALL, GROUT COLOR
	FLOOR					
OPT1	CARPET - BROADLOOM	SHAW	LAYER 5A183			
CT1	CERAMIC TILE - 1X1 TILE - GROUT NOTED IN COMMENTS	AMERICAN OLEAN	UNGLAZED MOSAIC			GROUT COLOR
CT2	CERAMIC TILE - 12X12	AMERICAN OLEAN	DANYA			GROUT COLOR
SV1	SHEET VINYL FLOOR - HEAT WELDED SEAMS - WOOD LOOK	ARMSTRONG	TIMBERLINE			
SV2	SHEET VINYL FLOOR - HEAT WELDED SEAMS	ARMSTRONG	MEDINTONE			
LVT1	LUXURY VINYL TILE - WOOD PLANK	ARMSTRONG	NATURAL CREATIONS: ARBOR ART			
LVT2	LUXURY VINYL TILE - WOOD PLANK - ACCENT ONLY	ARMSTRONG	NATURAL CREATIONS: ARBOR ART			
VCT1	VINYL COMPOSITE TILE - 12X12	ARMSTRONG	STD EXCELON			
SC	SEALED CONCRETE		IMPERIAL TEXTURE	CLEAR		
	BASE					
CTB1	CERAMIC TILE BASE - GROUT NOTED IN COMMENTS	AMERICAN OLEAN	DANYA			
VB1	VINYL BASE	VPI	4" BASE			
INT2	INTEGRAL BASE - FOR USE WITH SV2 ONLY	ARMSTRONG	MEDINTONE			
	CASEWORK					
PLAM1	HORIZONTAL - COUNTER TOPS	WILSONART	PATTERNED			
PLAM2	VERTICAL - CASEWORK	WILSONART	WOOD GRAIN			
PLAM3	VERTICAL - CASEWORK	WILSONART	WOOD GRAIN			
SSM1	COUNTER TOPS - INTEGRAL SINKS	FORMICA SOLID SURFACE				
SSM2	WINDOW SILLS	CULTURED GRANITE				
SSM3	TRANSACTON TOP ONLY	FORMICA SOLID SURFACE				
	FABRICS					
SHCRTN	SHOWER CURTAIN	STANDARD TEXTILE				CURTAINS PROVIDED UNDER OWNER EQUIPMENT
ASB	ACCOUSTIC SOUND BOARD	KORSEAL	SOUND DESIGNS			
WT1	WINDOW TREATMENTS - ROLLER SHADES, 3% OPENESS	INSOLROLL	ROLLER SHADES			
	MISC ITEMS					
HR	HAND RAIL	CS AGRUVYN	HRE-20			

MOCK-UPS

- A. Textured finishes, 24x24

INTERIOR GYPSUM BOARD

- A. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - a. Thickness: 5/8 inch (15.9 mm).
 - b. Long Edges: Tapered.
- B. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 - a. Thickness: 5/8 inch (15.9 mm).
 - b. Long Edges: Tapered.

TILE BACKING PANELS

- A. Product: USG Corporation; DUROCK Cement Board.
- B. Thickness: 5/8 inch (15.9 mm), Type X

FINISHING GYPSUM BOARD

- A. Level 2: Ceiling plenum areas, concealed areas, and where indicated.
- B. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.

STENCILING

Walls shall be stenciled with fire separation/rating every 20' above ACT ceiling.

END OF SECTION

SUBMITTALS

1. Full size verification Samples for each type of approved tile, grout, and sealant, mounted on plywood or hardboard, 24 inches square
2. 6 inch long, full profile sample of Metal Edge Strip

SITE CONDITIONS

1. Maintain temperature in tiled areas of at least 60 degrees F for 7 days before, during and after installation.

MAINTENANCE STOCK

1. Furnish additional tile from same production run for a total of 5% of installed quantity

PRODUCT

- | | | |
|--------------------------|------------------|-------|
| 1. (PT1) Porcelain Tile: | To Be Determined | _____ |
| 2. (CT1) Ceramic Tile: | To Be Determined | _____ |
| 3. Epoxy Grout: | To Be Determined | _____ |

ACCESSORIES

1. Metal Edge Strip: Extruded profile sized for set tile thickness and adjoining floor finishes.
 - A. Manufacturer: Schluter Systems L.P.
 - B. Finish: To be determined.

END OF SECTION

SUBMITTALS

1. Full-size Samples of selected panels, and 6 inches long Samples of each linear component.

MAINTENANCE STOCK

2. Furnish 2 percent of the installed area for each type of panel from the same production run for maintenance stock.

MANUFACTURER

1. USGBC
2. or equal

STYLE

1. ACT1 - Halcyon Climaplus R-3.3 (3/4" product): For Offices and Exam Rooms without walls to deck
2. ACT2 – Clean Room Climaplus Class 100: For Wet Rooms and Surgery Rooms
3. ACT3 – Frost Climaplus: For common spaces, corridors, etc. (Also for offices and exam rooms if walls go to deck)

GRID

1. ACT1 – Standard 2' x 2' grid
2. ACT2 – Extruded Aluminum 2' x 2' grid
1. ACT3 – Standard 2' x 2' grid

INSTALLATION

1. Lay out ceiling to balance border widths at opposite edges of each ceiling. Avoid use of border units that are less than half size. Comply with reflected ceiling plans.
2. Install grid supports 48 inches o.c. maximum.

END OF SECTION

SECTION 09-6500 - RESILIENT FLOORING**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Sheet flooring.
- B. Rubber Flooring.
- C. Resilient base.
- D. Transition strips.

1.02 SUBMITTALS

- A. Manufacturer's Product Data for each product and accessory.
- B. Samples of selections specified, or color charts of standard colors for items not already specified, for selection by Architect.
- C. Shop Drawings showing location and extent of resilient flooring, clearly indicating directions, locations, patterns, types of edge strips. Show installation details at special conditions.

1.03 QUALITY ASSURANCE

- A. Installer of sheet flooring shall be certified in writing by the sheet flooring manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Store materials containing solvents in sealed containers.

1.05 SITE CONDITIONS

- A. Continuously heat areas to receive resilient flooring to 70 degrees F 48 hours before, and until 48 hours after installation. After installation maintain 55 degrees F.
- B. Store materials in the installation area at least 48 hours prior to installation.

1.06 MAINTENANCE STOCK

- A. Furnish 2 percent of installed area of each type of resilient flooring from same production run, exclusive of material required to properly complete the installation. Wrap each type separately in protective coverings. Label with Project title and number, manufacturer, brand name, pattern, color, and lot number.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Acceptable manufacturers: Products indicated in Section 09-0610 are the standard for color, texture, and performance.

2.02 GENERAL

- A. Appearance: Same color run, color, and pattern uniformly distributed throughout thickness; variation in shade or pattern between containers shall be rejected.
- B. Dimensions: Uniform size and thickness; edges sharply cut to permit tight, inconspicuous joints.

2.03 FLOORING PRODUCTS

- A. Sheet vinyl without backing (RF1 and RF2): ASTM F1303, wear layer Type 1, Grade 1, Class B, 3 ply fused backing, 0.20 inch thick clear PVC wear layer, 2.34 inch total thickness.
- B. Rubber flooring (RF3 thru RF11): ASTM F1344, Class 1, slip resistance meeting ASTM D2047 greater than 0.5, flammability meeting ASTM E 648 and NFPA 253 not less than 0.45 watts per square centimeter.
- C. Resilient base (RB): ASTM F1861, Type TP, Group 1, rubber; Style A straight (toeless) and Style B coved (toe); height as indicated; 1/8 inch gauge.

2.04 ACCESSORIES

- A. Adhesives: Waterproof, low VOC, stabilized type recommended by the flooring manufacturer for conditions of use.
- B. Adhesives at beds: Armstrong S-240 Epoxy Adhesive to be used under entire bed area (minimum of 4 feet by 7 feet) in all rooms utilizing Hill-Rom beds.
- C. Edge strips: Rubber or vinyl reducing strips of same thickness as adjacent resilient flooring; color as selected.
- D. Miscellaneous: Primers, cleaners, floor finishing products, fasteners, and other accessories with low VOC recommended by primary flooring manufacturer for conditions of use.

PART 3 - EXECUTION**3.01 SURFACE PREPARATION**

- A. Prior to start of work, clean surfaces to be covered; remove grease, oil, and other surface contamination which might prevent satisfactory results. Surface preparation and installation shall comply with manufacturer's recommendations.
- B. Fill cracks, holes, and depressions with leveling compound. Remove surface irregularities which might telegraph to the finished flooring surface.
- C. Perform moisture tests to ensure that new concrete floors, patches, and repairs are sufficiently cured to receive resilient flooring.

- D. Apply primers as recommended by manufacturer.

3.02 INSTALLATION

- A. Install flooring materials only after finishing operations are complete. Where movable equipment is shown, install flooring before installation of equipment.
- B. Butt flooring material tightly to vertical surfaces; scribe and cut edges neatly. Extend into toe spaces, door reveals, closets, and similar openings and recesses.
- C. Lay sheet flooring to provide as few seams as possible without undue waste of material. Lay with seam edges matched for color and pattern; if necessary reverse adjoining sheets so abutting edges are from the same edge of roll. Double cut seams if required. Roll material in two directions, starting at center of sheet, to remove blisters, wrinkles, and air pockets. Weld seams in sheet flooring in compliance with manufacturer's instructions to produce a seamless installation.
1. Welded seams at RF1 and RF2.
 2. Welded seams only as indicated on Drawings for RF3 thru RF11.
- D. If the manufacturer recommends waxing, wax and buff immediately after installation.
- E. Install base on walls, columns, casework, and similar items in rooms scheduled to have resilient base.
- F. Cement base to backing, using the longest lengths practicable. Both top and bottom edges shall be perfectly aligned and in continuous contact with abutting surface. Butt joints shall be tight. On irregular wall surfaces, fill voids along top edge of base with manufacturer's recommended adhesive filler.

3.03 CLEANING AND PROTECTION

- A. Remove excess adhesive and other blemishes created by this work from flooring and adjacent surfaces using cleaning material recommended by manufacturer.
- B. Protect floor against damage from rolling loads for initial period following installation by covering with plywood or hardboard. Use dollies to move stationary equipment or furnishings across floor. Protect finished work from damage with Kraft paper or other protective covering.
- C. Immediately prior to final inspection, thoroughly clean floor covering and replace damaged material with new material. Clean floor by method recommended by manufacturer.

- D. For patching work, match pattern of existing materials.

- E. Do not wash floor until time period recommended by resilient flooring manufacturer has elapsed to allow floor to become well-sealed in adhesive. Clean resilient flooring by method recommended by the manufacturer.

END OF SECTION

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. Rubber floor tile.

B. Related Sections:

- 1. Section 079200 "Joint Sealants".
- 2. Section 033000 "Cast-in-Place-Concrete" for concrete slab-on-grade or topping slabs.
- 3. Section 096513 "Resilient Base and Accessories" for resilient wall base and accessories installed with resilient tile flooring.
- 4. Section 096516 "Resilient Sheet Flooring" for floor finishes related to this section.
- 5. Section 096543 "Linoleum Flooring" for floor finishes related to this section.
- 6. Section 096813 "Tile Carpeting" for floor finishes related to this section.
- 7. Section 096816 "Sheet Carpeting" for floor finishes related to this section.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include manufacturer's technical data, installation and maintenance instructions for flooring and accessories.

- B. Shop Drawings: For each type of floor tile. Include floor tile layouts, edges, columns, doorways, enclosing partitions, built-in furniture, cabinets, and cutouts.

- 1. Show details of special patterns.

- A. Samples for Initial Selection: For each type of floor tile indicated.

- B. Samples: Submit the manufacturer's standard samples showing the required colors for flooring and applicable accessories.

- C. Moisture Testing Locations and Results: Submit a diagram of the area showing the locations and results of each test to Architect and General Contractor. Flooring shall not be installed until sub-floor meets moisture requirements.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Test Reports: Submit the manufacturer's certification that the flooring has been tested by an independent laboratory and complies with the required fire tests.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of floor tile to include in maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

- 1. Floor Tile: Furnish one box for every 50 boxes or fraction thereof, of each type, color, and pattern of floor tile installed.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified installer who employs workers for this Project who are competent in techniques required by manufacturer for floor tile installation and seaming method indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store floor tile and installation materials in dry spaces protected from the weather, with ambient temperatures maintained within range recommended by manufacturer, but not less than 50 deg F or more than 85 deg F. Store floor tiles on flat surfaces.

1.9 FIELD CONDITIONS

- A. Maintain ambient temperatures within range recommended by manufacturer, but not less than 65 deg F or more than 85 deg F, in spaces to receive floor tile during the following time periods:
 - 1. 48 hours before installation.
 - 2. During installation.
 - 3. 48 hours after installation.
- B. After installation and until Substantial Completion, maintain ambient temperatures within range recommended by manufacturer, but not less than 55 deg F or more than 95 deg F.
- C. Close spaces to traffic during floor tile installation.
- D. Close spaces to traffic for 48 hours after floor tile installation.
- E. Install floor tile after other finishing operations, including painting, have been completed.
- F. Do not install flooring over concrete slabs until they are sufficiently dry to achieve a bond with the adhesive, in accordance with the manufacturer's recommended bond and moisture tests.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Fire-Test-Response Characteristics: For resilient tile flooring, as determined by testing identical products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
 - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 W/sq. cm.
- B. FloorScore Compliance: Resilient tile flooring shall comply with requirements of FloorScore certification.

2.2 RUBBER FLOOR TILE (RT)

- A. Manufacturers: Subject to compliance with requirements, provide the manufacturer/product(s) listed below.
- B. RT-1:
 - 1. Manufacturer/Product: Noraplan Environcare, Article 2462.
 - 2. Tile Standard: ASTM F 1344, Class I-A, homogeneous rubber tile, solid color.
 - 3. Hardness: Not less than 85 as required by ASTM F 1344, measured using Shore, Type A durometer per ASTM D 2240.
 - 4. Wearing Surface: Smooth.
 - 5. Thickness: 0.125 inch.
 - 6. Size: 24 by 24 inches.
 - 7. Colors and Patterns:
 - a. VT-1: Noraplan Environcare - Driftwood #2787.

2.3 INSTALLATION MATERIALS

- A. 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.
- B. Adhesives: Water-resistant type recommended by floor tile and adhesive manufacturers to suit floor tile and substrate conditions indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, with Installer present, for compliance with requirements for maximum moisture content and other conditions affecting performance of the Work.

1. Verify that finishes of substrates comply with tolerances and other requirements specified in other Sections and that substrates are free of cracks, ridges, depressions, scale, and foreign deposits that might interfere with adhesion of floor tile.

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

3.2 PREPARATION

A. Prepare substrates according to floor tile manufacturer's written instructions to ensure adhesion of resilient products.

B. Concrete Substrates: Prepare according to ASTM F 710.

1. Subfloor finishes comply with requirements specified in Section 033000 "Cast-in-Place Concrete" for slabs receiving installation of a finished material.
2. Verify that substrates are dry and free of curing compounds, sealers, and hardeners.
3. Remove substrate coatings and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone, using mechanical methods recommended by floor tile manufacturer. Do not use solvents. . Remove foreign matter and curing agents at least 24 hours before anhydrous calcium chloride tests and 48 hours before relative humidity tests will be run.
4. Alkalinity and Adhesion Testing: Perform tests recommended by floor tile manufacturer. Proceed with installation only after substrate alkalinity falls within range on pH scale recommended by manufacturer in writing, but not less than 5 or more than 9 ph.
5. Moisture Testing: Proceed with installation only after substrates pass testing according to floor tile manufacturer's written recommendations, but not less stringent than the following:
 - a. Perform anhydrous calcium chloride test according to ASTM F 1869. Proceed with installation only after substrates have maximum moisture-vapor-emission rate of 5 lb of water/1000 sq. ft in 24 hours.
-OR-
 - b. Perform relative humidity test using in situ probes according to ASTM F 2170 Allow 72 hours to achieve moisture equilibrium within the hole before taking measurements. Proceed with installation only after substrates have a maximum 85 percent relative humidity level.
 - c. Perform a minimum of 3 tests for the first 1000 sq ft and 1 test for each 1000 sq ft after. Place the first test in the center of the room and remaining tests around the perimeter.
 - d. Submit a diagram of the area showing the locations and results of each test to Architect and General Contractor.
 - e. Flooring shall not be installed until sub-floor meets moisture requirements.
 - f. Where results are not achieved and approved by Architect and General Contractor, apply a moisture vapor reduction/containment product following manufacturer's recommendations.
 - g. After all tests are completed and results verified and approved, floor installation must not be delayed or test results will no longer be valid.

C. Access Flooring Panels: Remove protective film of oil or other coating using method recommended by access flooring manufacturer.

D. Fill cracks, holes, and depressions in substrates with trowelable leveling and patching compound; remove bumps and ridges to produce a uniform and smooth substrate.

E. Preparation for Flush Flooring Surface Material Transitions:

1. Slope, or "feather", sub-floor where necessary with leveling compound 1/16"/1'-0" to attain a flush flooring surface transition to adjacent metal edge profile, threshold or flooring material.

F. Do not install floor tiles until they are the same temperature as the space where they are to be installed.

1. At least 48 hours in advance of installation, move resilient floor tile and installation materials into spaces where they will be installed.

G. Immediately before installation, sweep and vacuum clean substrates to be covered by resilient floor tile.

3.3 FLOOR TILE INSTALLATION

A. Comply with manufacturer's written instructions for installing floor tile.

- B. Install material in each area from the same production run. Unmatched materials will be rejected and will be replaced at no expense to the owner.
- C. Lay out floor tiles from center marks established with principal walls, discounting minor offsets, so tiles at opposite edges of room are of equal width. Adjust as necessary to avoid using cut widths that equal less than one-half tile at perimeter.
 - 1. Lay tiles square with room axis unless pattern is indicated.
- D. Match floor tiles for color and pattern by selecting tiles from cartons in the same sequence as manufactured and packaged, if so numbered. Discard broken, cracked, chipped, or deformed tiles.
 - 1. Lay tiles with grain running in one direction.
- E. Scribe, cut, and fit floor tiles to butt neatly and tightly to vertical surfaces and permanent fixtures including built-in furniture, cabinets, pipes, outlets, and door frames.
- F. Extend floor tiles into toe spaces, door reveals, closets, and similar openings. Extend floor tiles to center of door openings.
- G. Maintain reference markers, holes, and openings that are in place or marked for future cutting by repeating on floor tiles as marked on substrates. Use chalk or other nonpermanent marking device.
- H. Adhere floor tiles to flooring substrates using a full spread of adhesive applied to substrate to produce a completed installation without open cracks, voids, raising and puckering at joints, telegraphing of adhesive spreader marks, and other surface imperfections.
- I. Joint Sealant: Apply clear sealant to floor tile at door frames, flooring surface transition seams, gaps between flooring and base caused by uneven subfloor, and at other joints and penetrations.

3.4 CLEANING AND PROTECTION

- A. Comply with manufacturer's written instructions for cleaning and protecting floor tile.
- B. Perform the following operations immediately after completing floor tile installation:
 - 1. Remove adhesive and other blemishes from exposed surfaces.
 - 2. Sweep and vacuum surfaces thoroughly.
 - 3. Damp-mop surfaces to remove marks and soil. Do not flood floor.
- C. Protect floor tile from mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period.
 - A. Floor Finish: Verify with manufacturer the recommended products and process for finishing/polishing resilient sheet flooring installations. Remove soil, adhesive, and blemishes from floor tile surfaces before applying manufacturer's recommended coatings.
 - 1. Apply number of coat(s) as recommended by manufacturer.
 - B. Cover floor tile until Substantial Completion.

END OF SECTION 096519

SECTION 09-9100 - PAINTING**PART 1 - GENERAL****1.01 SECTION INCLUDES**

- A. Field application of a finish paint coating throughout the construction area, on all exposed surfaces of new, repaired, or patched exterior and interior materials and equipment, unless excluded.
- B. Field finish painting is not required for:
 1. Stainless steel or plated metal finishes.
 2. Factory-applied finish coatings.
 3. Glass, plastics, floors, acoustic materials, face brick, stonework, chalkboards, and other surfaces not normally requiring a painted finish.
 4. Concealed or inaccessible surfaces, such as pipe or duct shafts, elevator shafts, crawl spaces, attics.
- C. Requirements for shop priming steel.
- D. Special coatings: Fire retardant varnish.

1.02 RELATED WORK

- A. Prime coats for field-finished products: See respective sections.

1.03 SUBMITTALS

- A. Manufacturer's Product Data verifying compatibility with substrates and conditions to be encountered.
- ~~B. LEED submittals: Refer to Section 01-8112 for submittal forms and requirements.

 1. For products containing recycled materials: Documentation of post-consumer and pre-consumer recycled content, and cost of each product having recycled content.
 2. Documentation of VOC content for materials used in interior spaces.
 3. Documentation of place of extraction and manufacture for materials or components extracted or harvested, and manufactured within 500 miles of the project site.~~
 - ~~B.~~ B. Samples of available colors, sheens, and textures for preliminary selection.
 - ~~C.~~ C. Samples of selected finishes on clearly labeled 8 inches by 10 inches wood or hardboard surfaces to simulate actual conditions.
 - ~~D.~~ D. Finish schedule, including all surfaces to be painted; and manufacturer, type, and color to be applied to each.

1.04 QUALITY ASSURANCE

- A. Prepare demonstration panels by duplicating the finish of the approved Samples at the work site on designated wall surfaces and building components.
- B. Demonstration panels shall consist of an area of at least 50 square feet, a complete door assembly and hollow metal frame assembly.
- C. Preserve accepted panels, which will be used as the standard for remaining work.
- D. Paints and accessories of each type shall be produced or recommended by a single manufacturer.

1.05 DELIVERY

- A. Deliver in original containers with manufacturer's labels intact. Labels shall indicate manufacturer's name, product name, listing of pigment and vehicle constituents, color identification, and application instructions.
- B. Store materials at job site in a single location, protected from freezing.

1.06 SITE CONDITIONS

- A. Maintain surface and air temperatures between 45 and 90 degrees F, and relative humidity below 85 percent.
- B. Do not apply paint to damp or wet surfaces.
- C. Do not apply paint in snow, rain, fog, or mist.
- D. Enclose, heat, and dry substrates as required to maintain limits specified by the paint manufacturer.
- E. Do not paint plaster containing more than 15 percent moisture.
- F. Do not paint surfaces exposed to hot sun.

PART 2 - PRODUCTS**2.01 MANUFACTURERS**

- A. Acceptable manufacturers:
 1. Benjamin Moore & Co., Montvale, NJ.
 2. Diamond-Vogel Paints, Orange City, IA.
 3. Hirshfield's, Minneapolis, MN.
 4. ICI Paints, Cleveland, OH.
 5. Iowa Paint Mfg. Co., Inc., Des Moines, IA.
 6. Pittsburgh Paints (PPG), Pittsburgh, PA.
 7. Pratt and Lambert, Cleveland, OH.
 8. Sherwin-Williams, Cleveland, OH.
- B. Standard: Paint systems are specified using Sherwin-Williams product numbers to establish type, quality, and content of paint. Provide specified

products or approved equivalent by another acceptable manufacturer.

2.02 MATERIAL QUALITY

- A. Pigments: Non-fading, suitable for conditions of use.
- B. Washability: Finished surfaces shall withstand normal washing to remove ordinary soil without showing discoloration, loss of gloss, staining, or other damage.
- C. Exterior or high temperature areas: Products specifically recommended by manufacturer for such use.

2.03 ~~SPECIAL COATINGS – FIRE RETARDANT VARNISH [AD1]~~

- A. ~~Acceptable manufacturer: Flame Control Coatings, Inc., Niagara Falls, NY. [AD 1]~~
- B. ~~Sealer: Flame Control Coatings No. 10 low VOC FR. [AD 1]~~
- C. ~~[AD 1]~~

PART 3 - EXECUTION

3.01 PRIMING STEEL

- A. Prepare products that are not shop-primed as follows.
- B. Exterior exposed steel:
 - 1. Surface preparation: SSPC-SP6 Commercial Blast Cleaning, surface profile: 1.5 to 2.0 mils.
 - 2. Primer: One of the following, DFT as recommended by manufacturer.
 - a. Tnemec 90-97 Tneme-Zinc.
 - b. Sherwin-Williams Corothane I Zinc Primer.
- C. Interior steel:
 - 1. Surface preparation: SSPC-SP3 Power Tool Cleaning.
 - 2. Primer: One of the following, DFT as recommended by manufacturer.
 - a. Tnemec 10 Primer.
 - b. Sherwin-Williams Hi-Solids Alkyd Metal Primer B50NZ2 or B50WZ3.
- D. Visually evaluate surface preparation by comparison with pictorial standards in accordance with SSPC-Vis 1-89.
- E. Measure dry film thickness in accordance with SSPC-PA2.

- F. Repair runs, sags, dry spray, overspray, embedded particles, missed areas, and defective or damaged areas.

3.02 PREPARATION

- A. Protect other surfaces from damage during painting. Use materials that can be removed without damaging or leaving residue on substrate.
- B. Remove door hardware, device plates, light fixtures, and similar items, or provide surface-applied protection before surface preparation and painting. Replace items and remove protection after painting is completed.
- C. Remove dust, dirt, rust, scale, grease, and other surface contamination.
- D. Repair minor defects in concrete or masonry with spackle or patching plaster.
- E. Repair minor defects in wood with putty, tinted to match stain where transparent is used.
- F. Touch up shop applied prime coats where damaged or bare. Apply prime coat to surfaces that are not factory primed.
- G. Remove handling marks and other finish damage from wood doors and casework by hand sanding in the direction of the wood grain. Match factory finishes.
- H. Seal wood that has not been shop primed or sealed immediately upon delivery to work site. Back prime concealed wood surfaces. Use spar varnish to back prime wood that shall receive clear finish.
- I. Seal tops, bottoms, and mortises of wood doors and seal with 2 coats of sealer or varnish after final field fitting. Finish tops, bottoms, and edges of doors the same as faces.

3.03 APPLICATION

- A. Stir materials before and during application to produce uniform color and density. Use applicators and techniques best suited to substrate and material being applied. Sand lightly between coats.
- B. Apply materials under adequate illumination. Provide a surface free of brush marks, laps, roller skids, and other surface imperfections.
- C. Allow sufficient time between coats to permit proper drying.
- D. Do not paint over UL or other code-required labels, or equipment identification, performance, or name plates. Do not paint operating portions of valves, dampers, sensing devices, controls, motors, or similar devices.

- E. Tint each undercoat a slightly lighter color to facilitate identification of coats where multiple coats are specified.
- F. Roller-applied coats or spray-applied coats shall provide hiding equivalent to brush-applied coats. Do not double back over wet surfaces with spray or roller for purpose of building up film thickness of more than a normal brush coat.

3.04 NUMBER OF COATS

- A. Apply materials at the manufacturer's recommended spreading rate to establish the dry film thickness recommended by the manufacturer.
- B. The minimum number of coats required is indicated. Apply additional finish coats until the surface is of uniform color, sheen, and general appearance. Wall surfaces within the same room or corridor with the same finish color shall match.
- C. If factory-applied prime coats are in good condition and are compatible with finish coats, the specified prime coat may be omitted.

3.05 MISCELLANEOUS ITEMS

- A. Extend the finish beyond the end of demolition and patching to the next vertical corner, door, or window. If terminated at a door or window, cut to a straight vertical line from floor to ceiling at the edge of the frame.
- B. Finish closets the same as the room in which they occur, unless otherwise scheduled.
- C. Paint all edges and frame surfaces of doors, windows, access panels, and other field-finished operable assemblies exposed when opened. Leave open until paint is dry. Operate through full range of travel after paint is dry to ensure free operation; remove excess paint and repaint if required.
- D. Paint flat black the interior surfaces of ducts that are visible through grilles or registers.
- E. Prime new drywall that is indicated to receive wall covering.
- F. Size or seal surfaces mechanical insulation before painting.
- G. Finish interior surfaces of wood cabinets without doors or drawers the same as exterior surfaces. Finish interior of closed wood cabinets, including drawers, with 1 coat of sanding sealer and 1 coat of satin varnish.

3.06 PROTECTION AND CLEANING

- A. Provide barricades and "Wet Paint" signs to protect painted finishes.

- B. Remove temporary coverings. Clean glass and paint-spattered or smeared surfaces using materials and methods that will not scratch, stain, or damage such surfaces.

3.07 SHEEN

- A. Definitions:
 1. Flat: 0 to 9 units at 85 degrees.
 2. Eggshell: 10 to 24 units at 85 degrees.
 3. Satin: 25 to 29 units at 60 degrees.
 4. Semi-gloss: 30 to 45 units at 60 degrees.
 5. Gloss: 70 units minimum at 60 degrees.
- B. Exterior sheen schedule:
 1. Metal: Gloss.
 2. Concrete, CMU: Flat or satin.
 3. Wood trim: Gloss.
 4. Other wood: Satin.
- C. Interior sheen schedule:
 1. Steel bar joists, steel deck, mechanical insulation, exposed overhead work: Flat.
 2. Ceilings: Eggshell.
 3. Walls: Eggshell or satin.
 4. Steel frames, radiation covers, stairs, rails; accordion door track, chain guide, wall mounted striker posts; other steel: Gloss.
 5. Hollow metal door frames and doors: Semi-gloss.
- D. Wood, stained: Satin.

3.08 EXTERIOR PAINT SCHEDULE

- A. Concrete masonry units:
 1. 1 coat S-W PrepRite Block Filler B25W25. 42 grams per liter VOC.*
 2. 2 coats S-W 100 percent Acrylic B12WF Series, satin. 96 grams per liter VOC.
- B. Ferrous metal, primed metal, zinc-coated metal, light duty:
 1. 1 coat S-W Pro-Cryl Universal Metal Primer B66-310 Series. 110 grams per liter VOC.*
 2. 2 coats S-W SuperPaint Exterior High Gloss A85 Series. 118 grams per liter VOC.

3.09 INTERIOR PAINT SCHEDULE

- A. Gypsum wallboard, concrete, mineral-fiber reinforced cement panels; walls, normal exposure.
 1. 1 coat S-W Harmony Interior Primer B11W900. 0 grams per liter VOC.
 2. 2 coats S-W Harmony Interior Latex Eg-shel B9W900 Series. 0 grams per liter VOC.

- B. Gypsum wallboard, concrete, mineral-fiber reinforced cement panels; ceilings and soffits, normal exposure.
1. 1 coat S-W Harmony Interior Primer B11W900. 0 grams per liter VOC.*
 2. 2 coats S-W Harmony Interior Latex Flat B5W900 Series. 0 grams per liter VOC.
- C. Concrete masonry units:
1. 1 coat S-W PrepRite Block Filler B25W25. 42 grams per liter VOC.*
 2. 2 coats S-W Harmony Interior Latex Eg-shel B9W900 Series. 0 grams per liter VOC.
- D. Wood, transparent finish:
1. 1 coat (if color stain): S-W WoodClassics Wood Stain A49 Series. 524 grams per liter VOC.*
 2. 2 coats S-W WoodClassics Waterborne Polyurethane Varnish, stain. 309 grams per liter VOC.*
- E. Ferrous metal, primed metal, zinc-coated metal, and aluminum; light duty:
1. 1 coat S-W Pro-Cryl Universal Metal Primer B66-310 Series. 110 grams per liter VOC.*
 2. 2 coats S-W Harmony Interior Semi-Gloss B10W900 Series, semi-gloss. 0 grams per liter VOC.
- F. Ferrous metal, primed metal, zinc-coated metal, and aluminum; heavy duty:
1. 1 coat S-W Pro-Cryl Universal Metal Primer B66-310 Series. 110 grams per liter VOC.*
 2. 2 coats S-W Centurian Water Based 2K Urethane B65-700, gloss. 66 grams per liter VOC.
- G. Exposed overhead work:
1. 1 coat (as needed): S-W Pro-Cryl Metal Primer B66-310. 110 grams per liter VOC.*
 2. 1 coat S-W Waterborne Acrylic Eg-shel Dryfall B42W2. 58 grams per liter VOC.
- H. Wall surfaces scheduled to receive vinyl wall covering:
1. 1 coat PrepRite Classic Interior Latex Primer B28W101. 89 grams per liter VOC.*
- I. * Denotes coatings that are not categorized as flat or non-flat coatings. The Environmental Protection Agency has assigned 63 different categories for architectural and industrial maintenance coatings. Four of those categories are flat (interior and exterior) and non-flat (interior and exterior). GreenSeal requirements referenced by LEED refer only to flat and non-flat coatings.

- J. Pipe color coding schedule: Color coding of exposed piping color numbers are based upon Pratt and Lambert numbers, other paint systems may be specified, however, colors are to match these Pratt and Lambert numbers as listed below:
1. Natural gas: 1104 Queen's Jubilee B2 / 4.
 2. Propane: 1869 Mandarin B0 / 7.
 3. Fuel Oil: 2049 Safari B1 / 1.
 4. Standpipe and Sprinkler Piping: Banner Red.
 5. Steam Condensate: 1836 Carrot BY / 7.
 6. Chilled Water: 1653 Chufa B1 / 1.
 7. Condensed Water: 1404 Tide Pools B2 / 2.
 8. Heating Hot Water: 1029 Doll's Dress B1 / 3.
 9. Domestic Cold Water: 1208 Blueberry B3 / 4.
 10. Domestic Hot Water: 1032 Cerise Delight B3 / 5.
 11. Stenciled pipes at appropriate intervals to indicate carried contents, (e.g. Oxygen, Fire Sprinkler, Vacuum, etc.).

~~K. Gypsum board walls and ceilings EPNT: Locations – Room No.s 2102, 2105, 2106 and 2107. [AD 2]~~

~~1. 1 coat S-W PrepRite 200 Latex Wall Primer B28W200, 4 mils wet, 2 mils dry DFT. [AD 2]~~

~~2. Topcoat, Semi-Gloss: 2 coat S-W Water Based Catalyzed Epoxy, two component, B70W211 B60V25, 6.5 to 8.0 mils wet, 2.5 to 3.0 mils dry DFT. [AD 2]~~

END OF SECTION

OWNER FURNISHED ITEMS

- Owner Furnished, Contractor Installed Items
 - Paper towel dispenser
 - Toilet paper dispenser
 - Sanitary napkin dispenser
 - Soap dispenser
 - Alcohol dispenser
 - Cubicle Curtains and track
 - TV's and TV mounts

- Owner Furnished, Owner Installed Items
 - Fridge
 - Freezer
 - Microwave

END OF SECTION

PRODUCTS

(SWP) Sheet Wall Protection

- Construction Specialties, Inc.
- Size: 48x96 or 48x120
- Thickness: .040"
- Color: To be determined
- Mounting: Adhesive
- Texture: Suede

(BG) Bumper Guard

- Construction Specialties, Inc.: SCR-50N
- Profile: Convex
- Color/Texture: To be determined

(CG) Corner Guards

- Construction Specialties, Inc.: SSM-20
- Length: 4'-0"
- Color/Texture: To be determined

MAINTENANCE STOCK

Three full pieces of each material or 2%, whichever is greater

END OF SECTION

PUBLIC-USE WASHROOM ACCESSORIES

- (GB1) Grab Bar:
1. Mounting: Flanges with concealed fasteners
 2. Material: Stainless steel, 0.05 inch thick (min)
 - a. Finish: Smooth, No. 4 finish (satin)
 3. Outside Diameter: 1-1/2 inches
 4. Configuration and Length: As indicated on drawings
- (M1) Mirror 1:
1. Frame: Stainless-steel channel
 2. Corners: Manufacture's standard
 3. Hangers: Produce rigid, tamper and theft resistant installation
 4. Size: See drawings
- (CH) Coat Hook:
1. Description: Double-prong unit
 2. Material and Finish: Polished chrome-plated brass

END OF SECTION

FIRE PROTECTION CABINET (FEC)

MANUFACTURER

1. J.L. Industries, Inc. – Embassy Series, 10.5 inches by 24 inches by 6 inches
2. Or equal

CABINET CONSTRUCTION

Non-rated, steel construction

DOOR STYLE

Vertical duo panel with frame, clear float tempered glass

DOOR LOCK

Cam lock that allows door to be opened during emergency by pulling sharply on door handle.

IDENTIFICATION

Lettering to comply with authorities have jurisdiction.

Semi-recessed cabinets

FIRE EXTINGUISHERS

MANUFACTURER

1. J.L. Industries, Inc.
2. Or equal

TYPE

Multipurpose Dry-Chemical Type in Steel Container (FEC): UL rated, 5-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.

INSTALLATION

Mounting brackets: 54 inches above finish floor to top of fire extinguisher

END OF SECTION

- A. Window covering shall be provided on all exterior windows and all interior windows requiring privacy or light control.
- B. Fabrics used for drapery, curtains and other loosely hanging decorations must meet standards set forth in NFPA.
- C. Basis-of-design: MechoShade Systems, Inc.
 - Operation: Manual
 - Material: PVC-Coated fiberglass and polyester blend
 - Style: Basket weave
 - Color: To be determined _____
 - Material Openness Factor: 3 to 10%
 - UV Blockage Factor: 97 to 90%
 - Bottom Hem: Straight

END OF SECTION

DIVISION 21 - FIRE SUPPRESSION

SECTION 210100 - GENERAL PROVISIONS

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

This Section pertains to general provisions and requirements for construction of work specified in all sections of Division 21 herein.

"Contractor" referred to in this Section of the specification implies the Contractor, Subcontractor and/or Subcontractors which are responsible for all or any part of the mechanical installation specified in Division 21 and/or as shown on the Contract Drawings.

Where the specifications in subsequent Sections of Division 21 conflict with requirements of this Section, the specifications in the subsequent Sections shall govern.

The Contractor shall provide all items, articles, materials, operations or methods listed, mentioned or scheduled on the Drawings and/or herein specified, including all labor, materials, equipment, accessories, wiring and incidentals necessary to be installed in accordance with manufacturer's recommendations except as otherwise approved.

1.02 PERMITS AND SERVICE CHARGES:

All permits and service charges necessary for execution of the work under this Contract shall be obtained by and be paid for by the Contractor. It shall be the responsibility of the Contractor to determine the permit requirements of the local authorities and utility companies and the cost of required permits, service charges, tap fees and development fees shall be included in the Contractor's bid.

All work shall be executed in accordance with all local, state and national rules, regulations, codes, etc., which are applicable and shall be subject to inspection by the proper authorities.

1.03 CODES AND STANDARDS:

All work performed and all equipment furnished under this Division of the Contract shall be manufactured and installed in strict accordance with all applicable codes and standards, including the applicable provisions of the following codes and standards.

1. Local and State Codes, Standards and Regulations.
2. National Fire Protection Association (NFPA).
3. National Electric Code (NEC).
4. Underwriter's Laboratory (UL).
5. American Gas Association (AGA) Standards.
6. Uniform Plumbing Code.
7. International Mechanical Code.
8. ASME Boiler and Pressure Vessel Codes.
9. American Waterworks Association (AWWA).

10. National Sanitation Foundation (NSF).
11. Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA).
12. International Building Code.
13. Life Safety Code.
14. Americans with Disabilities Act (ADA).

All materials installed shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255 and UL 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.04 COMPLIANCE:

Where specific requirements of any code vary with the requirements of another code, the higher standard as determined by the Architect/Engineer shall govern the installation.

All equipment manufactured in accordance with the provisions of the above codes and standards shall bear the label of the respective association bureau thereon.

1.05 DRAWINGS:

In general, the Drawings of the mechanical systems and equipment are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural drawings which are dimensioned. Drawings shall not take precedence over field measurements.

Drawings of piping and ductwork, although shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction. If it is found, before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the Drawings, the Architect/Engineer may require the Contractor to change the location or arrangement of the work without additional cost to the Owner. Such rearrangement shall be in accordance with directions from the Architect/Engineer.

Where discrepancies are discovered after certain portions or phases of the work have been installed, the Architect/Engineer reserves the right to require the Contractor to make changes in pipe, duct, fixture or equipment locations or arrangements to avoid conflicts with work at no additional cost to the Owner.

Because the Drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the system are indicated does not mean that other similar or different features or details will not be required. The Contractor shall furnish all incidental labor, material or equipment for the systems so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the specifications.

The Contractor, Subcontractor's and their respective trades shall cooperate in laying out their work so it will fit properly into the space provided. Promptly report to the Architect/Engineer any delay or difficulties encountered in the installation of this work which might prevent prompt and proper installation, or make it unsuitable to connect with or receive the work of others. Failure to so report shall constitute an acceptance of the work of other trades as being fit and proper for the execution of this work.

1.06 SUBSTITUTIONS AND PRODUCT OPTIONS:

The Contractor and equipment suppliers shall read and familiarize themselves with articles concerning substitution of materials, as indicated in the Instructions to Bidders. Material and equipment substitutions will be handled as follows:

Materials or equipment specified by name of manufacturer, brand, trade name or catalog reference, shall be furnished under the contract unless changed by Addenda or a Contract modification. Where two (2) or more materials are named, the choice of these shall be optional with the Contractor.

Material or equipment followed by the phrase "or equal" shall establish a standard of required function, dimension, appearance and quality to be met by any proposed substitute. No substitution will be considered unless written request for substitution has been submitted by the bidder and has been received by the Architect/Engineer at least ten days prior to the date for receipt of bids. The Architect/Engineer's decision on a proposed substitute shall be final. If the Architect/Engineer considers any proposed substitution equal, such will be set forth in an Addendum. Bidders shall not rely upon substitutions made in any other manner.

Should the Contractor wish to use materials or equipment other than those specified or listed as equal by Addenda, he shall attach his proposed substitution along with the appropriate add or deduct to the Contract amount, should the substitution be accepted. Substitutions proposed by the Contractor will not be considered in the award of the Contract.

1.07 SHOP DRAWINGS:

Refer to the requirements of the General Conditions. Unless indicated otherwise in the General Conditions, submit to the Architect/Engineer seven (7) copies (minimum) of Shop Drawings for each item of equipment to be installed under this contract with two (2) copies to be retained by the Architect/Engineer. Furnish additional Shop Drawings as required for coordination with General Contractor and other Subcontractors.

To the extent practical, complete sets of shop drawings for each specification section shall be submitted. In the case that a particular item is required to be expedited, that particular item may be submitted individually.

Submit shop drawings punched in 3-hole format.

Furnish Shop Drawings as follows:

1. For all major items of equipment or materials, regardless of whether the item is to be furnished as specified.
2. For all equipment, systems or devices where Shop Drawings are specifically called for.
3. For all minor items of equipment or materials where the Contractor proposes to deviate from the specified and/or scheduled manufacturer or material.

The Contractor shall check all Shop Drawing submittals for size, capacity, arrangement, connection locations, materials, finish, color, electrical characteristics, accessories, and shall so note the Shop

Drawings prior to submittal to the Architect/Engineer. Any deviation from the Drawings and Specifications shall be indicated.

Shop Drawings will be reviewed by the Architect/Engineer, and copies of Shop Drawings will be returned to the Contractor. Shop Drawings shall be submitted sufficiently in advance of the construction schedule to allow time for checking Drawings, resubmittal and rechecking when necessary.

Any equipment or material which is installed without authorization by properly processed Shop Drawings will be subject to removal by the Contractor and reinstallation as directed, without cost to the Owner. All cost for repair for damages as may be incurred to the structure as a result of the above correction shall be paid by this Contractor.

Shop drawing material quantities will not be checked by the Architect/Engineer, and review of Shop Drawings by the Architect/Engineer shall not be construed to be verification of the material quantities and sizes shown on the Shop Drawings. Quantities, sizes, dimensions and locations shown on the Drawings and as specified shall determine material requirements.

1.08 CLEANING:

The Contractor and/or Subcontractors for the various phases of the work shall clear away all debris, surplus materials, etc., resulting from their work or operations, leaving the job and equipment furnished under any or all contracts in a clean first class condition.

Permanent heating and ventilating systems shall not be used during the construction period unless the project site is in a clean and dust free condition and shall be subject to the approval of the Architect/Engineer and Owner.

Surfaces of all mechanical equipment shall be wiped clean or washed if required, leaving the installation in a first class condition.

All equipment shall be thoroughly cleaned of all plaster, stickers, rust stains, and other foreign matter or discoloration, leaving every part in a first class condition and ready for use.

1.09 PAINTING:

Painting of materials and equipment furnished under the mechanical portion of the contract shall be as described in Division 9 - FINISHES. Contractor shall refinish and restore to the original condition and appearance, all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and workmanship shall be equal to the requirements described in Division 9 - FINISHES.

1.10 RECORD DRAWINGS:

The Contractor shall keep a complete set of all mechanical drawings in the jobsite office for purpose of showing the installation of mechanical systems and equipment. This set of drawings shall be used for no other purpose. Where any materials equipment or system components are installed different from that shown on the Architect/Engineer's drawings, such differences shall be clearly and neatly shown on this set of drawings using ink or indelible pencil. At the completion of the project, the record set of drawings shall be turned over to the Architect/Engineer and shall become his property.

1.11 OPERATING INSTRUCTIONS:

The Contractor shall furnish the Owner two (2) sets of complete catalog data, manufacturer's literature and detailed manuals covering the operation and maintenance of all equipment specified under this Division. All such literature shall be bound in an amply sized three-ring binder and submitted to the Architect/Engineer for approval and for eventual transmittal to the Owner. The manual shall have a Table of Contents at the front of the manual.

The Contractor shall also supervise the initial operation of all equipment and instruct the operator selected by the Owner in such operation as required to acquaint him thoroughly with the equipment.

1.12 DELIVERY AND STORAGE OF MATERIALS:

Make provisions for delivery and safe storage of materials on the jobsite and make arrangements with other Contractors for introduction into the building of equipment too large to pass through finished openings. Materials to be delivered at such stages of the work as will expedite the work as a whole and marked and stored in such a way as to be easily checked and inspected. All stored equipment shall be protected from the weather conditions and construction debris with a protective covering securely tied in place.

1.13 MECHANICAL PROVISIONS:

Mechanical equipment shall operate without objectionable noise or vibration, as determined by the Architect/Engineer. If such noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, piping, or other parts of the work, make necessary changes and additions, as approved, without extra cost to Owner.

Provide oil level gauges, grease cups and grease gun fittings for machinery bearings as recommended by the manufacturer. Extend oil or grease fittings by copper tubing to readily accessible locations.

1.14 CONCRETE BASES:

Concrete bases are required for floor mounted mechanical equipment inside buildings and are specified in Division 3 - CONCRETE. After bases are poured they shall set at least seven (7) days before mounting equipment. The Contractor shall coordinate the setting of expansion bolts in the bases for attachment of equipment and/or isolators.

This Contractor shall verify and coordinate the exact location of the bases and the exact size requirements for specific items of equipment.

1.15 COORDINATION OF WORK:

The Contractor shall process shop drawings and order equipment and materials expeditiously after receiving the Contract and the mechanical installation shall be substantially complete when the general construction work is completed. This Contractor shall confer and cooperate with all other Contractors on this project and shall arrange his work in proper relation to the work of others. Each Contractor shall furnish, install, and maintain in place all anchors, inserts, sleeves, etc., required for his work. Each Contractor will also be held solely responsible for proper size and location of all anchors, inserts, sleeves, chases, recesses, openings, bases, etc., required for proper installation of his

work. All cutting and patching made necessary by failure or neglect to coordinate with other Contractors shall be the responsibility of this Contractor. Any cutting or patching shall be subject to the direction and approval of the Architect/Engineer and all damage due to cutting or patching shall be repaired by this Contractor.

After being instructed by this Contractor to do so, the General Contractor will leave all openings in roof, walls, floors, etc., for the passage of pipes, etc. The General Contractor shall also provide concrete bases and roof curbs where shown for mounting the mechanical equipment unless specified otherwise. This Contractor shall verify the exact size and location required for installation of his equipment with the General Contractor.

In general, the Division 26 – Electrical Contractor will provide all power wiring and make one power connection to each item of mechanical equipment, as outlined under Electrical Section.

1.16 GUARANTEE:

All mechanical equipment including equipment used during construction for temporary purposes shall be guaranteed for a period of one year after the time of final acceptance of this work and shall be in like new condition at time of final acceptance.

1.17 ELECTRICAL:

Electric Motors:

All electric motor driven equipment being furnished and installed under Division 21 of these specifications shall be complete with electric motors, unless specified otherwise.

All electric motors shall be as manufactured by Westinghouse, Century, Wagner, Allis Chalmers, Reliance, General Electric, or equal. Bearings shall be ball type with alemite lubricating fittings extended to an easily accessible location for field servicing. Minimum service factors for all motors shall be 1.15. All motors shall conform to applicable NEMA standards and all motors specified for use in hazardous locations shall bear the stamp of approval of the Underwriter's Laboratories. All motors, except direct connected motors, shall be furnished complete with cast iron or stamped steel adjustable slide rails. Single phase motors shall be capacitor start type, drip proof, unless specified otherwise. All motors shall be single speed and shall operate at 1,750 RPM, unless specified otherwise.

Horsepower Rating: All electric motors shall be sized to meet the horsepower requirements of the driven unit at design characteristics including all V-belt and/or drive and coupling losses which are incurred without loading the motor beyond its nameplate horsepower rating. Where V-belt drives are employed, the motor horsepower nameplate ratings shall not be less than 120 percent of the driven unit brake horsepower requirements.

Single Phase Motors: Unless specifically noted otherwise, all electric motors shall be designed for operation in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current. Motors shall be thermally protected.

Three Phase Motors: All electric motors shall be designed for operating in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current.

All motors less than 3/4 horsepower shall be 115 volt, single phase unless designated otherwise and all motors 3/4 horsepower and larger shall be as specified in the specific section or as noted on the Drawings.

Two Speed Motors:

Two speed motors shall have two separate windings.

Premium Efficiency Motors:

Premium efficiency motors shall be furnished on all mechanical equipment where 1 horsepower or larger motors are required.

Motors shall be designed with special stator steel for reduced core losses. Windings shall be oversized copper placed for maximum efficiency. Stator and rotor shall be extra long to reduce flux losses. Frame shall be ODP (unless specified otherwise) of cast iron or cast aluminum construction.

Motors shall be squirrel cage, horizontal base mount, ball bearing, NEMA B design, Class B design, Class B insulation, continuous duty, 1.15 SF, 40 degrees C. ambient.

Minimum nominal full load motor efficiencies shall be based on ASHRAE Standard 90 (latest edition).

Furnish and install Aegis SGR, or equal, maintenance free, circumferential, conductive micro fiber shaft grounding rings on all AC motors controlled by adjustable frequency drives to discharge shaft currents to ground.

Motors shall be similar to Louis Allis "Spartan" Series, Gould "E-Plus" Series, or Westinghouse "MAC II" Series. Manufacturer shall furnish proof of efficiency rating.

Motor Starters:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 21 of these specifications, all motor starters will be furnished and installed under Division 26, ELECTRICAL.

Electrical Wiring:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 21, all electric power wiring shall be furnished and installed in Division 26, ELECTRICAL. The Electrical Contractor will make one power connection to each item of mechanical equipment, unless specified otherwise.

Electrical wiring furnished and installed under these specifications shall conform to all applicable requirements of Division 26, ELECTRICAL.

Unless otherwise indicated, all motors and controls shall be furnished, set in place and wired in accordance with the following schedule:

<u>Item</u>	<u>Division Furnished Under</u>	<u>Set in Place or Mounted Under</u>	<u>Division Wired & Connected Under</u>
Equipment Motors	21	21	26
Magnetic Motor Starters:			
Automatically controlled, with or without HOA switches	26	26	26
Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	21	21	26
Manually controlled	26	26	26
Manually controlled and furnished as part of factory wired equipment	21	21	26
Motor valves, Solenoid valves, EP and PE switches, etc.	21	21	21
Alarm bells	21	21	21
Control circuit feeders	26	26	26
Low voltage controls, valves, etc.	21	21	21
Fire protection controls	21	21	26

Heat tape	26	26	26
Disconnect switches, thermal overload switches, manual operating switches	26	26	26
Multi-speed switches	21	26	26
Contactors	26	26	26
Control relays, transformers	21	26	26

NOTES:

- (1) Wiring from alarm contacts to alarm system shall be by the Division 26 Contractor; control function wiring shall be by the Division 21 Contractor.

All control wiring and controls as noted on the Drawings and/or as specified in these specifications shall be provided by this Contractor, including items set in place and wired and connected by the Division 26 Contractor, unless specifically shown otherwise on the Drawings.

1.18 SLEEVES:

Any pipe passing through building construction including walls, floors, roofs or masonry partitions or as noted on the Drawings shall be encompassed with sleeves in accordance with the following:

All pipe sleeves through slabs, floors, masonry walls and masonry partitions shall be 1/2 inch greater in inside diameter than the external diameter of pipe passing through. Sleeves for insulated piping shall be large enough to accommodate the insulation without harming the insulation or vapor barrier. All sleeves shall be fabricated from new material cut square and reamed.

Sleeves shall be provided in all masonry partition walls including locations above suspended ceilings where masonry partition walls extend from floor slab to slab above. Sleeves shall be Schedule 40 steel pipe finishing flush with the wall surface.

Sleeves through exterior building walls shall be Schedule 40 steel pipe with welded flange in the middle of the sleeve and ends finishing flush with finished surfaces. Space between pipe and sleeve shall be packed to provide a watertight joint.

Sleeves through roof slabs and floor slabs in concealed locations shall be No. 22 gauge galvanized steel or crete sleeves (linear polyethylene). Concealed sleeves shall be considered as pipe sleeves in shafts, pipe chases and within walls and partitions.

Sleeves through floor slabs in exposed areas shall be Schedule 40 steel pipe and sleeves shall extend 1/4 inch above the finished floor surface. For slabs in equipment rooms and in other

wet areas, sleeves shall be Schedule 40 steel pipe and shall extend 2 inches above finished floor surface.

Floor sleeves in membraned floors shall be furnished with flashing rings and clamps.

All sleeves in exposed locations, except equipment rooms, shall be set so plates specified will cover the sleeves.

All pipe sleeves where wet conditions exist, except sleeves through exterior walls, shall be caulked with a plastic caulking, including sleeves in concealed locations. The space between the pipe and the sleeves shall be packed with oakum and approximately 1/2 inch depth of a polyisobutylene sealer shall be packed or caulked in both ends of sleeve, even with the ends of the sleeve. The sealer shall be suitable for temperatures from minus 50 degrees to 300 degrees, suitable for painting, non-corrosive and have good adhesion.

All sleeves required to provide the proper openings in masonry construction for the passage of piping, mechanical equipment, etc., shall be furnished and installed by this Contractor. These sleeves shall also be removed by this Contractor after the opening has been formed. The opening around all equipment, etc., passing through slabs, floors, walls and partitions shall be sealed as specified above for piping.

All sleeves shall be set and maintained in place by this Contractor during the progress of the work. This Contractor shall be responsible for locating all sleeves at the proper location.

Sleeves are not required for core drilled masonry wall and floor holes, masonry wall and floor holes formed by polyethylene plastic (removable) sleeves, or for masonry holes made in another neat manner except in equipment rooms and other wet areas.

Sleeves are not required in metal or wood stud wall construction. Rated systems shall be provided as required to provide the necessary rating of the penetration.

Interior wall sleeves are only required on insulated piping. All other steel or cast iron piping 4 inches and smaller shall be grouted directly into the wall as necessary to provide the required fire and smoke rating. Piping larger than 4 inch size and all non-rated piping shall be provided with a rated system.

Firestopping materials shall be 3M, Hilti, MetaCaulk, Nelson or equal.

1.19 WALL, FLOOR AND CEILING PLATES:

Furnish and install chrome-plated wall, floor and ceiling plates on all exposed pipes where they pass through walls, floors, or ceilings in finished areas. Finished areas shall be those areas which are painted or have special finishes within the room. The wall plates shall be a minimum of 3/32 inch thickness and shall have set screws or spring locks for clamping to the piping. The plates shall be chrome-plated steel, cast iron or brass and shall set tight against the wall.

1.20 EQUIPMENT SUPPORT:

Furnish and install all necessary wall backing, brackets, braces, plates, angles, wall hangers, etc., required for properly supporting mechanical equipment and mechanical appurtenances. All supports

shall be securely anchored with lead inserts, expansion shields, through-going bolts, lag screws or other devices as required.

All items of mechanical equipment hung from overhead structure shall be hung from 2-1/2 inches by 2-1/2 inches by 3/16 inch angles minimum which shall span at least 3 members, unless noted otherwise.

1.21 EXISTING SERVICES:

The Contractor shall verify the exact location of all existing building services extended and/or relocated for this project. The Contractor shall also verify the exact location and take proper precautions to protect all services which may be encountered during construction.

All active services which are encountered shall be protected, braced and supported where required for proper execution of the work and without interruption of the service if possible.

All inactive services which are encountered shall be protected or removed as directed by the Architect/Engineer, Owner, Utility Company or Municipal Agency having jurisdiction. The service shall also be plugged or capped as directed.

When active services must be temporarily interrupted, the interruption shall be scheduled at night or at such time as approved by the Owner or authority having jurisdiction and so as to cause the minimum of interference with establishing operating routine. Arrangements shall be made to work continuously including overtime if required, to assure that services will be interrupted only as long as actually required to complete necessary work.

1.22 EXCAVATION:

Trenching and excavation for all underground piping and equipment shall be excavated to the required depths. The bottom of the excavation shall be tamped hard and graded to secure the required fill. Bell holes shall be excavated so that pipe will rest on solid ground for its entire length. Rock, where encountered, shall be excavated to a depth of 6 inches below the bottom of pipe and before pipe is laid, the space between bottom of pipe and rock surface shall be filled with gravel. Sewer and water pipes shall be laid in separate trenches, except where otherwise noted and in accordance with applicable codes.

After the piping and equipment have been tested, inspected and approved by the Architect/Engineer and prior to the backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris. Materials for backfilling shall consist of the excavation, or borrow of sand or gravel, and shall be free of trash, lumber, or other debris. Backfill shall be placed in horizontal layers, not exceeding 9 inches in thickness, and properly moistened. Backfill inside the building and under any exterior slabs or other paved areas shall be compacted by hand or mechanical means to the density of 95 percent Proctor and areas outside the building not covered by concrete slabs or other structures or pavement shall be compacted to the density of the adjacent undisturbed soil. Any settling within the one (1) year guarantee period shall be repaired at no cost to the Owner.

1.23 ACCESS TO EQUIPMENT:

Access shall be provided to all motors, valves, controls, specialties, etc., for maintenance purposes. All access doors, access panels, removable sections, etc., required for access shall be provided. The

location of the access openings relative to the equipment shall be coordinated to assure proper access to the equipment. The door shall maintain any ratings of the wall, ceiling, etc. that it penetrates.

Access openings are required for valves and other devices requiring access and shall be provided in the housings, tanks, walls, ceilings, etc., under this portion of the Contract.

1.24 PROTECTIVE DEVICES:

All sheaves, belts, drives, couplings, and moving parts shall be protected by approved permanent guards, shields, or railings, which shall be in place whenever the equipment is in operation and shall be in accordance with applicable safety standards.

All drains, etc. shall have the discharge piped full size to within 6 inches of the floor or floor drain. The piping shall be securely anchored.

1.25 PIPE AND PIPE FITTINGS:

Furnish and install where shown on the Drawings and required to connect equipment, pipe and fittings of type and material for the various services as noted below.

Piping that is not shown on the Drawings, which is obviously necessary for complete systems, shall be provided and shall be amply sized in accordance with applicable codes and standards.

Grooved pipe fittings, valves and couplings shall be Victaulic, Anvil Gruvlok, Central Sprink, Star or equal. All components shall be supplied by one manufacturer.

Plastic piping shall not be used in air plenums or in buildings classified as noncombustible construction unless the piping is rated for installation in air plenums.

The piping for the various systems shall be as follows:

Water piping outside of building, 3 inches and smaller shall be Type K copper, ASTM B88 and Federal Specification WW-T-799. Fittings shall be cast bronze or brass with copper swaged joints made with a proper flanging tool. One inch and 1-1/4" inch sizes may be coil stock and 1-1/2 inch through 3 inch shall be straight 20 foot lengths.

Water piping outside of building, 4 inches and larger shall be ductile iron or DR18 plastic as follows:

Water outside of building, 4 inches and larger shall be ductile iron, bell and spigot. Four inch through six inch may be Class 52 and eight inch and larger shall be Class 50 water pipe with mechanical joint fittings meeting AWWA Standard C153. Pipe and fittings shall be coated with asphaltum and internally cement lined. Furnish and install thrust blocks and/or tie-rods in accordance with the local water department standards and regulations.

Water beyond 5 feet outside of buildings 4 inches and larger may be Class 150, AWWA C900 plastic pipe meeting the requirements of DR18 where codes permit. Pipe fittings shall be mechanical joint fittings meeting AWWA Standard C153.

Furnish and install thrust blocks and/or tie-rods in accordance with the local water department standards and regulations.

Fire sprinkler piping shall be black steel, ASTM A135 and Federal Specification WW-P-406, Schedule 40 screwed through 2 inch size. For sizes above 2 inches, piping shall be schedule 10 light wall pipe approved for sprinkler application. Fittings shall be extra heavy pattern having screwed ends for sizes through 2 inches. For sizes above 2 inches, fittings shall be groove type fittings, Victaulic, Grinnell, Anvil Gruvlok, Central Sprink, Star, Iowa Fabricators or equal. Branch connections to mains shall be welded using Weld-o-let type connections or grooved fittings. In wet systems, piping 1 ½ inch size and larger may be schedule 10, black steel with roll grooved fittings.

Copper piping shall be hard drawn Type L copper tubing, ASTM B88 and Federal Specification WW-T-799. Fittings shall be wrought copper solder type, ANSI B16.22. Joints for pipe and fittings shall be made with No. 95-5 (tin-antimony) solder and No. 50 non-corrosive flux.

1.26 VALVES:

Furnish and install valves in piping where so indicated on the Drawings. In addition, shut-off valves shall be provided in piping adjacent to each item of equipment.

All gate and globe valves shall be installed with stem in a vertical position wherever possible.

Of the several manufacturers listed, the Contractor is to standardize on one make as much as practical but not to the extent of sacrificing quality listed. Valves shall be Milwaukee, Crane, Powell, Stockham, Walworth, Victaulic, Grinnell, Anvil Gruvlok, Watts, Nibco, Hammond or equal.

The valves designated in the following schedule are fully described in the valve list following this schedule.

Valve Service

Valve Designation

Shut-Off Valves For:

Standpipe and Fire Sprinklers

Pipe sizes 2 in. and smaller
Pipe sizes 2-1/2 in. and larger

V-1 or V-15
V-13 or V-17

Check Valves For:

Standpipe and Fire Sprinkler

Pipe sizes 2-1/2 in. and larger

V-18

The following is a list of valves types from which valves for use on this project have been selected. See the valve service schedule preceding this list for types to be used on each service.

(V-1) Ball Valves (Fed. Spec. WW-V-35b.): Bronze body ball valve, conventional port, lever handle, screwed or soldered and teflon seats and stem packing, 150 psi SWP, 400 psi WOG, Milwaukee BA-100 or BA-150, 1/2 inch through 2 inch size. Provide Memory Stop on all valves used for balancing purposes.

(V-13) Butterfly Valve: Wafer or lug type iron body butterfly valve, extended neck, stainless steel shaft, bronze disc, EPT seal and seal with 275 degrees F. temperature rating, lever operated up through 6 inch valve size and gear and crank operator over 6 inch valve size, 150 psi WOG, 2-1/2 inch size and larger Milwaukee "M" series.

(V-15) Butterfly Valve: Full flow, bronze body, threaded or grooved ends, fire protection butterfly valve, 1/2 inch thru 2-1/2 inch size, UL listed, FM approved, slow close operator with position indicator, 175 PSI WWP, Milwaukee Butterball BB-SC Series.

(V-17) Iron Body Gate Valve: Iron body fire protection gate valve, 2-1/2 inch size and larger, UL listed, FM approved, bolted bonnet, outside screw and yoke, solid wedge, flanged ends, 175 psi WWP, 2-1/2 inch size and larger Stockham Fig. G-634.

(V-18) Iron Body Check Valve: Iron body fire protection horizontal swing check valve, UL listed, FM approved, bolted bonnet, renewable seat bronze disc, 175 psi WWP, 2-1/2 inch size and larger, Stockham Fig. G-939.

1.27 PIPING CONNECTIONS:

Furnish and install unions or mating flanges at all connections to each piece of equipment, conveniently located to facilitate quick and easy disconnecting of equipment for replacement or general maintenance. Flanged or union connections shall be used on both sides of equipment connections. Unions or flanges shall be of the same material or finish as the piping systems in which they are installed. Unions are not required for grooved pipe systems.

Grooved pipe and mechanical joint couplings may be utilized in certain piping systems with Architect/Engineer approval. See section on pipe and pipe fittings.

1.28 PIPE HANGERS, SUPPORTS AND ANCHORS:

Anchors as shown and detailed on the Drawings and specified herein and/or as required. All support components shall conform to Manufacturer's Standardization Society Specification SP-58. The hangers shall adequately support the piping system. They shall be located near or at changes in piping direction and at concentrated loads. They shall provide vertical adjustment to maintain pitch required for proper drainage. They shall allow for expansion and contraction of the piping. Hangers shall bear directly on piping.

Hangers shall be constructed of malleable or wrought iron unless noted otherwise, and hangers supporting copper pipe shall be copper plated. Hangers for pipe 3 inches and smaller shall be band and socket Michigan Model No. 100 or equal. For piping over 3 inches, hangers shall be adjustable, Clevis type, Michigan Model No. 400 or equal.

Horizontal steel or cast iron piping shall be supported as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Maximum Spacing</u>
Up to 1-1/4 inch	3/8 inch	8 feet
1-1/2 inch & 2 inch	3/8 inch	10 feet
2-1/2 inch & 3-1/2 inch	1/2 inch	15 feet
4 inch & 5 inch	5/8 inch	15 feet
6 inch	3/4 inch	17 feet
8 inch through 12 inch	7/8 inch	22 feet

Horizontal copper piping shall be supported as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Maximum Spacing</u>
Up to 1 inch	3/8 inch	6 feet
1-1/4 inch & 1-1/2 inch	3/8 inch	8 feet
2 inch	3/8 inch	9 feet
2-1/2 inch	1/2 inch	9 feet
3 inch & 4 inch	1/2 inch	10 feet

For vertical piping, where supports are not indicated on the Drawings, support steel and copper pipe at every other floor.

Pipe hangers shall not be attached to the roof deck. Hangers shall be attached to the structure with beam clamps, beam attachment and brackets bolted to joists and beams. Use Michigan Model No. 340 or equal, steel washer plates for pipe supported from steel joist. The Contractor shall endeavor to hang near joist panel joints wherever possible.

Hanging from one pipe to another is prohibited.

Pipe Hangers shall be Michigan, Grinnell, PHD, B-Line or equal.

1.29 PIPING INSTALLATION:

All pipes shall be round and straight, of required size. Cutting shall be done with proper tools and pipes shall be reamed to full size after cutting.

Piping shall be properly enclosed, supported, guided, anchored, sway braced, connected, tested, cleaned and flushed out and shall be properly protected, where required.

All pipes shall be run with proper grade to provide for easy draining and in group runs where applicable and in a neat and orderly manner, to the satisfaction of the Architect/Engineer. Lines required to be enclosed in ceiling, chaseways or similar spaces shall be installed to permit such enclosure as intended. All pipe runs shall be carefully laid out and scheduled to avoid necessary interferences with other work. Pipe sizes shown on the Drawings are nominal pipe sizes and not outside diameters.

Pipes shall be run substantially as indicated on the Drawings. However, the Architect/Engineer reserves the right to require this Contractor to make changes in pipe locations where conflicts occur with other trades. Such changes shall be made without extra cost to the Owner.

Piping shall be installed with ample provisions for expansion and contraction to prevent injury to the same and to the building construction. Such provision shall be made by means of piping offsets, changes in direction, expansion loops and/or suitable expansion joints. Suitable anchors and guides shall be provided to permit proper deflection and compression of offset loops and expansion joints. Expansion joints shall not be used in lieu of offsets, changes in direction or loops, except where specified and/or indicated on the Drawings or where otherwise obviously necessary.

Exposed piping shall be installed in a sanitary manner for ease in cleaning. Pipe shall be cut and threaded to fit the installation.

1.30 PRESSURE GAUGES:

Furnish and install U.S. Gauge Model 5105 or equal pressure gauges in pipelines and on equipment as indicated herein and/or where shown on the Drawings. Gauges shall have phosphor bronze bourdon tube with brass movement.

Gauges shall be compound, pressure or vacuum as required with 4-1/2 inch diameter dial. Each gauge shall be complete with Trerice No. 872 pressure snubbers, and brass ball valves. Ball valves shall be provided on all gauges.

The normal operating pressure of each gauge shall be 50-70 percent of full scale. The range of the scale shall be suitable for the application.

The gauges shall be located and mounted such that they can be conveniently read by a person standing on the equipment room floor. Accuracy shall be Grade "A". Case shall be aluminum.

Pressure gauges shall be U.S. Gauge, Trerice, Weksler, Ashcroft, Weiss or equal.

END OF SECTION 210100

SECTION 210500 - FIRE SUPPRESSION

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 210100, General Provisions, in its entirety, including references to the General Construction Specifications, are hereby adopted and made a part of these Specifications.

The Work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install a complete fire protection system as described herein and/or shown on the Drawings. This includes all piping, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

The fire protection system shall be a wet system. The system in office areas shall be designed for light hazardous classification. The storage and mechanical areas shall be designed for ordinary hazard, group 1 classification. Provide coverage for all concealed combustible spaces including, but not limited to the attics. The system shall be complete with sprinkler heads, piping, valves, alarm bell, fire department connection and controls necessary for a complete system.

1.02 CONTRACTOR QUALIFICATIONS:

The Contractor for the Fire Protection installation shall be a qualified Fire Protection Contractor regularly engaged in the installation of Automatic Fire Sprinkler Systems and other Fire Protection Equipment.

1.03 AUTHORITIES AND AGENCIES:

All work will be installed for the approval and acceptance of the Fire Chief of the City of Tyndall, SD.

All material, equipment, valves and devices installed or furnished under this Section shall be listed or approved for use in the fire protection installation by the authorities, agencies, codes and standards named in this Section of the Specifications:

Underwriters Laboratories - Approved Fire Protection.
NFPA Pamphlet No. 13.
Factory Mutual.

1.04 DESIGN AND INSTALLATION STANDARDS:

The Fire Protection System shall be designed and installed to comply with the following standards and/or codes of the latest issue:

NFPA Pamphlet No. 13 - Sprinkler Systems.
Building Code of the City of Tyndall, SD.

1.05 WORKING DRAWINGS:

Before commencing with the sprinkler installation, the Fire Protection Contractor shall submit Working Drawings to the authorities having jurisdiction and agencies specified for review and approval and/or acceptance. Following approval by authorities and agencies having jurisdiction, the

Contractor shall submit the Drawings to the Architect/Engineer in accordance with the General Conditions and Section 210100, GENERAL PROVISIONS - SHOP DRAWINGS.

1.06 INSPECTION AND TESTS:

All inspections, examinations and tests required by the authorities and agencies specified shall be arranged and paid for by the Fire Protection Contractor as necessary, to obtain complete and final acceptance of the Fire Protection System.

1.07 CONTRACTOR'S CERTIFICATE:

After completion of the fire protection installation and at the start of the guarantee year, the Fire Protection Contractor shall execute and file five (5) copies of the "Contractor's Material and Test Certificate, Sprinkler systems - Water Spray Systems" with the Architect. At the time of final inspection the following maintenance shall be performed:

Operation of all control valves.

Lubrication of operation stems of all interior control valves.

Operation of Horn/Strobe.

Cleaning of sprinkler valves.

Lubrication of fire protection inlet water connections.

1.08 PIPE AND PIPE FITTINGS:

Refer to the requirements of Section 210100 - General Provisions, subsection Pipe and Pipe Fittings.

All piping installed in exposed locations shall be designated as such in the Shop Drawing submittals

1.09 SPRINKLER HEADS:

Sprinkler heads shall be standard semi-recessed chrome-plated pendant type in all locations where piping is concealed above ceilings.

Sprinkler heads shall be standard upright type where piping is installed exposed in warehouse, garage and other locations as indicated on the Drawings. Upright heads shall be plain brass finish.

Sidewall sprinkler heads, where permitted, shall be chrome-plated in finished rooms, plain brass elsewhere.

Flush chrome-plated sprinkler heads shall be installed where noted on the Drawings.

Temperature rating of sprinklers shall be in accordance with requirements of approving authorities and as noted on the Drawings.

Sprinkler heads shall be installed centered in the ceiling tile where applicable. Three locations are acceptable in 2 foot by 4 foot ceiling tiles.

Sprinkler heads installed in areas where damage may occur, such as gymnasiums, shall have head guards.

1.10 WATER FLOW SWITCHES AND ALARMS:

Flow switches for alarm bell shall be furnished, installed and wired by this Contractor. This Contractor shall also furnish, install and wire an exterior horn/strobe.

The Division 26 Contractor will make one power connection to the sprinkler alarm system. All other wiring shall be furnished and installed by this Contractor.

The Contractor shall also furnish and install the required tamper switches and zone flow switches to be wired to the fire alarm system by DIVISION 26.

1.11 DRAINS:

Main system drain shall be piped to sewer connection or through wall of building to atmosphere where properly trapped sewer connection is not available. Auxiliary drains shall be piped to floor drain where practical or valved and plugged.

1.12 SIAMESE FIRE DEPARTMENT CONNECTION:

Furnish and install a Potter Roemer Series 5020 or equal Siamese connection where shown on the Drawings. Wall plate shall read "AUTOMATIC SPRINKLER." Finish shall be polished brass. Inlets shall be 2-1/2 inch size and outlet shall be 4 inch size. Install an automatic ball drips between the Siamese connection and the check valve.

Siamese connections shall have polished brass caps and chains. Locking Fire Department connection caps shall be provided where required by the fire code official and where the responding fire department carries appropriate key wrenches for removal. Outlets shall be 36 inches above finished grade. Threads for Fire Department connections shall be National Standard. Verify threads and cap type with the local Fire Department.

Fire Department connections shall be Potter Roemer, Central, Seco and Elkhart, or equal.

1.13 DOUBLE CHECK BACKFLOW PREVENTER:

Furnish and install Watts Regulator Co., series No. 007-S, 709-S or equal double check backflow preventers where shown. The backflow preventer shall be a complete assembly including tight closing shut-off valves before and after the device and also be protected by a strainer. It shall be a complete assembly including four ball type test cocks.

The device shall meet the requirements of A.S.S.E. standard 1015 and A.W.W.A. standard C506.

Double Check Backflow Preventer shall be Ames, Watts, Hersey, Conbraco, Febco, Wilkins or equal.

END OF SECTION 210500

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DIVISION 22 – PLUMBING AND HEATING

SECTION 220100 - GENERAL PROVISIONS

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

This Section pertains to general provisions and requirements for construction of work specified in all sections of Division 22 herein.

"Contractor" referred to in this Section of the specification implies the Contractor, Subcontractor and/or Subcontractors which are responsible for all or any part of the mechanical installation specified in Division 22 and/or as shown on the Contract Drawings.

Where the specifications in subsequent Sections of Division 22 conflict with requirements of this Section, the specifications in the subsequent Sections shall govern.

The Contractor shall provide all items, articles, materials, operations or methods listed, mentioned or scheduled on the Drawings and/or herein specified, including all labor, materials, equipment, accessories, wiring and incidentals necessary to be installed in accordance with manufacturer's recommendations except as otherwise approved.

1.02 PERMITS AND SERVICE CHARGES:

All permits and service charges necessary for execution of the work under this Contract shall be obtained by and be paid for by the Contractor. It shall be the responsibility of the Contractor to determine the permit requirements of the local authorities and utility companies and the cost of required permits, service charges, tap fees and development fees shall be included in the Contractor's bid.

All work shall be executed in accordance with all local, state and national rules, regulations, codes, etc., which are applicable and shall be subject to inspection by the proper authorities.

1.03 CODES AND STANDARDS:

All work performed and all equipment furnished under this Division of the Contract shall be manufactured and installed in strict accordance with all applicable codes and standards, including the applicable provisions of the following codes and standards.

1. Local and State Codes, Standards and Regulations.
2. National Fire Protection Association (NFPA).
3. National Electric Code (NEC).
4. Underwriter's Laboratory (UL).
5. American Gas Association (AGA) Standards.
6. Uniform Plumbing Code.
7. International Mechanical Code.
8. ASME Boiler and Pressure Vessel Codes.
9. State Boiler Safety Code.

10. American Waterworks Association (AWWA).
11. National Sanitation Foundation (NSF).
12. Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA).
13. International Building Code.
14. Life Safety Code.
15. State Energy Conservation Standards.
16. Americans with Disabilities Act (ADA).

All materials installed shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255 and UL 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.04 COMPLIANCE:

Where specific requirements of any code vary with the requirements of another code, the higher standard as determined by the Architect/Engineer shall govern the installation.

All equipment manufactured in accordance with the provisions of the above codes and standards shall bear the label of the respective association bureau thereon.

1.05 DRAWINGS:

In general, the Drawings of the mechanical systems and equipment are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural drawings which are dimensioned. Drawings shall not take precedence over field measurements.

Drawings of piping and ductwork, although shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction. If it is found, before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the Drawings, the Architect/Engineer may require the Contractor to change the location or arrangement of the work without additional cost to the Owner. Such rearrangement shall be in accordance with directions from the Architect/Engineer.

Where discrepancies are discovered after certain portions or phases of the work have been installed, the Architect/Engineer reserves the right to require the Contractor to make changes in pipe, duct, fixture or equipment locations or arrangements to avoid conflicts with work at no additional cost to the Owner.

Because the Drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the system are indicated does not mean that other similar or different features or details will not be required. The Contractor shall furnish all incidental labor, material or equipment for the systems so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the specifications.

The Contractor, Subcontractor's and their respective trades shall cooperate in laying out their work so it will fit properly into the space provided. Promptly report to the Architect/Engineer any delay or difficulties encountered in the installation of this work which might prevent prompt and proper

installation, or make it unsuitable to connect with or receive the work of others. Failure to so report shall constitute an acceptance of the work of other trades as being fit and proper for the execution of this work.

1.06 SUBSTITUTIONS AND PRODUCT OPTIONS:

The Contractor and equipment suppliers shall read and familiarize themselves with articles concerning substitution of materials, as indicated in the Instructions to Bidders. Material and equipment substitutions will be handled as follows:

Materials or equipment specified by name of manufacturer, brand, trade name or catalog reference, shall be furnished under the contract unless changed by Addenda or a Contract modification. Where two (2) or more materials are named, the choice of these shall be optional with the Contractor.

Material or equipment followed by the phrase "or equal" shall establish a standard of required function, dimension, appearance and quality to be met by any proposed substitute. No substitution will be considered unless written request for substitution has been submitted by the bidder and has been received by the Architect/Engineer at least ten days prior to the date for receipt of bids. The Architect/Engineer's decision on a proposed substitute shall be final. If the Architect/Engineer considers any proposed substitution equal, such will be set forth in an Addendum. Bidders shall not rely upon substitutions made in any other manner.

Should the Contractor wish to use materials or equipment other than those specified or listed as equal by Addenda, he shall attach his proposed substitution along with the appropriate add or deduct to the Contract amount, should the substitution be accepted. Substitutions proposed by the Contractor will not be considered in the award of the Contract.

1.07 SHOP DRAWINGS:

Refer to the requirements of the General Conditions. Unless indicated otherwise in the General Conditions, submit to the Architect/Engineer seven (7) copies (minimum) of Shop Drawings for each item of equipment to be installed under this contract with two (2) copies to be retained by the Architect/Engineer. Furnish additional Shop Drawings as required for coordination with General Contractor and other Subcontractors.

To the extent practical, complete sets of shop drawings for each specification section shall be submitted. In the case that a particular item is required to be expedited, that particular item may be submitted individually.

Submit shop drawings punched in 3-hole format.

Furnish Shop Drawings as follows:

1. For all major items of equipment or materials, regardless of whether the item is to be furnished as specified.
2. For all equipment, systems or devices where Shop Drawings are specifically called for.
3. For all minor items of equipment or materials where the Contractor proposes to deviate from the specified and/or scheduled manufacturer or material.

The Contractor shall check all Shop Drawing submittals for size, capacity, arrangement, connection locations, materials, finish, color, electrical characteristics, accessories, and shall so note the Shop Drawings prior to submittal to the Architect/Engineer. Any deviation from the Drawings and Specifications shall be indicated.

Shop Drawings will be reviewed by the Architect/Engineer, and copies of Shop Drawings will be returned to the Contractor. Shop Drawings shall be submitted sufficiently in advance of the construction schedule to allow time for checking Drawings, resubmittal and rechecking when necessary.

Any equipment or material which is installed without authorization by properly processed Shop Drawings will be subject to removal by the Contractor and reinstallation as directed, without cost to the Owner. All cost for repair for damages as may be incurred to the structure as a result of the above correction shall be paid by this Contractor.

Shop drawing material quantities will not be checked by the Architect/Engineer, and review of Shop Drawings by the Architect/Engineer shall not be construed to be verification of the material quantities and sizes shown on the Shop Drawings. Quantities, sizes, dimensions and locations shown on the Drawings and as specified shall determine material requirements.

1.08 CLEANING:

The Contractor and/or Subcontractors for the various phases of the work shall clear away all debris, surplus materials, etc., resulting from their work or operations, leaving the job and equipment furnished under any or all contracts in a clean first class condition.

Permanent heating and ventilating systems shall not be used during the construction period unless the project site is in a clean and dust free condition and shall be subject to the approval of the Architect/Engineer and Owner.

Air surfaces of all coils, heaters, boilers, pumps and mechanical equipment shall be wiped clean or washed if required, leaving the installation in a first class condition. All throwaway filters used during construction shall be replaced.

All plumbing fixtures shall be thoroughly cleaned of all plaster, stickers, rust stains, and other foreign matter or discoloration, leaving every part in a first class condition and ready for use. The surfaces of all floor drains, cleanouts and other equipment shall be cleaned, and each item shall be left in a first class condition.

1.09 PAINTING:

Painting of materials and equipment furnished under the mechanical portion of the contract shall be as described in Division 9 - FINISHES. Contractor shall refinish and restore to the original condition and appearance, all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and workmanship shall be equal to the requirements described in Division 9 - FINISHES.

1.10 RECORD DRAWINGS:

The Contractor shall keep a complete set of all mechanical drawings in the jobsite office for purpose of showing the installation of mechanical systems and equipment. This set of drawings shall be used for no other purpose. Where any materials equipment or system components are installed different from that shown on the Architect/Engineer's drawings, such differences shall be clearly and neatly shown on this set of drawings using ink or indelible pencil. At the completion of the project, the record set of drawings shall be turned over to the Architect/Engineer and shall become his property.

1.11 STERILIZATION OF WATER SUPPLY SYSTEM:

All domestic water systems shall be sterilized with sufficient chlorine to provide a dosage of not less than 200 ppm with a contact period of not less than 3 hours, and with all valves in line opened and closed at least three times during the sterilized period. Following the contact period, the water is to be thoroughly flushed from the system until the residual chlorine content is not more than 0.20 ppm.

A certificate of completion shall be provided.

1.12 OPERATING INSTRUCTIONS:

The Contractor shall furnish the Owner two (2) sets of complete catalog data, manufacturer's literature and detailed manuals covering the operation and maintenance of all equipment specified under this Division. All such literature shall be bound in an amply sized three-ring binder and submitted to the Architect/Engineer for approval and for eventual transmittal to the Owner. The manual shall have a Table of Contents at the front of the manual.

The Contractor shall also supervise the initial operation of all equipment and instruct the operator selected by the Owner in such operation as required to acquaint him thoroughly with the equipment.

1.13 DELIVERY AND STORAGE OF MATERIALS:

Make provisions for delivery and safe storage of materials on the jobsite and make arrangements with other Contractors for introduction into the building of equipment too large to pass through finished openings. Materials to be delivered at such stages of the work as will expedite the work as a whole and marked and stored in such a way as to be easily checked and inspected. All stored equipment shall be protected from the weather conditions and construction debris with a protective covering securely tied in place.

1.14 MECHANICAL PROVISIONS:

Mechanical equipment shall operate without objectionable noise or vibration, as determined by the Architect/Engineer. If such noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, piping, or other parts of the mechanical work, make necessary changes and additions, as approved, without extra cost to Owner.

Provide oil level gauges, grease cups and grease gun fittings for machinery bearings as recommended by the manufacturer. Extend oil or grease fittings by copper tubing to readily accessible locations.

1.15 CONCRETE BASES:

Concrete bases are required for floor mounted mechanical equipment inside buildings and are specified in Division 3 - CONCRETE. After bases are poured they shall set at least seven (7) days before mounting equipment. The Contractor shall coordinate the setting of expansion bolts in the bases for attachment of equipment and/or isolators.

This Contractor shall verify and coordinate the exact location of the bases and the exact size requirements for specific items of equipment.

1.16 COORDINATION OF WORK:

The Contractor shall process shop drawings and order equipment and materials expeditiously after receiving the Contract and the mechanical installation shall be substantially complete when the general construction work is completed. This Contractor shall confer and cooperate with all other Contractors on this project and shall arrange his work in proper relation to the work of others. Each Contractor shall furnish, install, and maintain in place all anchors, inserts, sleeves, etc., required for his work. Each Contractor will also be held solely responsible for proper size and location of all anchors, inserts, sleeves, chases, recesses, openings, bases, etc., required for proper installation of his work. All cutting and patching made necessary by failure or neglect to coordinate with other Contractors shall be the responsibility of this Contractor. Any cutting or patching shall be subject to the direction and approval of the Architect/Engineer and all damage due to cutting or patching shall be repaired by this Contractor.

After being instructed by this Contractor to do so, the General Contractor will leave all openings in roof, walls, floors, etc., for the passage of pipes, etc. The General Contractor shall also provide concrete bases and roof curbs where shown for mounting the mechanical equipment unless specified otherwise. This Contractor shall verify the exact size and location required for installation of his equipment with the General Contractor.

In general, the Division 26 – Electrical Contractor will provide all power wiring and make one power connection to each item of mechanical equipment, as outlined under Electrical Section.

1.17 GUARANTEE:

All mechanical equipment including equipment used during construction for temporary purposes shall be guaranteed for a period of one year after the time of final acceptance of this work and shall be in like new condition at time of final acceptance.

1.18 ELECTRICAL:

Electric Motors:

All electric motor driven equipment being furnished and installed under Division 22 of these specifications shall be complete with electric motors, unless specified otherwise.

All electric motors shall be as manufactured by Westinghouse, Century, Wagner, Allis Chalmers, Reliance, General Electric, or equal. Bearings shall be ball type with alemite lubricating fittings extended to an easily accessible location for field servicing. Minimum service factors for all motors shall be 1.15. All motors shall conform to applicable NEMA standards and all motors

specified for use in hazardous locations shall bear the stamp of approval of the Underwriter's Laboratories. All motors, except direct connected motors, shall be furnished complete with cast iron or stamped steel adjustable slide rails. Single phase motors shall be capacitor start type, drip proof, unless specified otherwise. All motors shall be single speed and shall operate at 1,750 RPM, unless specified otherwise.

Horsepower Rating: All electric motors shall be sized to meet the horsepower requirements of the driven unit at design characteristics including all V-belt and/or drive and coupling losses which are incurred without loading the motor beyond its nameplate horsepower rating. Where V-belt drives are employed, the motor horsepower nameplate ratings shall not be less than 120 percent of the driven unit brake horsepower requirements.

Single Phase Motors: Unless specifically noted otherwise, all electric motors shall be designed for operation in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current. Motors shall be thermally protected.

Three Phase Motors: All electric motors shall be designed for operating in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current.

All motors less than 3/4 horsepower shall be 115 volt, single phase unless designated otherwise and all motors 3/4 horsepower and larger shall be as specified in the specific section or as noted on the Drawings.

Two Speed Motors:

Two speed motors shall have two separate windings.

Premium Efficiency Motors:

Premium efficiency motors shall be furnished on all mechanical equipment where 1 horsepower or larger motors are required.

Motors shall be designed with special stator steel for reduced core losses. Windings shall be oversized copper placed for maximum efficiency. Stator and rotor shall be extra long to reduce flux losses. Frame shall be ODP (unless specified otherwise) of cast iron or cast aluminum construction.

Motors shall be squirrel cage, horizontal base mount, ball bearing, NEMA B design, Class B design, Class B insulation, continuous duty, 1.15 SF, 40 degrees C. ambient.

Minimum nominal full load motor efficiencies shall be based on ASHRAE Standard 90 (latest edition).

Furnish and install Aegis SGR, or equal, maintenance free, circumferential, conductive micro fiber shaft grounding rings on all AC motors controlled by adjustable frequency drives to discharge shaft currents to ground.

Motors shall be similar to Louis Allis "Spartan" Series, Gould "E-Plus" Series, or Westinghouse "MAC II" Series. Manufacturer shall furnish proof of efficiency rating.

Motor Starters:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 22 of these specifications, all motor starters will be furnished and installed under Division 26, ELECTRICAL.

Electrical Wiring:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 22, all electric power wiring shall be furnished and installed in Division 26, ELECTRICAL. The Electrical Contractor will make one power connection to each item of mechanical equipment, unless specified otherwise.

Electrical wiring furnished and installed under these specifications shall conform to all applicable requirements of Division 26, ELECTRICAL.

Unless otherwise indicated, all motors and controls shall be furnished, set in place and wired in accordance with the following schedule:

<u>Item</u>	<u>Division Furnished Under</u>	<u>Set in Place or Mounted Under</u>	<u>Division Wired & Connected Under</u>
Equipment Motors	22	22	26
Magnetic Motor Starters:			
Automatically controlled, with or without HOA switches	26	26	26
Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	22	22	26
Manually controlled	26	26	26

Manually controlled and furnished as part of factory wired equipment	22	22	26
Line voltage thermostats, time clocks, etc., not connected to control panel systems	22	26	26
Electric thermostats, time clocks, remote bulb thermostats, motor valves, float controls, etc., which are an integral part or directly attached to ducts, pipes, etc.	22	22	22
Temperature control panels and time switches mounted on temperature control panels	22	22	22
Motor valves, solenoid valves, EP and PE switches, etc.	22	22	22
Alarm bells	22	22	22
Control circuit feeders	26	26	26
Low voltage controls, thermostats, valves, etc.	22	22	22
Fire protection controls	22	22	26
Fire and smoke Detectors	26	26	26 ⁽¹⁾
Pushbutton stations, pilot lights	26	26	26
Heat tape	26	26	26

Disconnect switches, thermal overload switches, manual operating switches	26	26	26
Multi-speed switches	22	26	26
Contactors	26	26	26
Control relays, transformers	22	26	26

NOTES:

- (1) Wiring from alarm contacts to alarm system shall be by the Division 26 Contractor; control function wiring shall be by the Division 22 Contractor.

All control wiring and controls as noted on the Drawings and/or as specified in these specifications shall be provided by this Contractor, including items set in place and wired and connected by the Division 26 Contractor, unless specifically shown otherwise on the Drawings.

1.19 SLEEVES:

Any pipe passing through building construction including walls, floors, roofs or masonry partitions or as noted on the Drawings shall be encompassed with sleeves in accordance with the following:

All pipe sleeves through slabs, floors, masonry walls and masonry partitions shall be 1/2 inch greater in inside diameter than the external diameter of pipe passing through. Sleeves for insulated piping shall be large enough to accommodate the insulation without harming the insulation or vapor barrier. All sleeves shall be fabricated from new material cut square and reamed.

Sleeves shall be provided in all masonry partition walls including locations above suspended ceilings where masonry partition walls extend from floor slab to slab above. Sleeves shall be Schedule 40 steel pipe finishing flush with the wall surface.

Sleeves through exterior building walls shall be Schedule 40 steel pipe with welded flange in the middle of the sleeve and ends finishing flush with finished surfaces. Space between pipe and sleeve shall be packed to provide a watertight joint.

Sleeves through roof slabs and floor slabs in concealed locations shall be No. 22 gauge galvanized steel or crete sleeves (linear polyethylene). Concealed sleeves shall be considered as pipe sleeves in shafts, pipe chases and within walls and partitions.

Sleeves through floor slabs in exposed areas shall be Schedule 40 steel pipe and sleeves shall extend 1/4 inch above the finished floor surface. For slabs in equipment rooms and in other wet areas, sleeves shall be Schedule 40 steel pipe and shall extend 2 inches above finished floor surface.

Floor sleeves in membraned floors shall be furnished with flashing rings and clamps.

All sleeves in exposed locations, except equipment rooms, shall be set so plates specified will cover the sleeves.

All pipe sleeves where wet conditions exist, except sleeves through exterior walls, shall be caulked with a plastic caulking, including sleeves in concealed locations. The space between the pipe and the sleeves shall be packed with oakum and approximately 1/2 inch depth of a polyisobutylene sealer shall be packed or caulked in both ends of sleeve, even with the ends of the sleeve. The sealer shall be suitable for temperatures from minus 50 degrees to 300 degrees, suitable for painting, non-corrosive and have good adhesion.

All sleeves required to provide the proper openings in masonry construction for the passage of ductwork, mechanical equipment, etc., shall be furnished and installed by this Contractor. These sleeves shall also be removed by this Contractor after the opening has been formed. The opening around all ductwork, equipment, etc., passing through slabs, floors, walls and partitions shall be sealed as specified above for piping. Fire/smoke dampers shall be installed in accordance with the manufacturer's installation instructions.

All sleeves shall be set and maintained in place by this Contractor during the progress of the work. This Contractor shall be responsible for locating all sleeves at the proper location.

Sleeves are not required for core drilled masonry wall and floor holes, masonry wall and floor holes formed by polyethylene plastic (removable) sleeves, or for masonry holes made in another neat manner except in equipment rooms and other wet areas.

Sleeves are not required in metal or wood stud wall construction. Rated systems shall be provided as required to provide the necessary rating of the penetration.

Interior wall sleeves are only required on cold insulated piping (cold water, downspout, chilled water supply and return, etc.). All other steel or cast iron piping 4 inches and smaller shall be grouted directly into the wall as necessary to provide the required fire and smoke rating. Piping larger than 4 inch size and all non-rated piping shall be provided with a rated system.

Firestopping materials shall be 3M, Hilti, MetaCaulk, Nelson or equal.

1.20 WALL, FLOOR AND CEILING PLATES:

Furnish and install chrome-plated wall, floor and ceiling plates on all exposed pipes where they pass through walls, floors, or ceilings in finished areas. Finished areas shall be those areas which are painted or have special finishes within the room. The wall plates shall be a minimum of 3/32 inch thickness and shall have set screws or spring locks for clamping to the piping. Flush valves shall have set screw type wall plates. The plates shall be chrome-plated steel, cast iron or brass and shall set tight against the wall.

1.21 EQUIPMENT SUPPORT:

Furnish and install all necessary wall backing, brackets, braces, plates, angles, closet carriers, lavatory carriers, urinal carriers, wall hangers, etc., required for properly supporting plumbing fixtures, mechanical equipment and mechanical appurtenances. All supports shall be securely

anchored with lead inserts, expansion shields, through-going bolts, lag screws or other devices as required.

All items of mechanical equipment hung from overhead structure shall be hung from 2-1/2 inches by 2-1/2 inches by 3/16 inch angles minimum which shall span at least 3 members, unless noted otherwise.

1.22 EXISTING SERVICES:

The Contractor shall verify the exact location of all existing building services extended and/or relocated for this project. The Contractor shall also verify the exact location and take proper precautions to protect all services which may be encountered during construction.

All active services which are encountered shall be protected, braced and supported where required for proper execution of the work and without interruption of the service if possible.

All inactive services which are encountered shall be protected or removed as directed by the Architect/Engineer, Owner, Utility Company or Municipal Agency having jurisdiction. The service shall also be plugged or capped as directed.

When active services must be temporarily interrupted, the interruption shall be scheduled at night or at such time as approved by the Owner or authority having jurisdiction and so as to cause the minimum of interference with establishing operating routine. Arrangements shall be made to work continuously including overtime if required, to assure that services will be interrupted only as long as actually required to complete necessary work.

1.23 EXCAVATION:

Trenching and excavation for all underground piping and equipment shall be excavated to the required depths. The bottom of the excavation shall be tamped hard and graded to secure the required fill. Bell holes shall be excavated so that pipe will rest on solid ground for its entire length. Rock, where encountered, shall be excavated to a depth of 6 inches below the bottom of pipe and before pipe is laid, the space between bottom of pipe and rock surface shall be filled with gravel. Sewer and water pipes shall be laid in separate trenches, except where otherwise noted and in accordance with applicable codes.

After the piping and equipment have been tested, inspected and approved by the Architect/Engineer and prior to the backfilling, forms shall be removed and the excavation shall be cleaned of trash and debris. Materials for backfilling shall consist of the excavation, or borrow of sand or gravel, and shall be free of trash, lumber, or other debris. Backfill shall be placed in horizontal layers, not exceeding 9 inches in thickness, and properly moistened. Backfill inside the building and under any exterior slabs or other paved areas shall be compacted by hand or mechanical means to the density of 95 percent Proctor and areas outside the building not covered by concrete slabs or other structures or pavement shall be compacted to the density of the adjacent undisturbed soil. Any settling within the one (1) year guarantee period shall be repaired at no cost to the Owner.

1.24 ACCESS TO EQUIPMENT:

Access shall be provided to all motors, valves, controls, specialties, etc., for maintenance purposes. All access doors, access panels, removable sections, etc., required for access shall be provided. The location of the access openings relative to the mechanical equipment shall be coordinated to assure proper access to the equipment. The door shall maintain any ratings of the wall, ceiling, etc. that it penetrates.

Access openings are required for valves and other devices requiring access and shall be provided in the ductwork, plenums, housings, tanks, walls, ceilings, etc., under this portion of the Contract.

1.25 PROTECTIVE DEVICES:

All sheaves, belts, drives, couplings, and moving parts shall be protected by approved permanent guards, shields, or railings, which shall be in place whenever the equipment is in operation and shall be in accordance with applicable safety standards.

All pressure and/or temperature relief valves shall have the discharge piped full size to within 6 inches of the floor or floor drain. The piping shall be securely anchored. All relief valves shall be ASME approved and proper size for the application.

1.26 PIPE AND PIPE FITTINGS:

Furnish and install where shown on the Drawings and required to connect fixtures and equipment, pipe and fittings of type and material for the various services as noted below. At all exposed fixture supply connections, nipples are required between copper tubing and fixtures, such nipples shall be standard weight full iron pipe size chrome-plated brass pipe nipples with suitable brass or copper adapters. Steel or iron nipples will not be permitted in any location in copper lines where connections are made to brass fixtures, valves or trim. Compression stops may be used when fitted tight against the wall escutcheon with no exposed copper piping. Sweat adapters and chrome plated cover tubes may be used when the cover tube extends the entire pipe from the elbow in the wall or chase to the flush valve and fits tight.

Piping that is not shown on the Drawings, which is obviously necessary for complete systems, shall be provided and shall be amply sized in accordance with applicable codes and standards.

All welding fittings shall be Tube Turn, Taylor Forge, B & W, Ladish Yology, or equal.

The Contractor may use a mechanically formed tee fitting as manufactured by T-Drill or equal. All joints created in this manner shall be installed and brazed in compliance with Plumbing Codes and the manufacturer's recommendation. Soft soldered joints are not allowed in mechanically formed tee fitting installations. The branch tube shall be notched and contain a double dimple. The first to insure proper penetration into the main line. The second dimple (1/4" above the first) will serve as a visual inspection point.

Grooved pipe fittings, valves and couplings shall be Victaulic, Anvil Gruvlok, Central Sprink, Star or equal. All components shall be supplied by one manufacturer.

Underground steel piping systems shall be coated with asphaltum or bituminous paper for corrosion protection.

Plastic piping shall not be used in air plenums or in buildings classified as noncombustible construction.

The piping for the various systems shall be as follows:

Cold, hot and recirculating hot water in buildings above ground, 3 inches and smaller shall be Type L, hard drawn copper tubing, ASTM B88 and Federal Specification WW-T-799. Fittings shall be wrought copper solder type, ANSI B16.22. Joints for pipe and fittings shall be made with No. 95-5 (tin-antimony) solder and No. 50 non-corrosive flux.

Soil, waste, rainwater and vent piping in buildings underground shall be cast iron, ABS or PVC plastic.

Piping may be service weight cast iron soil pipe, Federal Specification WW-P-401 hub and spigot to 5 feet outside building walls, coated with asphaltum. Fittings shall be cast iron hub and spigot, coated with asphaltum. Piping may be hubless cast iron pipe and fittings.

Where codes permit, piping may be ABS or PVC Schedule 40 plastic piping and fittings. ABS piping and fittings shall meet ASTM D2661-68. PVC piping and fittings shall meet ASTM D2665-68 and Federal Specification L-P-320.

Soil, waste, rainwater and vent piping in building, above ground shall be galvanized steel, cast iron, ABS or PVC plastic, or DWV copper as follows:

Piping may be galvanized steel pipe, ASTM A120, Federal Specification WW-P-406, Schedule 40, screwed. After assembly of pipe and fittings, paint visible threads with aluminum paint. Fittings shall be standard weight, black cast iron (galvanized cast iron where required by code), screwed. For waste, soil, and rainwater piping, drainage type (Durham) fittings of long pattern shall be used. For rainwater piping the Contractor may use grooved galvanized steel pipe, grooved fittings and mechanical couplings by written request to the Architect/Engineer including evidence that governing codes permit its use and naming the material manufacturer, pressure rating and other pertinent data.

Piping may be standard weight screwed, or hubless cast iron pipe and fittings. If screwed cast iron is used, threads shall be painted after assembly.

Where codes permit, piping may be ABS or PVC Schedule 40 plastic piping and fittings. ABS piping and fittings shall meet ASTM D2661-68. PVC piping and fittings shall meet ASTM D2665-68 and Federal Specification L-P-320.

Where codes permit, piping may be hard drawn, DWV copper, ASTM B306. Fittings shall be cast red bronze and wrought copper DWV incorporating 1/4 inch per foot drainage pitch. Joints for pipe and fittings shall be made with No. 50-50 solder and No. 50 non-corrosive flux.

For 2 inch and larger pipe, piping may be standard weight, cast iron, hub and spigot soil pipe, Federal Specification WW-P-401. For 1-1/2 inch and smaller pipe, Schedule 40, galvanized steel, ASTM A120 and Federal Specification

WW-P-406. Fittings for hub and spigot shall be long pattern. For 1-1/2 inch and smaller fittings shall be black cast iron, screwed, drainage fittings (Durham) long pattern. Hub and spigot joints shall be preformed molded rubber rings where codes permit.

For sizes 1-1/2 inch and smaller, piping may be Schedule 40, galvanized Yoloy screwed pipe, ASTM A53 and Federal Specification WW-P-404.

Soil, waste, and rainwater piping outside of building shall be ABS or PVC plastic or cast iron pipe (CIP) as follows:

Cast iron pipe shall be service weight soil pipe Federal Specification WW-P-401, coated.

Where codes permit, piping may be ABS or PVC Schedule 40 plastic piping and fittings. ABS piping and fittings shall meet ASTM D2661-68. PVC piping and fittings shall meet ASTM D2665-68 and Federal Specification L-P-320.

Where codes permit, piping may be ABS or PVC type SDR 35 plastic piping and fittings. Piping and fittings shall meet ASTM 3033 and 3034.

Cooling coil condensate drains and louver drains in buildings above ground shall be Type L, hard drawn copper tubing, ASTM B88 and Federal Specification WW-T-799. Fittings shall be wrought copper solder type, ANSI B16.22. Joints for pipe and fittings shall be made with No. 95-5 (tin-antimony) solder and No. 50 non-corrosive flux.

Hot water heating supply and return shall be Schedule 40 black steel or copper pipe as follows:

Schedule 40 black steel pipe shall conform to ASTM A120/ASTM A53 and Federal Specification WW-P-406, Weight A. Sizes 2 inch and smaller shall have screwed ends. Sizes 2-1/2 inch and larger shall have plain ends for welding. Fittings shall be 125 pound screwed, banded, black cast iron for sizes 2 inch and below, and standard weight welding fittings (use long radius ells) for sizes 2-1/2 inch and larger. Welding flanges shall be used adjacent to equipment and valves. Welding rods as recommended by ASTM Specification A233. Welding rings shall be used at all joints.

The Contractor may use grooved steel pipe, grooved fittings and mechanical couplings as manufactured by Victaulic, Grinnell, Anvil Gruvlok or equal on all systems recommended by the manufacturer. Grooved piping systems including valves, fittings, etc., shall be supplied by only one manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components. Grooved fittings shall be ASTM A536 ductile iron or ASTM A53 forged or fabricated carbon steel with grooved ends designed to accept grooved joint couplings of the same manufacturer. Coupling gaskets shall be Grade EPDM suitable for hot water systems up to 250 deg F. Rigid style coupling housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity. Flexible style couplings shall be installed where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors for

vibration isolation at equipment connections. Three (3) couplings, for each connection, shall be placed in close proximity to the source of the vibration.

Copper piping shall be hard drawn Type L copper tubing, ASTM B88 and Federal Specification WW-T-799. Fittings shall be wrought copper solder type, ANSI B16.22. Joints for pipe and fittings shall be made with No. 95-5 (tin-antimony) solder and No. 50 non-corrosive flux.

The Contractor may use roll grooved copper tubing, grooved fittings and mechanical couplings as manufactured by Victaulic, or equal, on all systems recommended by the manufacturer. Grooved piping systems including valves, fittings, etc., shall be supplied by only one manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components. Fittings shall be ASME B16.22 wrought copper or ASME B16.18 bronze casting with copper tube dimensioned grooved ends (flaring of tube and fitting ends to IPS dimensions is not permitted). Housings shall be cast with offsetting, angle pattern bolt pads coated with copper-colored enamel. Gasket shall be Grade EPDM suitable for hot water systems up to 250 deg F.

The grooved coupling manufacturer's factory-trained field representative (direct employee) shall provide on-site training to the Contractor's field personnel in the proper use of grooving tools and installation of grooved piping products. The factory-trained representative shall periodically review product installation. The Contractor shall remove and replace any improperly installed products.

Medical gas and vacuum piping shall be Type L, hard drawn copper tubing, ASTM B88 and Federal Specification WW-T-799. Fittings shall be wrought copper solder type, ANSI B16.22. All joints shall be made with silver solder and installed in conformance with NFPA 99. All piping for oxygen service shall be tested, cleaned and capped prior to shipping.

1.27 VALVES:

Furnish and install valves in piping where so indicated on the Drawings. In addition, shut-off valves shall be provided in piping adjacent to each item of equipment, fixtures, etc., in the branch piping to each toilet group and at the base of all water risers.

All cold water and chilled water valves shall have an extended operator stem and insulation sleeve to accommodate the pipe insulation and vapor barrier.

All gate and globe valves shall be installed with stem in a vertical position wherever possible.

Of the several manufacturers listed, the Contractor is to standardize on one make as much as practical but not to the extent of sacrificing quality listed. Valves shall be Milwaukee, Crane, Powell, Stockham, Walworth, Victaulic, Grinnell, Anvil Gruvlok, Watts, Nibco, Hammond or equal.

The valves designated in the following schedule are fully described in the valve list following this schedule.

<u>Valve Service</u>	<u>Valve Designation</u>
Shut-Off Valves For:	
Cold, Hot and Recirculating Hot Water	
Pipe sizes 2 in. and smaller	V-1 or V-2
Pipe sizes 2-1/2 in. and larger	V-13
Circulating Heating Water	
Pipe sizes 2 in. and smaller	V-1 or V-2
Pipe sizes 2-1/2 in. and larger	V-5 or V-13
Duct Mounted Heating Coils	
Unit Heaters, Convectors, Radiation	
Balancing Valves For:	
Recirculating Domestic Hot Water	
Circulating Heating Water	
Pipe sizes 2 in. and smaller	V-1
Pipe sizes 2-1/2 in. and larger	V-13
Unit Heaters, Convectors, Radiation	
Check Valves For:	
Cold, Hot and Recirculating Hot Water	
Pipe sizes 2 in. and smaller	V-4
Pipe sizes 2-1/2 in. and larger	V-8
Circulating Heating Water	
Pipe sizes 2 in. and smaller	V-4
Pipe sizes 2-1/2 in. and larger	V-8
Drain Valves	

The following is a list of valves types from which valves for use on this project have been selected. See the valve service schedule preceding this list for types to be used on each service.

(V-1) Ball Valves (Fed. Spec. WW-V-35b,): Bronze body ball valve, conventional port, lever handle, screwed or soldered and teflon seats and stem packing, 150 psi SWP, 400 psi WOG,

Milwaukee BA-100 or BA-150, 1/2 inch through 2 inch size. Provide Memory Stop on all valves used for balancing purposes.

(V-2) Gate Valves (Fed. Spec. WW-V-54c, Class A, Type II): Bronze body gate valve, rising stem, solid bronze wedge, screw-in bonnet, threaded or soldered ends, teflon packing, 125 psi SWP, 200 psi WOG, 1/4 inch through 2 inch size, Milwaukee 148 or 149.

(V-3) Globe Valve (Fed. Spec. WW-V-51d, Class A, Type I): Bronze body globe valve, rising stem, solid bronze wedge, screw-in bonnet, threaded or soldered ends, teflon packing, 125 psi SWP, 200 psi WOG, 1/4 inch through 2 inch size, Milwaukee 502 or 1502.

(V-4) Bronze Check Valve (Fed. Spec. WW-V-51d, Class A, Type IV): Bronze check valve, horizontal swing regrinding type, Y-pattern, renewable disc, 125 psi SWP, 200 psi WOG, 1/4 inch through 2 inch size, Milwaukee 509 or 1509.

(V-5) Iron Body Gate Valve (Fed. Spec. WW-V-58a, Class I, Type I): Iron body gate valve, bolted bonnet, outside screw and yoke, solid wedge, flanged bronze rising stem, bronze trim, 125 psi SWP, 200 psi WOG, 2-1/2 inch size and larger, Milwaukee F-2885.

(V-6) Iron Body Gate Valve (Fed. Spec. WW-V-58a, Class I, Type I): Iron body gate valve, bolted bonnet, non-rising stem, solid wedge, flanged, bronze stem, bronze trim, 125 psi SWP, 200 psi WOG, 2-1/2 inch size and larger, Milwaukee F-2882.

(V-7) Iron Body Globe Valve: Iron body globe valve, bolted bonnet renewable seat and discs, flanged, outside screw and yoke, bronze stem, bronze trim, 125 psi SWP, 200 psi WOG, 2-1/2 inch size and larger, Milwaukee F-2981.

(V-8) Iron Body Check Valve: Iron body swing check valve, bolted bonnet, horizontal swing renewable seat and discs, flanged, bronze trim, 125 psi SWP, 200 psi WOG, 2-1/2 inch size and larger, Milwaukee F-2974.

(V-9) Plug Cock: Bronze body square head cock, screwed, 150 psi 1/8 inch through 2 inch size, Lunkenheimer 454.

(V-10) Drain Cock: Bronze body drain cock, steel handle, 125 psi SWP 1/8 inch through 1/2 inch size, Lunkenheimer 476 or 981.

(V-11) Lubricated Plug Valve: Semi-steel body lubricated plug valve, wrench operated, 100 percent area, rectangular port, screwed or flanged, teflon stem seal, natural gas service, 125 psi SWP, 150 psi WOG, Homestead 602.

(V-12) Butterfly Valve: (Fed. Spec. WWV-1967) Full flow, bronze body, threaded or soldered ends, S.S. disc and stem, viton seal, 175 PSI working pressure, 300 PSI WOG, 1/4 inch thru 2 inch size, Milwaukee Butterball BB2-100 or BB2-350.

(V-13) Butterfly Valve: Wafer or lug type iron body butterfly valve, extended neck, stainless steel shaft, bronze disc, EPT seal and seal with 275 degrees F. temperature rating, lever operated up through 6 inch valve size and gear and crank operator over 6 inch valve size, 150 psi WOG, 2-1/2 inch size and larger Milwaukee "M" series.

(V-14) Drain Valve: Bronze body globe valve, screw-in bonnet, integral seat, renewable discs, 1/8 inch through 2 inch size, Milwaukee 502 or 1502.

(V-15) Butterfly Valve: Full flow, bronze body, threaded or grooved ends, fire protection butterfly valve, 1/2 inch thru 2-1/2 inch size, UL listed, FM approved, slow close operator with position indicator, 175 PSI WWP, Milwaukee Butterball BB-SC Series.

(V-16) Bronze body gate Valve: Bronze body, fire protection gate valve, 1/2 inch through 2 inch size, UL listed, FM approved, block pattern, screw-over bonnet, outside screw and yoke, solid wedge, screwed ends, 175 psi WWP, 1/2 inch through 2 inch size, Stockham Fig. B-133.

(V-17) Iron Body Gate Valve: Iron body fire protection gate valve, 2-1/2 inch size and larger, UL listed, FM approved, bolted bonnet, outside screw and yoke, solid wedge, flanged ends, 175 psi WWP, 2-1/2 inch size and larger Stockham Fig. G-634.

(V-18) Iron Body Check Valve: Iron body fire protection horizontal swing check valve, UL listed, FM approved, bolted bonnet, renewable seat bronze disc, 175 psi WWP, 2-1/2 inch size and larger, Stockham Fig. G-939.

1.28 PIPING CONNECTIONS:

Furnish and install unions or mating flanges at all connections to each piece of equipment, conveniently located to facilitate quick and easy disconnecting of equipment for replacement, tube cleaning or general maintenance. Flanged or union connections shall be used on both sides of equipment connection. Unions or flanges shall be of the same material or finish as the piping systems in which they are installed. Unions are not required for grooved pipe systems.

Dielectric unions, flanges, or waterways shall be installed in domestic hot, cold and recirculating water lines where copper or brass piping is connected to ferrous material such as steel piping, steel tanks, steel water heater, etc. Dielectric unions 2 inch size and smaller shall be steel body and nut with insulating gasket and copper connector, 250 psi rating at 190 degrees F., EBCO Model FX, FB, or EA. For 2-1/2 inch size and larger, the union shall be flanges, cast iron with insulated gasket and copper connector, 175 psi rating at 190 degrees F., EBCO Model GX or GA.

Grooved pipe and mechanical joint couplings may be utilized in certain piping systems with Architect/Engineer approval. See section on pipe and pipe fittings.

1.29 PIPE ALIGNMENT GUIDES:

Furnish and install pipe guides at expansion loops, expansion joints, and elsewhere shown on the Drawings. They shall consist of a heavy 4 inch pronged clamp, bolted to the pipe and sliding inside a bolted steel sleeve which is attached rigidly to the structure of the building by means of sturdy extension bracing.

Guides shall be of sufficient length to maintain at least 25 percent engagement (overlap) for maximum travel of the piping.

Manufactured guides shall be Keflex, Mave Type PM, Flexonics, Elcen Figure 511, or equal.

1.30 EXPANSION COMPENSATORS AND GUIDES:

Furnish and install Metra-Flex model HP or equal expansion compensators where shown on the Drawings and where required to allow for free expansion of piping. All expansion compensators, guides and anchors shall be installed in strict accordance with manufacturer's recommendations.

Expansion compensators shall be constructed of all metal with stainless steel bellows, carbon steel housings and fittings and be suitable for 150 psi operating pressure and 850 degrees F. operating temperature. Compensators shall be designed for 1.5 inches of expansion per 100 feet of piping.

Expansion Compensators and guides shall be MetraFlex, Flexonics or equal.

1.31 PIPE HANGERS, SUPPORTS AND ANCHORS:

Anchors as shown and detailed on the Drawings and specified herein and/or as required. All support components shall conform to Manufacturer's Standardization Society Specification SP-58. The hangers shall adequately support the piping system. They shall be located near or at changes in piping direction and at concentrated loads. They shall provide vertical adjustment to maintain pitch required for proper drainage. They shall allow for expansion and contraction of the piping. On other than vapor barrier insulated lines, hangers shall bear directly on piping.

Hangers shall be constructed of malleable or wrought iron unless noted otherwise, and hangers supporting copper pipe shall be copper plated. Hangers for pipe 3 inches and smaller shall be band and socket Michigan Model No. 100 or equal. For piping over 3 inches, hangers shall be adjustable, Clevis type, Michigan Model No. 400 or equal.

Where groups of three or more pipes occur, they may be supported with trapeze hangers using two hangers as specified with a capped pipe cross member.

Where clearance between pipe and overhead support is insufficient for the use of other hangers specified, use Michigan Model No. 605 or equal.

Horizontal steel or cast iron piping shall be supported as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Maximum Spacing</u>
Up to 1-1/4 inch	3/8 inch	8 feet
1-1/2 inch & 2 inch	3/8 inch	10 feet
2-1/2 inch & 3-1/2 inch	1/2 inch	15 feet
4 inch & 5 inch	5/8 inch	15 feet
6 inch	3/4 inch	17 feet
8 inch through 12 inch	7/8 inch	22 feet

Horizontal copper piping shall be supported as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Maximum Spacing</u>
Up to 1 inch	3/8 inch	6 feet
1-1/4 inch & 1-1/2 inch	3/8 inch	8 feet
2 inch	3/8 inch	9 feet

2-1/2 inch	1/2 inch	9 feet
3 inch & 4 inch	1/2 inch	10 feet

For vertical piping, where supports are not indicated on the Drawings, support steel and copper pipe at every other floor.

Pipe hangers shall not be attached to the roof deck. Hangers shall be attached to the structure with beam clamps, beam attachment and brackets bolted to joists and beams. Use Michigan Model No. 340 or equal, steel washer plates for pipe supported from steel joist. The Contractor shall endeavor to hang near joist panel joints wherever possible.

Pipe hangers for cold piping and all insulated piping on trapeze hangers shall be large enough to encompass the insulation, using a metal shield so the vapor barrier jacket will not be broken. See Insulation Section.

Pipe mounting brackets for cold piping shall be large enough to encompass the insulation B-Line Model B2417 or equal. This piping shall be anchored securely at the point of connection to plumbing fixtures. The last mounting bracket adjacent to fixtures and equipment may clamp directly onto the pipe. A short length (18 inches maximum) of piping between the last bracket and the connection is allowed without insulation.

Hanging from one pipe to another is prohibited.

Pipe Hangers shall be Michigan, Grinnell, PHD, B-Line or equal.

1.32 PIPING INSTALLATION:

All pipes shall be round and straight, of required size. Cutting shall be done with proper tools and pipes shall be reamed to full size after cutting.

Piping shall be properly enclosed, supported, guided, anchored, sway braced, connected, tested, cleaned and flushed out and shall be properly insulated and protected where required.

All pipes shall be run with proper grade to provide for easy draining and in group runs where applicable and in a neat and orderly manner, to the satisfaction of the Architect/Engineer. Lines required to be enclosed in ceiling, chaseways or similar spaces shall be installed to permit such enclosure as intended. All pipe runs shall be carefully laid out and scheduled to avoid necessary interferences with other work. Pipe sizes shown on the Drawings are nominal pipe sizes and not outside diameters.

Pipes shall be run substantially as indicated on the Drawings. However, the Architect/Engineer reserves the right to require this Contractor to make changes in pipe locations where conflicts occur with other trades. Such changes shall be made without extra cost to the Owner.

Piping shall be installed with ample provisions for expansion and contraction to prevent injury to the same and to the building construction. Such provision shall be made by means of piping offsets, changes in direction, expansion loops and/or suitable expansion joints. Suitable anchors and guides shall be provided to permit proper deflection and compression of offset loops and expansion joints. Expansion joints shall not be used in lieu of offsets, changes in direction or

loops, except where specified and/or indicated on the Drawings or where otherwise obviously necessary.

Exposed piping shall be installed in a sanitary manner for ease in cleaning. Pipe shall be cut and threaded to fit the installation. Wherever possible, rough-in exposed pipe connections at the wall rather than the floor for ease in cleaning.

Equipment piping shall also include wastes and drains which are safe-wasted without a direct connection.

Minimum grade for horizontal drainage piping shall be 1/4 inch per foot for 3 inch diameter piping or less, 1/8 inch per foot for 4 inch and 6 inch diameter piping and 1/16 inch per foot for drainage piping over 6 inch diameter.

1.33 PRESSURE GAUGES:

Furnish and install U.S. Gauge Model 5105 or equal pressure gauges in pipelines and on equipment as indicated herein and/or where shown on the Drawings. Gauges shall have phosphor bronze bourdon tube with brass movement.

Gauges shall be compound, pressure or vacuum as required with 4-1/2 inch diameter dial. Each gauge shall be complete with Trerice No. 872 pressure snubbers, and brass ball valves. Ball valves shall be provided on all gauges at the inlet and outlet of each and all heating circulating pumps.

The normal operating pressure of each gauge shall be 50-70 percent of full scale. The range of the scale shall be suitable for the application.

The gauges shall be located and mounted such that they can be conveniently read by a person standing on the equipment room floor. Accuracy shall be Grade "A". Case shall be aluminum.

Pressure gauges shall be provided on each pump with shut off valves arranged to read both sides of the pump with a single gauge.

Pressure gauges shall be U.S. Gauge, Trerice, Weksler, Ashcroft, Weiss or equal.

1.34 PRESSURE/TEMPERATURE TEST PORTS:

Furnish and install where indicated on the Drawings or tabulated below pressure/temperature test ports. Port shall be solid brass with valve cores capable of receiving either temperature or pressure probe with 1/8 inch o.d. Cores shall be Neoprene when application maximum temperature is 200 degrees F. or less and 500 psi, or Nordel for temperature up to a maximum of 275 degrees F. at 500 psi.

Pressure/temperature test ports shall be installed at each and all heat/cooling coil inlets and outlets. On coils with 3-way control valves an additional port shall be required between the control valve discharge and the balance valve or flow meter.

Test Plugs shall be Sisco, Pete's or equal.

END OF SECTION 220100

SECTION 220400 – PLUMBING

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 220100, General Provisions, in its entirety, including references to the General Construction Specifications, are hereby adopted and made part of these Specifications.

The work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install complete sanitary sewer systems and potable hot and cold water systems, as described herein and/or shown on the Drawings. This includes all piping, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

See Section 220850 for insulation requirements.

1.02 SYSTEM OF PLUMBING:

The continuous waste and vent method of plumbing shall be installed. Hot, tempered and cold water lines are to be installed where shown. All water piping in finished areas shall be concealed in joist spaces above ceilings, and in walls.

Pipes run overhead shall be placed as close to the ceiling as possible, to maintain proper headroom and to present a neat appearance, all consistent with the pitching of pipes for drainage of the systems.

The plumbing work shall be installed in strict accordance with the best plumbing practice, all subject to the Architect/Engineer's approval in accordance with all applicable local, state and national plumbing regulations.

1.03 PLUMBING VENT THRU ROOF (VTR):

Vent stacks from sewer, soil, waste and drain pipes shall be extended at least 12 inches above the roof. The top of the vent shall be designed so as to permit the insertion therein of a testing plug of such form that it can be readily seen until removed, and said plug shall be removed at once after final inspection has been made and approved by the Architect/Engineer. The minimum size of any vent passing through roof shall be 4 inches.

1.04 CLEANOUTS:

Full size brass screw cleanout plugs shall be furnished and installed at the bottom of all soil and waste stacks and at all points where shown on the Drawings and where necessary to permit the entire drainage system to be rodded out easily. Floor drains located in branch lines shall have cleanouts adjacent to the drains.

Floor cleanouts shall be cast iron with inside caulk ferrule, brass plug, adjustable housing and round nickel brass secured frame and scoriated cover. Wade covers shall be heavy duty. In

ceramic and quarry tile floor finishes the cover shall be square. The cover shall be provided to accept the floor covering in the location being installed, i.e., synthetic covering, composition tile, terrazzo, etc., Zurn Z-1425, Wade W-6010; Josam 58100; or equal. Flashing clamp and collar shall be furnished with all cleanouts installed in floors having waterproof membranes. Wall and ceiling plates shall be Zurn Z-1460-9, Wade W-8480-R, Josam 58600, or equal.

Cleanouts shall be Wade, Zurn, Josam, Ancon, J. R. Smith, Mifab, Sioux Chief or equal.

1.05 FLOOR DRAINS:

Furnish and install floor drains where shown on the Drawings and as specified or equal. All floor drains installed in floors with waterproof membranes shall have flashing clamps.

Floor drains shall be Josam Series 30000-A, Wade W-1100 or equal with 5 inch diameter Nickaloy strainer having a minimum of 7.3 square inch free area. In ceramic and quarry tile floor finishes the floor drain strainer shall be square. Furnish and install a deep seal trap.

Floor drains shall be Josam, Zurn, Wade, Smith, Ancon, Mifab, Sioux Chief or equal.

1.06 WASTE, VENT AND WATER CONNECTIONS TO FIXTURES:

Rough-in for waste, vent and water connections at the various fixtures shall be as follows, unless noted otherwise:

	<u>Waste</u>	<u>Vent</u>	<u>Water</u>
Water closet (tank)	4"	2"	1/2"
Water closet (flush)	4"	2"	1-1/4"
Urinal	2"	1-1/2"	1"
Lavatory	1-1/2"	1-1/2"	1/2"
Sink	2"	1-1/2"	1/2"
Kitchen sink	2"	1-1/2"	1/2"
Service sink and receptor	3"	1-1/2"	1/2"
Drinking fountain and EWC	1-1/4"	1-1/4"	1/2"

Waste, vent and water supply piping to plumbing fixtures and equipment which is not shown on the Drawings shall be provided and shall be amply sized in accordance with the above schedule. All plumbing fixtures, wastes, and drains shall be vented in accordance with all applicable Local, State and National Plumbing Regulations.

1.07 PLUMBING FIXTURES:

Furnish and install all plumbing fixtures as specified hereinafter and as designated on the Drawings. Catalog numbers shown are used to designate the type of fixture desired. Special equipment included in this schedule is identified by brand name and number.

Caulk around all floor and wall mounted fixtures. Caulking shall be done in a skilled manner with silicone based white acrylic latex caulk. Caulking shall be water tight, flexible, mildew and shrink resistant.

All exposed flush, waste and supply pipes at the fixtures shall be chromium-plated brass pipe, iron pipe size. No steel nipples or cover tubes will be allowed. The stop valves, pop-up wastes, flush valves, etc., shall be heavy cast brass chromium-plated. Waterlines to all the individual fixtures, where exposed, shall be equipped with high grade, loose key chromium plated brass stop valves unless scheduled otherwise on the Drawings. All chromium plating shall be applied over a nickel plated base. Enameled fixtures shall be acid resistant. Provide backing in the wall to support the fixture. All water closets shall have bolt caps with retainer clips. Groups of fixtures shall be matched.

The Schedule shown on the Drawings is given for the convenience of the Contractor who is to be responsible for exact quantities. Any fixtures indicated on the Drawings, but not specifically mentioned in the Specifications or scheduled, shall be furnished by the Contractor.

Plumbing Fixtures shall be as scheduled, American Standard, Crane, Eljer, Briggs, Kohler, Sloan, Vitra, Zurn-One, or equal.

Fixture carriers shall be Josam, Wade, Zurn, Blake, Smith, Watts or equal.

Brassware shall be the manufacturer's own brass, Chicago Faucet, T&S Brass, Speakman, Cambridge Brass, Zurn as scheduled or equal. Faucets shall meet NSF Standard 61, Section 9 for drinking water.

Lavatory faucets shall have a lifetime warranty against leaking and shall be equipped with temperature limit stops and vandal resistant aerators. Faucet bodies shall be chrome-plated zinc die-cast or solid cast brass (polished or chrome plated) as scheduled on the Drawings. Lavatory faucets shall be American Standard, Eljer, Delta, Moen, Zurn, Chicago/Geberit, Kohler, Sloan, Bradley, Speakman, T&S Brass, Cambridge Brass or equal.

Fiberglass shower enclosures shall be Warm Rain, Aqua Glass, Lasco, Kohler, Aquarius or equal.

Mop sinks shall be Fiat, Stern Williams, Swan, Mustee, Zurn as scheduled or equal.

Stainless Steel sinks shall be Elkay, Carlton, Just, as scheduled or equal.

Water Closet seats shall be as scheduled, Centoco, Church, Bemis, Beneke, Sperzel, Olsonite, or equal.

Flush Valves shall be as scheduled, Sloan , Zurn or equal.

1.08 SHOCK ABSORBERS:

Piping shall be installed with proper safeguards to prevent water hammer. This will be done by installing a sufficient number of shock absorbers where indicated on the Drawings. Air cushion shall be same size as piping on which installed, 16 inches long, with removable cap wherever accessible.

The commercial shock absorbers indicated on the Drawings shall be sized as follows:

<u>Size</u>	<u>Fixture Units</u>
SA-1	1 -11
SA-2	12-32
SA-3	33-60
SA-4	61-113
SA-5	114-154
SA-6	155-330

Shock Absorbers shall be Josam, Wade, Zurn, Sioux Chief or equal.

1.09 WALL HYDRANTS:

Furnish and install 3/4 inch freezeless type wall hydrants where shown on the Drawings. Wall hydrants shall be Woodford Model 65-C or equal, modular brass body with brushed chrome finish and self-draining vacuum breaker. Operating stem shall be hardened stainless steel with loose-key operator. Provide a key with each hydrant and unless stated otherwise, the hydrant shall be installed 24 inches above finished grade.

Wall hydrants shall be Woodford, Zurn, Smith, Watts or equal.

1.10 SANITARY SEWER SERVICE:

Furnish and install sanitary sewer service as shown on the Drawings. The service within 5'-0" of the building and as designated on the Drawings shall be cast iron or PVC pipe and fittings. The service shall be extended into the existing sanitary sewer at a uniform grade. The Contractor shall verify all invert elevations before beginning excavations.

The complete installation shall be in accordance with all applicable, Local, State, and National plumbing regulations.

1.11 ELECTRIC WATER COOLERS WITH BOTTLE FILLER:

Furnish and install a two level electric water coolers where shown on the Drawings. Units shall have light touch push bars, bubblers, pressure regulator, hermetic compressor, stainless steel tops and receptors, stainless steel cabinet faceplate. Units shall be air cooled with fractional horsepower, 115 volt, single phase motor including integral thermal overload protection and 3-wire grounded plug. Entire unit shall be guaranteed for 5 years.

The electric water cooler shall be ADA compliant and shall be lead free.

Furnish the cooler with an apron under the upper unit when the cooler is not installed in a recessed area.

Handicapped units shall be mounted with the outlet orifice at 36" maximum and standard units shall be mounted with the outlet orifice at 42" above finished floor unless noted otherwise on the Drawings.

Water cooler capacity shall be 7.6 gph of 50 degrees F. water with an 80 degrees F. inlet water temperature and 90 degrees F. ambient room temperature.

Water Coolers shall be Elkay, Oasis, Halsey-Taylor, Sunroc, General Electric, Haws or equal.

1.12 TESTS:

The following tests shall be performed on the respective systems. Tests shall be repeated until each system is proven acceptable.

The Contractor is responsible for the following tests:

Soil, waste, and vent piping and rain water conductors, etc., shall be tested in accordance with applicable state and local codes. Unless stated otherwise in the applicable codes, these systems shall be tested with 5 psi air pressure for a period of 15 minutes with a maximum drop of 1 psi during this period.

Cold, hot and recirculating hot water shall be tested and proven watertight under a hydrostatic pressure of 100 psi.

END OF SECTION 220400

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SECTION 220600 - HEATING

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 220100, General Provisions, in its entirety, including references to the General Construction Specifications, are hereby adopted and made a part of these specifications.

The work involved in this specification and the accompanying drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install complete heating system as described herein, and/or as shown on the Drawings. This includes all piping, equipment, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

See Section 220850 for insulation requirements.

1.02 CABINET UNIT HEATERS (CUH):

Furnish and install Cabinet Unit Heaters where shown on the Drawings. Types, sizes and performance shall be as tabulated in the schedule on the Drawings.

Floor type cabinets shall be a vertical console type enclosure fabricated of galvanized steel, phosphatized and finished in a baked enamel with the color to be selected by the Architect/Engineer from a standard color chart. Cabinet shall include integral discharge grille and full width electrical and piping compartments with access doors at each end.

Basic unit shall consist of base casing with wall plate fabricated of galvanized steel, top duct discharge opening or for installation in custom enclosure.

Horizontal cabinet models shall consist of 18 gauge steel panels. Bottom and end panels shall have channel formed edges around the entire panel perimeter. Integral, stamped outlet and inlet grilles, where required, shall have 15 degrees downward deflection. Bottom panel shall be hinged at the front and camlocked at the back.

Horizontal recessed models shall consist of 18 gauge steel removable, four-sided overlapped bottom panel with piano-type hinge at the back and camlocks at the front. The fan shall be enclosed with a filter rack at the inlet.

Coils shall have aluminum fins with copper tubes mechanically expanded for a permanent bond. Coils shall have a factory installed manual air vent. Coil performance shall be as tabulated in the schedule on the Drawings.

Fans shall be DWDI forwardly curved, centrifugal type. Fan housing shall be fabricated of heavy gauge galvanized steel and of 2-piece construction with removable front half for complete access to fans.

Units shall have 115/60/1 single speed, sleeve bearing, permanent split capacitor motors with oilers, inherent thermal overload protection with automatic reset, disconnect switch and resilient mounts.

Units shall have a unit mounted solid state variable speed controller with integral "on-off" switch which shall provide "high", "medium", "low" fan speed control. All capacities are based on high fan speed.

Cabinet Unit Heaters shall be Trane, McQuay, Airtherm, Carrier, Beacon Morris, International, Dunham-Bush, Sterling, York, Modine, Rittling, Sigma or equal.

1.03 HOT WATER RADIANT CEILING PANELS:

Furnish and install Hot Water Radiant Ceiling Panels where shown on the Drawings. All radiant panels shall be installed by personnel wearing white gloves to avoid soiling the panels. The ceiling supplier shall instruct the Contractor's personnel as to proper installation procedures.

Contractor shall refer to Room Finish Schedule and Architectural and Mechanical Drawings for locations of surfaces to be covered with various types of radiant metal pan units. Also refer to the architectural details which apply to this installation.

The radiant-acoustical panels shall produce a minimum heating output of 225 BTU per hour per square foot at 190 degrees F. mean water temperature (M.W.T.) in a room with 70 degrees F. air temperature, 67 degrees F. average unheated surface temperature, natural air convection, and one inch of three quarter pound density fiberglass insulation placed on the top side of the panel.

Radiant heating panels shall be non-perforated panels, consisting of 0.040" aluminum face plate, 6 pass 1/2" copper serpentine coil metallurgically bonded to face plate, 1" thick 3/4 lb. density glass fiber pads, and shall be of sizes as shown on Drawings.

All metal ceiling panels shall have two coats, baked white polyester finish, with a light reflection value of 70% to 80%.

It is the responsibility of this Contractor to coordinate his work with the reflected ceiling plans. Provide surface mount; Airtex Model ASF, or equal; or recess mount; Airtex Model ARF, or equal; trim kits wherever panels are mounted in plaster or gyp board ceilings. Frames shall be single piece, aluminum exterior frames with welded corners.

No installation of finished ceiling surface panels or sound absorbing elements shall begin until all glazing has been completed and all exterior openings closed in. All wet work, including cement, plastering, terrazzo, etc., shall be completed and dried out before finished ceiling panels are installed. Any or all trades responsible for the damage of ceiling panels due to unauthorized removal, and other neglects, shall be held responsible for the replacement of such parts.

Hot Water Radiant Ceiling Panels shall be Airtex, Shelley, AeroTech, Barcol Air or equal.

1.04 DUCT MOUNTED HEATING COILS:

The duct mounted heating coils are specified under Section 15800. The duct mounted heating coils shall be furnished and installed under Section 15800. This specification shall include the furnishing and installing of all valves, unions, air vents, etc., and make connections to the duct coils. Automatic control valves shall be furnished by the Automatic Temperature Control Contractor and installed under this specification.

1.05 STRAINERS:

Furnish and install, where shown on the Drawings, and where required, a "Y" type strainer.

Strainers shall have steel or brass bodies, with 20 mesh stainless steel screens. The pressure drop shall not exceed 0.1 PSI at rated flow. All strainers shall be rated at 125 psig steam working pressure minimum and 200 psig water working pressure minimum. All strainers shall be provided with a blowdown valve.

Strainers shall be Hoffman, Dunham-Bush, Sarco, Clark-Reliance, Armstrong, Illinois, Titan or equal.

1.06 AIR VENTS:

On each heating and cooling element, at the top of each heating or cooling pipe riser, and wherever required to vent the system, furnish and install a Taco No. 400, Bell & Gossett No. 4V or equal air vent.

1.07 HEATING AND COOLING ELEMENT VALVING:

Hot Water Radiation, Convectors and Unit Heaters: Install shutoff valves on the supply side of the coil and balancing valves on the return side. Where temperature control valves are used, the manual valves shall be installed to isolate both the temperature control valve and the coil.

Hot Water Coils: Provide shutoff valves on the supply to the coils and a balance valve on the return from the coils. Multiple section coil banks shall have the respective supply and return valves on each section.

See Drawings for additional valving requirements.

1.08 IN-LINE CIRCULATING PUMPS:

Furnish and install "in-line" centrifugal circulating pumps similar to Bell & Gossett Series 90 or equal.

Pumps shall be complete with cast iron volutes, bronze impellers, carbon steel shafts, and mechanical seals. Bronze sleeve pump bearings shall be oil lubricating. Pump and motor shall be close-coupled with a flexible spring type coupler for quiet operation.

Pump capacities shall be as listed in the schedule on the Drawings.

Circulating pumps shall be Bell & Gossett, Taco, Armstrong, Amtrol, Patterson or equal.

1.09 EXPANSION TANK(S):

Furnish and install Bell & Gossett expansion tank(s) of ASME construction for 125 psig working pressure or equal and sized as shown on the Drawings. Provide gauge glass(es) and tapplings on bottom of the tank for installation of tank fitting and drain. Tapplings shall be manufacturer's standard size.

Tank(s) shall be hung from overhead structure with four 1/2 inch rods and 3" x 3" x 1/4" angle at each end. If tanks are installed adjacent to each other, hanger rods shall be installed between each pair of tanks.

Tank(s) shall be Bell & Gossett, John Wood, Ace, Armstrong, Amtrol, Adamson, Taco, Wessels or equal.

1.10 AIR SEPARATORS:

Furnish and install Bell & Gossett Model RL Rolairtrol air separator(s) or equal, where shown on the Drawings. Unit shall be constructed in accordance with ASME Code and stamped for 125 psig working pressure. Air separators shall have 90 percent minimum efficiency and head loss shall not exceed 3.0 feet at rated flow.

Air separator for the heating system shall be Model RL-2 having a capacity of 50 gpm minimum.

Air Separators shall be Amtrol, Armstrong, Bell & Gossett, Taco or equal.

1.11 WATER TREATMENT:

Water treatment work shall be executed under the direct supervision of an independent water treatment company with personnel experienced in hydronic and steam system water treatment having an experience record of not less than five (5) years in the water treatment industry. System cleaning and treatment work shall not be done by the installing contractor without the proper supervision.

A certificate of completion of the system cleaning and treatment shall be provided by the Water Treatment Company.

The heating and cooling equipment shall not be fired nor shall the circulating water systems be operated prior to cleaning and treatment.

The Water Treatment Company shall provide a description of the water treatment and glycol in the individual systems and shall mount the descriptions with heavy plexiglass covers on the wall adjacent to the chemical feeder for each respective system.

Acceptable Water Treatment Companies meeting the above requirements are as follows:

Fremont Industries
EcoLab
Girton-Adams

Independent Water Treatment Companies not listed above must submit for approval. This approval is not required prior to the bid; however, must be completed prior to any treatment work being done and is at the sole discretion of the Architect/Engineer.

Cleaning and Flushing:

All heating circulating water system piping, and equipment shall be thoroughly flushed out with cleaning chemicals at a temperature of 140 degrees F. to remove all pipe dope, oils mill scale, and

other extraneous materials. The system may require multiple cleaning and flushing of the system to accomplish adequate low temperature cleaning and flushing. The system shall then be filled immediately with clean water and flushed, refilled with clean water to which water chemical treatment shall be added in the prescribed dosage.

Condenser Water Treatment Control System:

Provide a completely automatic Hydac Modu-Max Control System or equal to control inhibitor application and blowdown of the recirculating cooling tower system. Blowdown shall be conductivity activated, and directly responsive to all variables that affect evaporation, blowdown, and make-up quantities.

The system shall include a chemical feed pump of suitable materials of construction, and shall have adequate capacity to handle chemical inhibitors of variable pH. Pump shall be positive displacement, diatom type, with adjustable volume from zero to 100%. Pump shall be furnished with a foot valve strainer and backcheck valve assembly with 1/2" NPT male connection. Capacity shall be 18.2 GPD against 75 psi to feed the chemical inhibitor directly from the shipping drum. Pump shall be supplied with 115/1/60 wiring.

The system shall contain an electronic conductivity controller equipped with "flow through" sensing probe, "Power On" and "Blowdown" indicator lights, a system test button, and ground 3 wire power cord. Flow through probe shall have 3/8" O.D. copper tube fittings, mounting brackets, and clean out brush. Twin bleed and pump outlets shall be on the controller panel. The Conductivity controller, when sensing maximum permissible conductance of the circulating water, shall simultaneously open a solenoid valve on the blowdown line, meter the volume of make-up water and activate a chemical feed pump for application of suitable scale and corrosion inhibitors.

A blowdown control assembly shall be furnished, including a cast iron pipe strainer with 20 mesh Monel screen, Automatic Flow Control Valve sized by the treatment company, and solenoid valve. Assembly shall be 3/4" NPT pipe size. The solenoid valve shall be wired to the bleed outlet of the conductivity controller.

The system shall include one (1) injection assembly of 3/4" PVC injection nozzle with 1/2" NPT connection, to inject the chemical treatment into the center of flow of the condenser water circulating line.

Fail safe control shall be provided to prevent chemical feed when condenser water circulation stops, wire the conductivity controller parallel to the recirculating pump using auxiliary contacts.

Provide a one year's supply of water treatment for the condenser water system. The chemical treatment shall be organic phosphonate based scale inhibitor, and must contain corrosion inhibitors and an active sludge dispersant. This chemical must be in liquid form and be suitable for the feeding into the system direct from a shipping container. This chemical treatment must not contain chromate or phosphate, and acid for pH control will not be considered.

Provide a one year's supply of algae and slime control agents for the prevention of algae and slime accumulations in the cooling tower system. The products recommended shall be two separate algaecide formulations so that formulas can be alternated periodically. The algaecides are to be effective against all normally encountered algae and slime growths.

Circulating Water System Treatment (Heating and Cooling):

Chemical feeding equipment for closed systems shall include by-pass pot feeders of two gallon capacity with 3/4" brass drain valve. Feeders shall be furnished with slotted Lexan inlet and outlet strainers and able to withstand a maximum working pressure of 175 psi.

Provide a one (1) year's supply of liquid polymeric corrosion inhibitor treatment for the prevention of corrosion in closed systems at 20 ppm total phosphate level. Systems with 25 percent by volume or greater concentrations of specially inhibited glycol may not require additional corrosion inhibitor.

Furnish a supply of log sheets on which to record the test results and bound copy of full test instructions.

Service and Control:

The water treatment company shall provide the services of a fully qualified service representative for one year at no additional cost to the Owner. This service representative must have been active in the water treatment field for a minimum of five years.

The water treatment company shall train the operating personnel as to the proper testing procedures and applications of his products for proper treatment.

The water treatment company shall make technical service visits to the site of the Owner to perform field inspections and to make water analyses on site, both of such complexity as to evaluate the water systems operations. The service representative shall provide findings to the proper personnel in writing on proper practices, chemical treating requirements, and any corrective actions needed to protect the water systems from scale, corrosion, and fouling.

Heating Water Systems: November and February.

The water treatment company shall be on call at no additional cost to the Owner to make on site inspections of equipment during scheduled or emergency outages in order to properly evaluate the success of the water treatment program, and to make recommendations in writing based upon these inspections.

Water Treatment chemical shall match existing.

1.12 HEATING AND COOLING SYSTEMS COIL DAMAGE PROTECTION:

Furnish and install Dow Chemical Company Dowfrost HD or equal specially inhibited propylene glycol-based fluid in the heating and cooling circulating water systems to minimize the risk of coil damage. The glycol based fluid shall be a premixed fluid provided by the glycol supplier.

Circulating heating water systems shall incorporate 25 percent propylene glycol by volume.

Specially inhibited glycol shall be Dow Chemical Company, Fremont Industries, Houghton Chemical Company, Interstate Chemical Company, Union Carbide, or equal.

1.13 AUTOMATIC TEMPERATURE CONTROL:

Install the automatic temperature control valves, openings for water monitoring devices, flow switches, wells, alarms and control devices as provided by the Automatic Temperature Control Contractor. These valves and devices shall be installed under the direct supervision of the Section 230900, AUTOMATIC TEMPERATURE CONTROL Contractor and in strict accordance with the manufacturer's recommendations.

1.14 AUTOMATIC FLOW CONTROL VALVES:

Contractor shall provide and install Griswold, AutoFlow or equal Automatic Pressure compensating Automatic Flow Control Valves where shown on the Drawings. Contractor shall provide replacement cartridges as necessary for system balancing.

Automatic Flow Control Valves (FCV) shall automatically control flow rates with +/- 5% accuracy over an operating pressure differential range of at least 14 times the minimum required for control. Two operating pressure ranges shall be available with the minimum range requiring less than 3 PSID to actuate the mechanism. Valve internal control mechanism shall consist of a passivated stainless steel one-piece cartridge with segmented port design and full travel linear coil spring. Dual pressure or pressure/temperature test valves for verifying the pressure differential across the cartridge and system temperature shall be standard. Manufacturer shall provide certified independent laboratory tests verifying accuracy of performance.

Ball Valves integral to the automatic flow control valves shall be made of Bronze and rated for 600 WOG.

P/T Adapter for supply side shall include a pressure/temperature test valve for measuring temperature and/or pressure differential across the terminal unit. Provide a metal identification tag with chain for each installed valve. The tag shall be marked with zone identification and rated flow in gpm.

All components shall be warranted by manufacturer for no less than five years from date of purchase.

Correct flow shall be verified by establishing that the operating pressure differential across the valve tappings is within the range indicated on the submittal data sheet for that model number.

Each valve in cold piping shall have an extended operator stem with insulation sleeve and extended pressure/temperature test ports to accommodate the pipe insulation and vapor barrier.

Automatic Flow Control Valves shall be Griswold, Autoflow, Nexus, Pro Hydronics or equal.

1.15 TESTS:

General:

The Contractor shall furnish a competent individual familiar with the installation to assist the Balancing Company and make the necessary mechanical equipment adjustments as directed by the

Balancing Company. The Contractor shall also furnish the necessary ladders, scaffolding, etc., needed for access to test and balance all systems.

The Contractor shall provide replacement pulleys, etc. as required to properly balance the heating equipment.

The following tests shall be performed on the respective systems. Tests shall be repeated until each system is proven acceptable.

Heating and Cooling:

The Contractor shall make an operating test of the heating and chilled water systems and all relating equipment.

The operating test shall cover a total running period of 24 hours and all pertinent data shall be presented to the Owner as an indication of the proper operation of the plant.

The Contractor shall cooperate with and assist the independent Testing and Balancing Company specified in Section 230800 - VENTILATION AND AIR CONDITIONING to properly balance the water flow to and from all coils and equipment and make any adjustments necessary to meet the required flows.

All piping systems installed by the Contractor shall be tested with a pressure equal to 150 percent of the normal operating pressure for the specific systems (100 psi minimum).

END OF SECTION 220600

SECTION 220700 – PLUMBING AND HEATING INSULATION AND PIPING
IDENTIFICATION

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 220100, General Provisions, in its entirety, including references to the General Construction Specifications are hereby adopted and made part of these specifications.

The work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all labor, materials, fixtures, and equipment necessary to install complete piping, and equipment insulation as described herein and/or as shown on the Drawings. This includes all equipment and materials obviously necessary for complete systems though not specifically mentioned or shown.

1.02 MATERIALS AND WORKMANSHIP:

All covering and insulating materials used on this project must contain the manufacturer's name on the containers. All materials must be dry and in good condition, free of defects, mildew, rough ends, etc. Insulation materials shall be Certainteed, Owens-Corning, Johns Manville, Armstrong, Knauf or equal.

All insulation work shall be performed by an Insulation Contractor who uses workers skilled in this type of work. Only first class workmanship will be acceptable. The Insulation Contractor shall submit shop drawings for all materials proposed to be installed in this project.

All pipe covering shall have a density of not less than 3-1/2 pounds per cubic foot.

All materials shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255, AND U.L. 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.03 PIPING AND VESSELS INSULATION:

All pipe covering shall be furnished with a factory-applied all service jacket. All longitudinal joints shall be sealed with adhesive such as Benjamin Foster 30-35, or equal, or factory applied self-sealing laps. All end joints shall be sealed with 3 inches wide butt strips of material identical to pipe covering jackets, using adhesive or self-sealing jacket. No stapling will be permitted on any vapor-barrier jackets. No vapor-barrier work or self-sealing laps or lap work shall be installed when temperatures are below 40 degrees F.

Insulation shall be continuous through properly sized wall and floor sleeves with no joints within 12 inches of the penetration. Where a fitting is adjacent to the wall a continuous section of insulation must extend from the fitting to 12 inches beyond the other side of the wall.

Wrap pipe at penetrations of fire or smoke barriers with firestop pipe insulation, seal jacket seam and seal end joints to adjacent sections of insulation. Seal opening between insulation and pipe sleeve with firestopping material.

All plastic, fiberglass or other piping and fittings that are not rated for unprotected installation in return air plenums shall be wrapped with 3M Fire Barrier Plenum Wrap 5A+, or equal. The installation shall be in strict accordance with the manufacturer's written instructions. Wrap shall be a high temperature fiber blanket thermal insulation encapsulated in a fiberglass reinforced aluminum foil. Plenum wrap density shall be nominal 6 pcf and have a nominal 1/2 inch minimum thickness. The fiberglass blanket shall have a continuous use limit in excess of 1832 degrees F (1000 degrees C). Flame Spread Index and Smoke Developed Index of the foil encapsulated blanket shall be equal to or less than 25/50.

All insulation installations shall conform to ASHRAE Standard 90.

1.04 FITTING AND EQUIPMENT INSULATION:

Insulate all fittings, valves, flanges and strainers with mitered segments of pipe insulation wired in place and premolded PVC plastic covers. Plastic covers shall be taped and sealed with a continuous vapor barrier on all cold systems. Plastic covers shall be Zeston or equal.

The Contractor shall allow for the removal and replacement of four (4) fitting or joint covers selected by the Architect/Engineer for inspection purposes. If any of the removed covers reveal unsatisfactory installation as determined by the Architect/Engineer, four (4) additional covers may be removed and replaced. Fitting covers may be removed and replaced four (4) at a time until the system installation is satisfactory.

For fittings where premolded PVC plastic covers are not available, coat each fitting with two 1/8 inch coats of an approved vapor-barrier mastic such as Childers CP-30 or equal. Reinforce each fitting by wrapping with glass fabric cloth extending 2 inches onto adjacent pipes and finish with additional coating of mastic worked into mesh of cloth to provide a smooth finish.

Coat vapor barrier penetrations, including insulation end butts, piping brackets, valve operator stems, etc., with two 1/8 inch coats of an approved vapor-barrier mastic. Trim the insulation at valve handle operators to allow for valve operation without damaging the vapor barrier. Insulation mastic for cold systems shall be Childer's CP-30 or equal for cold system vapor barriers. Vapor barrier shall be rated at 0.02 perms or less in accordance with ASTM E96 procedures.

Corner beads shall be used on all square corners.

Insulation shall be cut or mitered where necessary to fit the contour of the fittings and equipment. All voids shall be packed with light density glass fiber insulation. Insulation sections shall be banded in place with 3/4 inch x 0.015 inch thick galvanized steel bands at 18 inch o.c. for all large equipment. Insulation shall be covered with one inch galvanized hexagonal wire mesh. Apply 1/2 inch of insulating cement such as OC-110 or equal in 2 layers over the wire mesh.

On all cold systems, insulation shall be impaled over welding pins at 12 inches o.c. and secured in place with speed washers. The 3/4 inch steel bands will not be required. Each layer of insulation shall have a vapor barrier cover to provide complete airtight envelope. Vapor-barrier shall consist of one layer of Ludflow foil barrier paper smoothly adhered to the insulation cement surface with vapor-barrier lap adhesive. Lap all joints a minimum of 3 inch and seal with vapor-barrier lap adhesive.

1.05 HOT PIPING AND VESSELS:

The following systems shall be insulated with the following minimum thicknesses of glass fiber insulation:

MINIMUM PIPE INSULATION – INTERNATIONAL ENERGY CONSERVATION CODE & ASHRAE 90.1

Based on thermal conductivity (k) of 0.23 btu-in./hour-ft²-°F
on a flat surface at 75° F. mean

Piping System Types	Fluid Temp. Range Deg.F.	Insulation Thickness for Pipe Sizes					
		1" & Under	1-1/4" to 1 1/2"	2"	2-1/2" to 4"	5 to 6"	8" & Over
Hot Water Heating Systems -							
Low Temp	120-200	1.0	1.0	1.5	1.5	1.5	2.0
Steam condensate and feed water	Any	1.0	1.5	1.5	2.0	2.0	2.0
Domestic Systems -							
HW, RHW	Any	1.0	1.0	1.0	1.5	1.5	1.5

Do not insulate radiation runouts enclosed in radiation cover and risers between floor and radiation cover.

The following equipment shall be insulated with thicknesses as noted of calcium silicate blocks such as OCF, Kaylor or equal:

Heating System Air Separator . . 2"

1.06 COLD PIPING AND VESSELS:

The following systems and services shall be insulated with the following thicknesses of glass fiber insulation including a factory-applied all service jacket and vapor barrier:

	Pipe Sizes	
	1/2" through 2"	2-1/2" to 12"
Domestic CW,	1/2"	1"

All rods for pipe hangers and metals having direct contact with cold water piping shall be insulated up to 8 inches and sealed same as fittings. Refer to Section 220100 for cold water pipe supports. Pipe hangers shall not be in direct contact with cold piping unless approved by the Architect/Engineer.

Pipe mounting brackets for cold piping shall be large enough to encompass the insulation. This piping shall be anchored securely at the point of connection to plumbing fixtures. The last mounting bracket adjacent to fixtures and equipment may clamp directly onto the pipe. A short

length (18 inches maximum) of piping between the last bracket and the plumbing fixture is allowed without insulation.

1.07 PIPING IDENTIFICATION:

Identify all piping, insulated and uninsulated, except where concealed inside walls or below floors, with 1 inch high black letters designating the type of service and an arrow in the direction of flow.

The lettering shall be applied after all painting of the piping is complete as specified in Division 9 - FINISHES. The lettering shall have an identifying word or phrase such as, cold water, gas, sprinkler, low pressure steam return, etc. Each pipe shall be identified at 30 feet intervals maximum and at each change in direction.

To standardize the lettering and abbreviations, use the following listing:

Domestic Cold Water - (CW).

Hot Water - (HW).

Recirculating Hot Water (RHW).

Vent (Vent).

Oxygen (Oxy).

Vacuum (VAC).

Waste (W).

Heating Water Supply (HWS).

Heating Water Return (HWR).

Sprinkler (SPR).

END OF SECTION 220700

DIVISION 23 – VENTILATION AND AIR CONDITIONING

SECTION 230100 - GENERAL PROVISIONS

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

This Section pertains to general provisions and requirements for construction of work specified in all sections of Division 23 herein.

"Contractor" referred to in this Section of the specification implies the Contractor, Subcontractor and/or Subcontractors which are responsible for all or any part of the mechanical installation specified in Division 23 and/or as shown on the Contract Drawings.

Where the specifications in subsequent Sections of Division 23 conflict with requirements of this Section, the specifications in the subsequent Sections shall govern.

The Contractor shall provide all items, articles, materials, operations or methods listed, mentioned or scheduled on the Drawings and/or herein specified, including all labor, materials, equipment, accessories, wiring and incidentals necessary to be installed in accordance with manufacturer's recommendations except as otherwise approved.

1.02 PERMITS AND SERVICE CHARGES:

All permits and service charges necessary for execution of the work under this Contract shall be obtained by and be paid for by the Contractor. It shall be the responsibility of the Contractor to determine the permit requirements of the local authorities and utility companies and the cost of required permits, service charges, tap fees and development fees shall be included in the Contractor's bid.

All work shall be executed in accordance with all local, state and national rules, regulations, codes, etc., which are applicable and shall be subject to inspection by the proper authorities.

1.03 CODES AND STANDARDS:

All work performed and all equipment furnished under this Division of the Contract shall be manufactured and installed in strict accordance with all applicable codes and standards, including the applicable provisions of the following codes and standards.

1. Local and State Codes, Standards and Regulations.
2. National Fire Protection Association (NFPA).
3. National Electric Code (NEC).
4. Underwriter's Laboratory (UL).
5. American Gas Association (AGA) Standards.
6. Uniform Plumbing Code.
7. International Mechanical Code.
8. ASME Boiler and Pressure Vessel Codes.
9. State Boiler Safety Code.

10. American Waterworks Association (AWWA).
11. National Sanitation Foundation (NSF).
12. Williams-Steiger Occupational Safety and Health Act of 1970 (OSHA).
13. International Building Code.
14. Life Safety Code.
15. State Energy Conservation Standards.
16. Americans with Disabilities Act (ADA).

All materials installed shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255 and UL 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.04 COMPLIANCE:

Where specific requirements of any code vary with the requirements of another code, the higher standard as determined by the Architect/Engineer shall govern the installation.

All equipment manufactured in accordance with the provisions of the above codes and standards shall bear the label of the respective association bureau thereon.

1.05 DRAWINGS:

In general, the Drawings of the mechanical systems and equipment are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural drawings which are dimensioned. Drawings shall not take precedence over field measurements.

Drawings of piping and ductwork, although shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction. If it is found, before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the Drawings, the Architect/Engineer may require the Contractor to change the location or arrangement of the work without additional cost to the Owner. Such rearrangement shall be in accordance with directions from the Architect/Engineer.

Where discrepancies are discovered after certain portions or phases of the work have been installed, the Architect/Engineer reserves the right to require the Contractor to make changes in pipe, duct, fixture or equipment locations or arrangements to avoid conflicts with work at no additional cost to the Owner.

Because the Drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the system are indicated does not mean that other similar or different features or details will not be required. The Contractor shall furnish all incidental labor, material or equipment for the systems so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the specifications.

The Contractor, Subcontractor's and their respective trades shall cooperate in laying out their work so it will fit properly into the space provided. Promptly report to the Architect/Engineer any delay or difficulties encountered in the installation of this work which might prevent prompt and proper

installation, or make it unsuitable to connect with or receive the work of others. Failure to so report shall constitute an acceptance of the work of other trades as being fit and proper for the execution of this work.

1.06 SUBSTITUTIONS AND PRODUCT OPTIONS:

The Contractor and equipment suppliers shall read and familiarize themselves with articles concerning substitution of materials, as indicated in the Instructions to Bidders. Material and equipment substitutions will be handled as follows:

Materials or equipment specified by name of manufacturer, brand, trade name or catalog reference, shall be furnished under the contract unless changed by Addenda or a Contract modification. Where two (2) or more materials are named, the choice of these shall be optional with the Contractor.

Material or equipment followed by the phrase "or equal" shall establish a standard of required function, dimension, appearance and quality to be met by any proposed substitute. No substitution will be considered unless written request for substitution has been submitted by the bidder and has been received by the Architect/Engineer at least ten days prior to the date for receipt of bids. The Architect/Engineer's decision on a proposed substitute shall be final. If the Architect/Engineer considers any proposed substitution equal, such will be set forth in an Addendum. Bidders shall not rely upon substitutions made in any other manner.

Should the Contractor wish to use materials or equipment other than those specified or listed as equal by Addenda, he shall attach his proposed substitution along with the appropriate add or deduct to the Contract amount, should the substitution be accepted. Substitutions proposed by the Contractor will not be considered in the award of the Contract.

1.07 SHOP DRAWINGS:

Refer to the requirements of the General Conditions. Unless indicated otherwise in the General Conditions, submit to the Architect/Engineer seven (7) copies (minimum) of Shop Drawings for each item of equipment to be installed under this contract with two (2) copies to be retained by the Architect/Engineer. Furnish additional Shop Drawings as required for coordination with General Contractor and other Subcontractors.

To the extent practical, complete sets of shop drawings for each specification section shall be submitted. In the case that a particular item is required to be expedited, that particular item may be submitted individually.

Submit shop drawings punched in 3-hole format.

Furnish Shop Drawings as follows:

1. For all major items of equipment or materials, regardless of whether the item is to be furnished as specified.
2. For all equipment, systems or devices where Shop Drawings are specifically called for.
3. For all minor items of equipment or materials where the Contractor proposes to deviate from the specified and/or scheduled manufacturer or material.

The Contractor shall check all Shop Drawing submittals for size, capacity, arrangement, connection locations, materials, finish, color, electrical characteristics, accessories, and shall so note the Shop Drawings prior to submittal to the Architect/Engineer. Any deviation from the Drawings and Specifications shall be indicated.

Shop Drawings will be reviewed by the Architect/Engineer, and copies of Shop Drawings will be returned to the Contractor. Shop Drawings shall be submitted sufficiently in advance of the construction schedule to allow time for checking Drawings, resubmittal and rechecking when necessary.

Any equipment or material which is installed without authorization by properly processed Shop Drawings will be subject to removal by the Contractor and reinstallation as directed, without cost to the Owner. All cost for repair for damages as may be incurred to the structure as a result of the above correction shall be paid by this Contractor.

Shop drawing material quantities will not be checked by the Architect/Engineer, and review of Shop Drawings by the Architect/Engineer shall not be construed to be verification of the material quantities and sizes shown on the Shop Drawings. Quantities, sizes, dimensions and locations shown on the Drawings and as specified shall determine material requirements.

1.08 CLEANING:

The Contractor and/or Subcontractors for the various phases of the work shall clear away all debris, surplus materials, etc., resulting from their work or operations, leaving the job and equipment furnished under any or all contracts in a clean first class condition.

Permanent heating and ventilating systems shall not be used during the construction period unless the project site is in a clean and dust free condition and shall be subject to the approval of the Architect/Engineer and Owner.

Air surfaces of all coils, fan housings, fan wheels, fan motors, air unit plenums, all air filters, and mechanical equipment shall be wiped clean or washed if required, leaving the installation in a first class condition. All throwaway filters used during construction shall be replaced.

The surfaces of all equipment shall be cleaned, and each item shall be left in a first class condition.

1.09 PAINTING:

Painting of materials and equipment furnished under the mechanical portion of the contract shall be as described in Division 9 - FINISHES. Contractor shall refinish and restore to the original condition and appearance, all mechanical equipment which has sustained damage to the manufacturer's prime and finish coats of enamel or paint. Materials and workmanship shall be equal to the requirements described in Division 9 - FINISHES.

1.10 RECORD DRAWINGS:

The Contractor shall keep a complete set of all mechanical drawings in the jobsite office for purpose of showing the installation of mechanical systems and equipment. This set of drawings shall be used for no other purpose. Where any materials equipment or system components are installed different from that shown on the Architect/Engineer's drawings, such differences shall be

clearly and neatly shown on this set of drawings using ink or indelible pencil. At the completion of the project, the record set of drawings shall be turned over to the Architect/Engineer and shall become his property.

1.11 OPERATING INSTRUCTIONS:

The Contractor shall furnish the Owner two (2) sets of complete catalog data, manufacturer's literature and detailed manuals covering the operation and maintenance of all equipment specified under this Division. All such literature shall be bound in an amply sized three-ring binder and submitted to the Architect/Engineer for approval and for eventual transmittal to the Owner. The manual shall have a Table of Contents at the front of the manual.

The Contractor shall also supervise the initial operation of all equipment and instruct the operator selected by the Owner in such operation as required to acquaint him thoroughly with the equipment.

1.12 DELIVERY AND STORAGE OF MATERIALS:

Make provisions for delivery and safe storage of materials on the jobsite and make arrangements with other Contractors for introduction into the building of equipment too large to pass through finished openings. Materials to be delivered at such stages of the work as will expedite the work as a whole and marked and stored in such a way as to be easily checked and inspected. All stored equipment shall be protected from the weather conditions and construction debris with a protective covering securely tied in place.

1.13 MECHANICAL PROVISIONS:

Mechanical equipment shall operate without objectionable noise or vibration, as determined by the Architect/Engineer. If such noise or vibration should be produced and transmitted to occupied portions of the building by apparatus, ducts, or other parts of the mechanical work, make necessary changes and additions, as approved, without extra cost to Owner.

Provide oil level gauges, grease cups and grease gun fittings for machinery bearings as recommended by the manufacturer. Extend oil or grease fittings by copper tubing to readily accessible locations.

1.14 COORDINATION OF WORK:

The Contractor shall process shop drawings and order equipment and materials expeditiously after receiving the Contract and the mechanical installation shall be substantially complete when the general construction work is completed. This Contractor shall confer and cooperate with all other Contractors on this project and shall arrange his work in proper relation to the work of others. Each Contractor shall furnish, install, and maintain in place all anchors, inserts, sleeves, etc., required for his work. Each Contractor will also be held solely responsible for proper size and location of all anchors, inserts, sleeves, chases, recesses, openings, bases, etc., required for proper installation of his work. All cutting and patching made necessary by failure or neglect to coordinate with other Contractors shall be the responsibility of this Contractor. Any cutting or patching shall be subject to the direction and approval of the Architect/Engineer and all damage due to cutting or patching shall be repaired by this Contractor.

After being instructed by this Contractor to do so, the General Contractor will leave all openings in roof, walls, floors, etc., for the passage of ducts, etc. The General Contractor shall also provide concrete bases and roof curbs where shown for mounting the mechanical equipment unless specified otherwise. This Contractor shall verify the exact size and location required for installation of his equipment with the General Contractor.

In general, the Division 26 – Electrical Contractor will provide all power wiring and make one power connection to each item of mechanical equipment, as outlined under Electrical Section.

1.15 GUARANTEE:

All mechanical equipment including equipment used during construction for temporary purposes shall be guaranteed for a period of one year after the time of final acceptance of this work and shall be in like new condition at time of final acceptance.

1.16 TEMPORARY HEAT:

The building ventilation and air conditioning systems shall not be used for temporary heating purposes without written approval of the Architect/Engineer.

Use of the building permanent heating and ventilating systems prior to substantial completion is subject to the written approval of the Architect/Engineer and extended warranties shall be provided at no additional cost.

Duct systems shall not be used during construction without the written approval of the Architect/Engineer. Systems used during construction without written approval, may be required to be professionally cleaned or replaced at no cost, as determined by the Architect/Engineer.

1.17 ELECTRICAL:

Electric Motors:

All electric motor driven equipment being furnished and installed under Division 23 of these specifications shall be complete with electric motors, unless specified otherwise.

All electric motors shall be as manufactured by Westinghouse, Century, Wagner, Allis Chalmers, Reliance, General Electric, or equal. Bearings shall be ball type with alemite lubricating fittings extended to an easily accessible location for field servicing. Minimum service factors for all motors shall be 1.15. All motors shall conform to applicable NEMA standards and all motors specified for use in hazardous locations shall bear the stamp of approval of the Underwriter's Laboratories. All motors, except direct connected motors, shall be furnished complete with cast iron or stamped steel adjustable slide rails. Single phase motors shall be capacitor start type, drip proof, unless specified otherwise. All motors shall be single speed and shall operate at 1,750 RPM, unless specified otherwise.

Horsepower Rating: All electric motors shall be sized to meet the horsepower requirements of the driven unit at design characteristics including all V-belt and/or drive and coupling losses which are incurred without loading the motor beyond its nameplate horsepower rating. Where V-belt drives are employed, the motor horsepower nameplate ratings shall not be less than 120 percent of the driven unit brake horsepower requirements.

Single Phase Motors: Unless specifically noted otherwise, all electric motors shall be designed for operation in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current. Motors shall be thermally protected.

Three Phase Motors: All electric motors shall be designed for operating in an ambient temperature not exceeding 40 degrees C., continuous duty and shall be designed for use with voltage as scheduled on Drawings or specified, 60 cycle alternating current.

All motors less than 3/4 horsepower shall be 115 volt, single phase unless designated otherwise and all motors 3/4 horsepower and larger shall be as specified in the specific section or as noted on the Drawings.

Two Speed Motors:

Two speed motors shall have two separate windings.

Premium Efficiency Motors:

Premium efficiency motors shall be furnished on all mechanical equipment where 1 horsepower or larger motors are required.

Motors shall be designed with special stator steel for reduced core losses. Windings shall be oversized copper placed for maximum efficiency. Stator and rotor shall be extra long to reduce flux losses. Frame shall be ODP (unless specified otherwise) of cast iron or cast aluminum construction.

Motors shall be squirrel cage, horizontal base mount, ball bearing, NEMA B design, Class B design, Class B insulation, continuous duty, 1.15 SF, 40 degrees C. ambient.

Minimum nominal full load motor efficiencies shall be based on ASHRAE Standard 90 (latest edition).

Furnish and install Aegis SGR, or equal, maintenance free, circumferential, conductive micro fiber shaft grounding rings on all AC motors controlled by adjustable frequency drives to discharge shaft currents to ground.

Motors shall be similar to Louis Allis "Spartan" Series, Gould "E-Plus" Series, or Westinghouse "MAC II" Series. Manufacturer shall furnish proof of efficiency rating.

Motor Starters:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 23 of these specifications, all motor starters will be furnished and installed under Division 26, ELECTRICAL.

Electrical Wiring:

Except where specifically described as being furnished as a part of the equipment furnished and installed under Division 23, all electric power wiring shall be furnished and installed in Division 26, ELECTRICAL. The Electrical Contractor will make one power connection to each item of mechanical equipment, unless specified otherwise.

Electrical wiring furnished and installed under these specifications shall conform to all applicable requirements of Division 26, ELECTRICAL.

Unless otherwise indicated, all motors and controls shall be furnished, set in place and wired in accordance with the following schedule:

<u>Item</u>	<u>Division Furnished Under</u>	<u>Set in Place or Mounted Under</u>	<u>Division Wired & Connected Under</u>
Equipment Motors	23	23	26
Magnetic Motor Starters:			
Automatically controlled, with or without HOA switches	26	26	26
Automatically controlled, with or without HOA switches and furnished as part of factory wired equipment	23	23	26
Manually controlled	26	26	26
Manually controlled and furnished as part of factory wired equipment	23	23	26
Line voltage thermostats, time clocks, etc., not connected to control panel systems	23	26	26

Electric thermostats, time clocks, remote bulb thermostats, float controls, etc., which are an integral part or directly attached to ducts, etc.	23	23	23
Temperature control panels and time switches mounted on temperature control panels	23	23	23
Damper motors, solenoid valves, EP and PE switches, etc.	23	23	23
Smoke damper operators	23	23	23
Alarm bells	23	23	23
Control circuit feeders	26	26	26
Low voltage controls, thermostats, valves, dampers, etc.	23	23	23
Fire and smoke detectors, including relays for fan shutdown	26	26	26 ⁽¹⁾
Pushbutton stations, pilot lights	26	26	26
Heat tape	26	26	26
Disconnect switches, thermal overload switches, manual operating switches	26	26	26
Multi-speed switches	23	26	26
Contactors	26	26	26

Control relays, transformers	23	26	26
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NOTES:

- (1) Wiring from alarm contacts to alarm system shall be by the Division 26 Contractor; control function wiring shall be by the Division 23 Contractor.

All control wiring and controls as noted on the Drawings and/or as specified in these specifications shall be provided by this Contractor, including items set in place and wired and connected by the Division 26 Contractor, unless specifically shown otherwise on the Drawings.

1.18 SLEEVES:

Any pipe passing through building construction including walls, floors, roofs or masonry partitions or as noted on the Drawings shall be encompassed with sleeves in accordance with the following:

All pipe sleeves through slabs, floors, masonry walls and masonry partitions shall be 1/2 inch greater in inside diameter than the external diameter of pipe passing through. Sleeves for insulated piping shall be large enough to accommodate the insulation without harming the insulation or vapor barrier. All sleeves shall be fabricated from new material cut square and reamed.

Sleeves shall be provided in all masonry partition walls including locations above suspended ceilings where masonry partition walls extend from floor slab to slab above. Sleeves shall be Schedule 40 steel pipe finishing flush with the wall surface.

Sleeves through exterior building walls shall be Schedule 40 steel pipe with welded flange in the middle of the sleeve and ends finishing flush with finished surfaces. Space between pipe and sleeve shall be packed to provide a watertight joint.

Sleeves through roof slabs and floor slabs in concealed locations shall be No. 22 gauge galvanized steel or crete sleeves (linear polyethylene). Concealed sleeves shall be considered as pipe sleeves in shafts, pipe chases and within walls and partitions.

Sleeves through floor slabs in exposed areas shall be Schedule 40 steel pipe and sleeves shall extend 1/4 inch above the finished floor surface. For slabs in equipment rooms and in other wet areas, sleeves shall be Schedule 40 steel pipe and shall extend 2 inches above finished floor surface.

Floor sleeves in membraned floors shall be furnished with flashing rings and clamps.

All sleeves in exposed locations, except equipment rooms, shall be set so plates specified will cover the sleeves.

All pipe sleeves where wet conditions exist, except sleeves through exterior walls, shall be caulked with a plastic caulking, including sleeves in concealed locations. The space between the pipe and the sleeves shall be packed with oakum and approximately 1/2 inch depth of a polyisobutylene sealer shall be packed or caulked in both ends of sleeve, even with the ends of the sleeve. The sealer shall be suitable for temperatures from minus 50 degrees to 300 degrees, suitable for painting, non-corrosive and have good adhesion.

All sleeves required to provide the proper openings in masonry construction for the passage of ductwork, mechanical equipment, etc., shall be furnished and installed by this Contractor. These sleeves shall also be removed by this Contractor after the opening has been formed. The opening around all ductwork, equipment, etc., passing through slabs, floors, walls and partitions shall be sealed as specified above for piping. Fire/smoke dampers shall be installed in accordance with the manufacturer's installation instructions.

All sleeves shall be set and maintained in place by this Contractor during the progress of the work. This Contractor shall be responsible for locating all sleeves at the proper location.

Sleeves are not required for core drilled masonry wall and floor holes, masonry wall and floor holes formed by polyethylene plastic (removable) sleeves, or for masonry holes made in another neat manner except in equipment rooms and other wet areas.

Sleeves are not required in metal or wood stud wall construction. Rated systems shall be provided as required to provide the necessary rating of the penetration.

Interior wall sleeves are only required on cold insulated piping (refrigerant suction piping, etc.). All other steel or cast iron piping 4 inches and smaller shall be grouted directly into the wall as necessary to provide the required fire and smoke rating. Piping larger than 4 inch size and all non-rated piping shall be provided with a rated system.

Firestopping materials shall be 3M, Hilti, MetaCaulk, Nelson or equal.

1.19 WALL, FLOOR AND CEILING PLATES:

Furnish and install chrome-plated wall, floor and ceiling plates on all exposed pipes where they pass through walls, floors, or ceilings in finished areas. Finished areas shall be those areas which are painted or have special finishes within the room. The wall plates shall be a minimum of 3/32 inch thickness and shall have set screws or spring locks for clamping to the piping. The plates shall be chrome-plated steel, cast iron or brass and shall set tight against the wall.

1.20 EQUIPMENT SUPPORT:

Furnish and install all necessary wall backing, brackets, braces, plates, angles, wall hangers, etc., required for properly supporting mechanical equipment and mechanical appurtenances. All supports shall be securely anchored with lead inserts, expansion shields, through-going bolts, lag screws or other devices as required.

All items of mechanical equipment hung from overhead structure shall be hung from 2-1/2 inches by 2-1/2 inches by 3/16 inch angles minimum which shall span at least 3 members, unless noted otherwise.

1.21 EXISTING SERVICES:

The Contractor shall verify the exact location of all existing building services extended and/or relocated for this project. The Contractor shall also verify the exact location and take proper precautions to protect all services which may be encountered during construction.

All active services which are encountered shall be protected, braced and supported where required for proper execution of the work and without interruption of the service if possible.

All inactive services which are encountered shall be protected or removed as directed by the Architect/Engineer, Owner, Utility Company or Municipal Agency having jurisdiction. The service shall also be plugged or capped as directed.

When active services must be temporarily interrupted, the interruption shall be scheduled at night or at such time as approved by the Owner or authority having jurisdiction and so as to cause the minimum of interference with establishing operating routine. Arrangements shall be made to work continuously including overtime if required, to assure that services will be interrupted only as long as actually required to complete necessary work.

1.22 EXCAVATION:

Trenching and excavation for all underground piping and equipment shall be excavated to the required depths. The bottom of the excavation shall be tamped hard and graded to secure the required fill. Rock, where encountered, shall be excavated to a depth of 6 inches below the bottom of duct or pipe and before duct or pipe is laid, the space between bottom of pipe and rock surface shall be filled with gravel.

After the installation has been tested, inspected and approved by the Architect/Engineer and prior to backfilling, the forms shall be removed and the excavation shall be cleaned of trash and debris. Materials for backfilling shall consist of the excavation, or borrow of sand or gravel, and shall be free of trash, lumber, or other debris. Backfill shall be placed in horizontal layers, not exceeding 9 inches in thickness, and properly moistened. Backfill inside the building and under any exterior slabs or other paved areas shall be compacted by hand or mechanical means to the density of 95 percent Proctor and areas outside the building not covered by concrete slabs or other structures or pavement shall be compacted to the density of the adjacent undisturbed soil. Any settling within the one (1) year guarantee period shall be repaired at no cost to the Owner.

1.23 ACCESS TO EQUIPMENT:

Access shall be provided to all motors, valves, dampers, controls, specialties, etc., for maintenance purposes. All access doors, access panels, removable sections, etc., required for access shall be provided. The location of the access openings relative to the mechanical equipment shall be coordinated to assure proper access to the equipment. The door shall maintain any ratings of the wall, ceiling, etc. that it penetrates.

Access openings are required for valves, manual, motorized, fire, and smoke dampers and other devices requiring access and shall be provided in the ductwork, plenums, housings, tanks, walls, ceilings, etc., under this portion of the Contract.

1.24 PROTECTIVE DEVICES:

All sheaves, belts, drives, couplings, and moving parts shall be protected by approved permanent guards, shields, or railings, which shall be in place whenever the equipment is in operation and shall be in accordance with applicable safety standards.

All pressure and/or temperature relief valves shall have the discharge piped full size to within 6 inches of the floor or floor drain. The piping shall be securely anchored. All relief valves shall be ASME approved and proper size for the application.

1.25 VALVES:

Furnish and install valves in piping where so indicated on the Drawings. In addition, shut-off valves shall be provided in piping adjacent to each item of equipment, etc.

Of the several manufacturers listed, the Contractor is to standardize on one make as much as practical but not to the extent of sacrificing quality listed. Valves shall be Milwaukee, Crane, Powell, Stockham, Walworth, Watts, Nibco, Hammond or equal.

The valves designated in the following schedule are fully described in the valve list following this schedule.

<u>Valve Service</u>	<u>Valve Designation</u>
Shut-Off Valves For:	
Drain Valves	V-14

The following is a list of valves types from which valves for use on this project have been selected. See the valve service schedule preceding this list for types to be used on each service.

(V-14) Drain Valve: Bronze body globe valve, screw-in bonnet, integral seat, renewable discs, 1/8 inch through 2 inch size, Milwaukee 502 or 1502.

1.26 PIPING CONNECTIONS:

Furnish and install unions or mating flanges at all connections to each piece of equipment, conveniently located to facilitate quick and easy disconnecting of equipment for replacement, tube cleaning or general maintenance. Flanged or union connections shall be used on both sides of equipment. Unions or flanges shall be of the same material or finish as the piping systems in which they are installed. Unions are not required for grooved pipe systems.

Dielectric unions, flanges, or waterways shall be installed where copper or brass piping is connected to ferrous material. Dielectric unions 2 inch size and smaller shall be steel body and nut with insulating gasket and copper connector, 250 psi rating at 190 degrees F., EBCO Model FX, FB, or EA. For 2-1/2 inch size and larger, the union shall be flanges, cast iron with insulated gasket and copper connector, 175 psi rating at 190 degrees F., EBCO Model GX or GA.

1.27 PIPE HANGERS, SUPPORTS AND ANCHORS:

Anchors as shown and detailed on the Drawings and specified herein and/or as required. All support components shall conform to Manufacturer's Standardization Society Specification SP-58. The hangers shall adequately support the piping system. They shall be located near or at changes in piping direction

and at concentrated loads. They shall provide vertical adjustment to maintain pitch required for proper drainage. They shall allow for expansion and contraction of the piping. On other than vapor barrier insulated lines, hangers shall bear directly on piping.

Hangers shall be constructed of malleable or wrought iron unless noted otherwise, and hangers supporting copper pipe shall be copper plated. Hangers for pipe 3 inches and smaller shall be band and socket Michigan Model No. 100 or equal. For piping over 3 inches, hangers shall be adjustable, Clevis type, Michigan Model No. 400 or equal.

Where groups of three or more pipes occur, they may be supported with trapeze hangers using two hangers as specified with a capped pipe cross member.

Where clearance between pipe and overhead support is insufficient for the use of other hangers specified, use Michigan Model No. 605 or equal.

Horizontal steel piping shall be supported as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Maximum Spacing</u>
Up to 1-1/4 inch	3/8 inch	8 feet
1-1/2 inch & 2 inch	3/8 inch	10 feet
2-1/2 inch & 3-1/2 inch	1/2 inch	15 feet
4 inch & 5 inch	5/8 inch	15 feet
6 inch	3/4 inch	17 feet
8 inch through 12 inch	7/8 inch	22 feet

Horizontal copper piping shall be supported as follows:

<u>Pipe Size</u>	<u>Rod Diameter</u>	<u>Maximum Spacing</u>
Up to 1 inch	3/8 inch	6 feet
1-1/4 inch & 1-1/2 inch	3/8 inch	8 feet
2 inch	3/8 inch	9 feet
2-1/2 inch	1/2 inch	9 feet
3 inch & 4 inch	1/2 inch	10 feet

For vertical piping, where supports are not indicated on the Drawings, support steel and copper pipe at every other floor.

Pipe hangers shall not be attached to the roof deck. Hangers shall be attached to the structure with beam clamps, beam attachment and brackets bolted to joists and beams. Use Michigan Model No. 340 or equal, steel washer plates for pipe supported from steel joist. The Contractor shall endeavor to hang near joist panel joints wherever possible.

Pipe hangers for refrigerant suction piping and all insulated piping on trapeze hangers shall be large enough to encompass the insulation, using a metal shield so the vapor barrier jacket will not be broken. See Insulation Section.

Pipe mounting brackets for cold piping shall be large enough to encompass the insulation B-Line Model B2417 or equal. This piping shall be anchored securely at the point of connection to

equipment. The last mounting bracket adjacent to equipment may clamp directly onto the pipe. A short length (18 inches maximum) of piping between the last bracket and the connection is allowed without insulation.

Hanging from one pipe to another is prohibited.

Pipe Hangers shall be Michigan, Grinnell, PHD, B-Line or equal.

1.28 PIPING INSTALLATION:

All pipes shall be round and straight, of required size. Cutting shall be done with proper tools and pipes shall be reamed to full size after cutting.

Piping shall be properly enclosed, supported, guided, anchored, sway braced, connected, tested, cleaned and flushed out and shall be properly insulated and protected where required.

All pipes shall be run with proper grade to provide for easy draining and in group runs where applicable and in a neat and orderly manner, to the satisfaction of the Architect/Engineer. Lines required to be enclosed in ceiling, chaseways or similar spaces shall be installed to permit such enclosure as intended. All pipe runs shall be carefully laid out and scheduled to avoid necessary interferences with other work. Pipe sizes shown on the Drawings are nominal pipe sizes and not outside diameters.

Pipes shall be run substantially as indicated on the Drawings. However, the Architect/Engineer reserves the right to require this Contractor to make changes in pipe locations where conflicts occur with other trades. Such changes shall be made without extra cost to the Owner.

Piping shall be installed with ample provisions for expansion and contraction to prevent injury to the same and to the building construction. Such provision shall be made by means of piping offsets, changes in direction, expansion loops and/or suitable expansion joints. Suitable anchors and guides shall be provided to permit proper deflection and compression of offset loops and expansion joints. Expansion joints shall not be used in lieu of offsets, changes in direction or loops, except where specified and/or indicated on the Drawings or where otherwise obviously necessary.

Exposed piping shall be installed in a sanitary manner for ease in cleaning.

Equipment piping shall also include wastes and drains which are safe-wasted without a direct connection.

Minimum grade for horizontal drainage piping shall be 1/4 inch per foot for 3 inch diameter piping or less, 1/8 inch per foot for 4 inch and 6 inch diameter piping and 1/16 inch per foot for drainage piping over 6 inch diameter.

END OF SECTION 230100

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SECTION 230700 - INSULATION AND PIPING IDENTIFICATION

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 230100, General Provisions, in its entirety, including references to the General Construction Specifications are hereby adopted and made part of these specifications.

The work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all labor, materials, fixtures, and equipment necessary to install complete piping, ductwork, and equipment insulation as described herein and/or as shown on the Drawings. This includes all equipment and materials obviously necessary for complete systems though not specifically mentioned or shown.

1.02 MATERIALS AND WORKMANSHIP:

All covering and insulating materials used on this project must contain the manufacturer's name on the containers. All materials must be dry and in good condition, free of defects, mildew, rough ends, etc. Insulation materials shall be Anco, Certainteed, Owens-Corning, Johns Manville, Armstrong, Knauf or equal.

All insulation work shall be performed by an Insulation Contractor who uses workers skilled in this type of work. Only first class workmanship will be acceptable. The Insulation Contractor shall submit shop drawings for all materials proposed to be installed in this project.

All pipe covering shall have a density of not less than 3-1/2 pounds per cubic foot.

All materials shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255, AND U.L. 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

1.03 EQUIPMENT INSULATION:

Insulation shall be cut or mitered where necessary to fit the contour of the fittings and equipment. All voids shall be packed with light density glass fiber insulation. Insulation sections shall be banded in place with 3/4 inch x 0.015 inch thick galvanized steel bands at 18 inch o.c. for all large equipment. Insulation shall be covered with one inch galvanized hexagonal wire mesh. Apply 1/2 inch of insulating cement such as OC-110 or equal in 2 layers over the wire mesh.

On all cold systems, insulation shall be impaled over welding pins at 12 inches o.c. and secured in place with speed washers. The 3/4 inch steel bands will not be required. Each layer of insulation shall have a vapor barrier cover to provide complete airtight envelope. Vapor-barrier shall consist of one layer of Ludflow foil barrier paper smoothly adhered to the insulation cement surface with vapor-barrier lap adhesive. Lap all joints a minimum of 3 inch and seal with vapor-barrier lap adhesive.

1.04 DUCT INSULATION - INTERNAL:

All rectangular supply and return ductwork shall be insulated with 1 inch of internal insulation.

Internal duct insulation shall be Owens-Corning Fiberglass Duct Liner or equal, 1-1/2 pound density, and have a thermal conductivity of 0.28 at 75 degrees F. mean temperature. The surface shall be coated with a black fire-resistant neoprene coating meeting NFPA 90A Standards and shall have no air erosion of the fibers with air velocities up to 6,000 fpm. Increase duct size to accommodate liner. Adhere liner, with coated side towards air stream, to all interior sides of duct with 100 percent coverage of fire resistant insulation bonding adhesive such as Benjamin Foster No. 81-20, 3M spray adhesive No. 77, or equal. When duct width or height exceeds 20 inches for horizontal ducts and 12 inches for vertical ducts, further secure the liner to these surfaces with mechanical fasteners at 15 inch o.c. Top pieces shall be supported by the side pieces. All edges and joints shall be coated with adhesive.

Velocities - 2,000-4,000 fpm: For all ducts exceeding 16 inches in height and 12 inches width, further secure the liner to these surfaces with mechanical fasteners at 15 inch O.C. The dimensions shall be reduced to 12 inches for vertical ducts.

Velocities - 4,000-6,000 fpm: Install as above except that mechanical fasteners shall be spaced 12 inches o.c. on all surfaces and metal noising shall be installed to secure liner at all upstream traverse edges.

1.05 PIPING IDENTIFICATION:

Identify all piping, insulated and uninsulated, except where concealed inside walls or below floors, with 1 inch high black letters designating the type of service and an arrow in the direction of flow. The lettering shall be applied after all painting of the piping is complete as specified in Division 9 - FINISHES. The lettering shall have an identifying word or phrase such as, cold water, gas, sprinkler, low pressure steam return, etc. Each pipe shall be identified at 30 feet intervals maximum and at each change in direction.

To standardize the lettering and abbreviations, use the following listing:

Refrigerant (R-22).

END OF SECTION 230700

SECTION 230800 - VENTILATION AND AIR CONDITIONING

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 230100 General Provisions, in its entirety, including references to the General Construction Specifications are hereby adopted and made part of these specifications.

The work involved in this specification and the accompanying Drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install complete ventilation and air conditioning systems as described herein and/or as shown on the Drawings. This includes all ductwork, equipment, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

See Section 230700 for insulation requirements.

1.02 DUCTWORK:

All ductwork is to be galvanized iron fabricated and erected in a workmanlike manner. Fabricate plenums and special fittings, as shown on the Drawings, or as required. Access doors to plenums shall be double wall construction with heavy hardware. All ductwork shall be of the gauges hereinafter specified and constructed to the best grade Inland, U.S. Steel, United Sheet Metal or equal brands, heavily galvanized.

Metal gauges for low and medium pressure duct systems shall be of metal gauges and reinforcing as recommended by SMACNA or as follows:

<u>Maximum Dimension of Rectangular Ducts or Diameter of Round Low Pressure Ducts</u>	<u>Galvanized Sheet Steel Gauge Number</u>
Up thru 12"	26
Over 12" thru 30"	24
Over 30" thru 54"	22
Over 54" thru 84"	20
Over 84"	18

<u>Maximum Dimension of Rectangular Ducts or Diameter of Round Medium Pressure Ducts</u>	<u>Galvanized Sheet Steel Gauge Number</u>
Up thru 18"	24
Over 19" thru 48"	22
Over 49" thru 72"	20
Over 73" thru 96"	18

Ductwork shall be constructed, braced, reinforced and sealed as recommended by ASHRAE and SMACNA. Environmental air ductwork as defined by the International Mechanical Code shall be substantially air tight. Low pressure ductwork shall be suitable for pressures up to 2 inch w.g. Medium pressure ductwork shall be suitable for pressures up to 3 inch w.g. All ductwork 18 inches and greater in width shall be cross-broken. See SMACNA requirements for proper sealing of ductwork. All supply air ductwork between VAV air handling units and VAV terminals shall be medium pressure construction.

Ductwork with the longest side 36" wide and over shall be constructed using Ductmate 35/25 or equal slide on systems, per Ductmate Industries Installation Procedures and Duct Construction Standards, latest edition. The non-proprietary SMACNA T-22 Flanged Connection may be used as defined on Page 1.63, 1.64 and 1.80, of the 1995 SMACNA Manual, Second Edition. The non-proprietary T-24, proprietary TDC/TDF flanges and Ductmate 35/25 may be used for transverse joint construction, 35" wide and smaller. Ductmate 440 Butyl Gasket, or equal, shall be used between all rectangular transverse flanged duct connections, Ductmate's 440 Butyl Gasket, shall be used with the Ductmate Systems. For rectangular ductwork located outdoors, exposed to weather, construct ductwork per, "Transverse Joints Rectangular" with a continuous metal cleat on top joints of ducts for added weather protection. Slide on systems shall be Ductmate, Ward Industries, Inc., or equal.

No obstruction shall be permitted in the ductwork to retard the flow of air. If it is necessary to run a pipe or conduit through a duct, the duct size shall be increased to compensate for the obstruction.

Where space permits, duct turns shall be constructed with an inside radius equal to or greater than the duct width or duct turn vanes may be used. Where space does not permit duct turns as described above, duct turn vanes shall be used. Where space permits, duct offsets 30 degrees and greater shall be constructed with an inside radius equal to or greater than the duct width.

Where interior duct insulation is required, increase the duct size to maintain the free area shown on the Drawings.

Provide exterior insulated drip pans, 3 inches deep, under or adjacent to all roof and wall openings including but not limited to under all intake or relief hoods and louvers. Drip pans to be soldered watertight.

Power operated dampers not furnished as a component of the ventilating machines will be furnished under the Temperature Control Specifications. They shall be installed in the ductwork under this specification. Caulk around all sides of high efficiency damper frames.

Flexible connections shall be installed between suction and discharge openings in fan units and the ducts with which they are connected as shown on the Drawings, to prevent transmission of vibration noises. Material shall be watertight and fire retardant canvas weighing not less than 20 ounces per square yard, or shall be glass fabric on high temperature systems where fire hazard exists. Both materials shall be approved by Underwriter's Laboratories. The flexible material shall be furnished with all necessary angles, bolts, clips or other fasteners.

Furnish and install access panels in the ductwork adjacent to all motorized dampers, fire dampers, louvers, reheat coils, and equipment which may require servicing or cleaning. Panels shall be tight fitting and shall be located so as to make them easily accessible. All panels installed in insulated ductwork shall be double wall, insulated type. Panels shall be Ruskin, Air Balance, Ventlok, ADCO, or equal.

Dynamic rated fire dampers shall have an 18 inch square access panel or an 18 inch long removable duct section shall be installed adjacent to dynamic rated fire dampers in addition to a smaller inspection access panel. The removable section shall be assembled using Ductmate or equal duct joints. The joint at the damper shall be assembled with plastic fastener clips. Ductwork 24 inches and wider shall have an 18 inch by 18 inch access door in lieu of removable section.

Ductwork installed above UL fire rated ceiling assemblies shall be installed in strict accordance with the provisions required by the UL Design Number designated in the Underwriters Laboratories Fire Resistance Directory.

All ductwork visible through the face of a register or grille shall be painted with a flat black paint.

All rigid and flexible ductwork materials installed shall have composite fire and smoke hazard ratings as tested by procedures ASTM 84, NFPA 255 and UL 723 not to exceed 25 Flame Spread and 50 Smoke Developed.

Concealed low pressure round ductwork may be rigid spiral ductwork or snaplock type with adjustable elbows.

All exposed round ductwork and round ductwork to the inlet of VAV terminals shall be United, Semco, Norlock, Foremost, SMC, SPOT or equal, rigid spiral duct and fittings. Tee fittings shall be factory built tee fittings or equal. Saddle branch takeoff fittings are not acceptable except as approved by the Architect/Engineer.

Round ductwork shall be supported at 6 feet o.c. where building framing does not provide such support. Support shall be minimum 3/4 inch metal strap suspended from the roof or framing.

Flexible duct shall not exceed 8 feet in length or pass through walls. Flexible round ductwork may only be used for final connections to supply registers and diffusers in concealed locations.

All round sheet metal supply air ductwork, except exposed, shall be insulated with 1 inch thick of Owens-Corning Fiberglass Faced Duct Wrap Series ED-100 FRK-25 or equal.

1.03 REGISTERS, GRILLES AND DIFFUSERS:

Furnish and install all registers, grilles and diffusers as specified hereinafter and as designated on the Drawings. Opposed blade, heavy duty dampers shall be used on systems having two or more duct openings where balancing of air discharge or intake is required. Grilles may be used where there is only one opening and where balancing is not required.

Diffusers, registers, and grilles shall be provided as listed in the schedule on the Drawings. All registers, grilles and diffusers shall be of size and capacity with special requirements, frames, dampers, blank-off baffles, etc., as listed in the schedule and as designated. Opposed blade, heavy duty dampers shall be provided on all units unless designated otherwise on the Drawings.

Louver faced ceiling diffusers shall have a minimum of three (3) inner diffuser cones plus the outer shell unless scheduled otherwise.

The installed location of all ceiling diffusers, registers, and grilles shall be as shown on the Reflected Ceiling Plans.

The finish on all aluminum registers, grilles and diffusers shall be etched to a lustrous satin finish and coated with a clear acrylic lacquer, or white finish as noted below and/or on the Drawings. All steel units shall have white enamel finish, unless noted otherwise. Interior of perforated diffusers shall be painted black.

All ceiling mounted registers, grilles and diffusers shall be white unless noted otherwise. All floor mounted registers, grilles and diffusers shall be satin anodized without mounting holes unless otherwise noted.

Ceiling registers, grilles and diffusers in fire rated ceilings shall have an outer cone of 24 gauge (minimum) steel construction and shall have UL Fire Resistance Classified fire dampers with radiation shields.

Registers, Grilles and Diffusers shall be Tuttle and Bailey, Carnes, Anemostat, Titus, J & J Register, Metal Industries, Grillmaster, Krueger, Price, Reliable, Nailor or equal.

1.04 AIR HANDLING UNITS:

Furnish and install a outdoor medium pressure draw-through single zone air handling units as shown and detailed on the Drawings. Units shall be complete with return/exhaust fan, mixing box, 2" pre-filter air blender, water heating coil, humidifier section, direct expansion cooling coil, fan, final filter and insulated cabinet with full height vestibule.

Cabinet shall be of sectionalized construction and fabricated of galvanized steel or steel with an enamel coat finish. The cabinet panels shall be removable for access and shall be internally insulated with 2 inch thick foam insulation. Cooling coil section shall include drain pan and all coil headers shall be enclosed within the cabinet. Cabinet panels shall be fabricated of standard metal gauges as listed by the manufacturer.

Fans shall be dynamically balanced single width, single inlet, direct drive plug fans rated in accordance with AMCA Code No. 210. Fans and motors shall be selected to be capable of 120 percent of nominal speed when controlled by an adjustable frequency drive. Fans shall be mounted on spring type vibration isolators.

Air mixing boxes for air handling units shall be constructed similar to unit cabinet and shall include interlocked outdoor air and return air dampers, and nylon bushing for the damper rods. The outside air damper shall be a high efficiency type with less than 1 percent leakage at 2 inches static pressure.

Pre-filters shall be Cambridge, Farr, Continental, AAF, or equal 2 inch pleated throwaway filters. Filter efficiency shall be 30 percent based upon ASHRAE Standard 52-68. Furnish and install magnehelic gauges to measure the pressure drop across the filters. Furnish and install separate gauges for each filter bank. The changeout pressure drop shall be marked.

Final-filters shall be Cambridge, Farr, Continental, AAF, or equal 12 inch pleated throwaway filters. Filter efficiency shall be 90 percent based upon ASHRAE Standard 52-68. Furnish and install magnehelic gauges to measure the pressure drop across the filters. Furnish and install separate gauges for each filter bank. The changeout pressure drop shall be marked.

Air Blenders shall be static mixing devices of the rotary turbulating design, by Blender Products, Inc., consisting of radially extending turbulators. Units shall be completely fixed devices, with no moving parts. Standard fabrication shall be of all welded .080" thick aluminum, .125" on air blenders larger than 96", construction. Steel units shall be epoxy or PVC coated to protect against rust and contaminated air. All units shall be factory built and tested. When multiple blenders are used, they shall impart a counter rotational mixing of the air streams to each other. Simple mixing devices which do not produce expanding radial discharge with counter rotational mixing will not be acceptable. The mixing device shall perform at face velocities from 500 FPM through 2500 FPM with no loss in mixing performance. The complete mixing section shall be constructed with proper mixing distances such that the two airstreams yield a maximum temperature standard deviation through a plane parallel with Blender at the discharge of the mixing section shall be 6 degrees F, and shall provide even airflow and temperature across filters, coils and control thermostats to insure accuracy of averaged temperature reading.

Coils shall be copper tube and aluminum fins mechanically bonded together. Coils shall have galvanized steel casing and water coils shall be drainable type. Coils shall include a vent at the highest point and shall be circuited for counterflow of air and water. Steam coils shall be steam distributing type. Coil face velocity for coils shall not exceed 500 fpm, unless noted otherwise on the schedule. All coil connections shall be on the same side. All cooling coils shall be ARI Standard 410 (Latest Edition) certified or the coil capacity shall be 120 percent of the cooling BTUH capacity specified.

Starters shall be included in Division 26. Motors shall be selected at 120 percent of fan brake horsepower requirements.

Unit capacities and design conditions shall be as listed in the schedule on the Drawings.

Air Handling Units shall be Innovent, Annexair, Trane, McQuay, Carrier, York or equal.

1.05 ADJUSTABLE FREQUENCY DRIVES :

Adjustable frequency drives shall be furnished for the following equipment:

1. Roof Mount AHU
2. Pumps 1&2

Furnish and install adjustable frequency motor drives consisting of a pulse width modulated (PWM) inverters for use on a standard NEMA Design B induction motors. The drives shall be designed specifically for variable torque HVAC applications, and shall be designated "ACH 500". It is required that the drive manufacturer have an existing:

1. Sales representative exclusively for HVAC products, with expertise in HVAC systems and controls.
2. An independent service organization.
3. A parts stocking depot local to the installation site.

The adjustable frequency drives (AFD's) shall be solid state, with a Pulse Width Modulated (PWM) output waveform (VVI, six-step, and current source drives are not acceptable). The AFD package as specified herein shall be enclosed in a NEMA 1 enclosure, completely assembled and tested by the manufacturer. The AFD shall employ a full wave rectifier (to prevent input line notching), DC Line Reactor capacitors, and Insulated Gate Bipolar Transistors (IGBT's) as the output switching device (SCR's, GTO's and Darlington transistors are not acceptable). The drive efficiency shall be 97% or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.

All printed circuit boards shall be completely tested and burned-in before being assembled into the completed AFD. The AFD shall then be subjected to a preliminary functional test, eight hour burn-in, and computerized final test. The burn-in shall be at 104 degrees F (40 degrees C), at full rated load, or cycled load. Drive input power shall be continuously cycled for maximum stress and thermal variation.

AFD's shall be UL Listed. The AFD's shall be designed to meet the requirements of the following standards: IEC 801-2, IEC 801-4, IEC 255-4.

Environmental operating conditions: 0 to 50 degrees C @ 3 kHz switching frequency, 0 to 3300 feet above sea level, less than 95% humidity, non-condensing.

Where required, adjustable frequency drives shall be UL508C Listed for installation in air plenums.

All AFD's shall have the following standard features:

1. All AFD's shall have the same customer interface, including digital display, keypad and customer connections; regardless of horsepower rating. The keypad is to be used for local control (start/stop, forward/reverse, and speed adjust), for setting all parameters, and for stepping through the displays and menus.
2. The AFD shall give the user the option of either (1) displaying a fault, or (2) running at a programmable preset speed if the input reference (4-20mA or 2-10V) is lost; as selected by the user.
3. The AFD's shall utilize plain English digital display (code numbers are not acceptable). The digital display shall be a 40-character (2 line x 20 characters/line) LCD display. The LCD shall be backlit to provide easy viewing in any light condition. The contrast should be adjustable to optimize viewing at any angle.
4. The AFD shall have the ability to automatically restart after an overcurrent, overvoltage, undervoltage, or loss of input signal protective trip. The number of restart attempts and trial time shall be programmable.
5. The AFD shall be capable of starting into a rotating load (forward or reverse) and accelerate or decelerate to setpoint without safety tripping or component damage (flying start).
6. The AFD shall be equipped with an automatic extended power loss ride-through circuit which will utilize the inertia of the load to keep the drive powered. Minimum power loss ride-through shall be one-cycle, based on full load and no inertia. Removing power from the motor is not an acceptable method of increasing power loss ride-through.

7. The customer terminal strip shall be isolated from the line and ground.
8. Prewired 3-position Hand-Off-Auto switch and speed potentiometer. When in "Hand", the AFD will be started, and the speed will be controlled from the speed potentiometer. When in "Off", the AFD will be stopped. When in "Auto", the AFD will start via an external contact closure, and its speed will be controlled via an external speed reference.
9. The drive shall employ three current limit circuits to provide trip free operation:
 - a. The Slow Current Regulation limit circuit shall be adjustable from 50% to 110% of the AFD's variable torque current rating. This adjustment shall be made via the keypad, and shall be displayed in actual amps, and not as percent of full load.
 - b. The Rapid Current Regulation limit shall be fixed at 140% of the AFD's variable torque current rating.
 - c. The Current Switch-off limit shall be fixed at 150% of the AFD's variable torque current rating.
10. The overload rating of the drive shall be 110% of its variable torque current rating for 1 minute every 10 minutes, and 115% of its variable torque current rating for 2 seconds every 10 seconds.
11. The AFD shall have input line fuses standard in the drive enclosure.
12. The AFD shall have a manual speed potentiometer in addition to using the keypad as a means of controlling speed manually.
13. The AFD shall have a DC Line Reactor to reduce the harmonics to the power line.
14. The AFD shall be optimized for a 3 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up engineer.

All AFD's shall have the following adjustments:

1. Five (5) programmable critical frequency lockout ranges to prevent the AFD from continuously operating at an unstable speed.
2. PI Setpoint controller shall be standard in the drive, allowing a pressure or flow signal to be connected to the AFD, using the microprocessor in the AFD for the closed loop control; thus eliminating the need for external controllers.
3. Two (2) programmable analog inputs shall accept a current or voltage signal for speed reference, or for reference and actual signals for PI controller. Analog inputs shall include a filter; programmable from 0.01 to 10 seconds to remove any oscillation in the input signal. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0 - 20 mA and 0 - 10 Volts.
4. Six (6) programmable digital inputs for maximum flexibility in interfacing with energy management systems.

5. Two (2) programmable analog outputs proportional to Frequency, Motor Speed, Output Voltage, Output Current, Motor Torque, Motor Power, or DC Bus Voltage.
6. Three (3) programmable digital relay outputs. The relays shall be rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; Continuous current rating 2 amps RMS.
7. Seven (7) programmable preset speeds.
8. Two independently adjustable accel and decel ramps. These ramp times shall be adjustable from 1 to 1800 seconds.
9. The AFD shall Ramp or Coast to a stop, as selected by the user.
10. The carrier frequency shall be adjustable by the start-up engineer.

The following operating information displays shall be standard on the AFD digital display. The display shall be in complete English words (alpha-numeric codes are not acceptable):

1. Output Frequency
2. Motor Speed (RPM)
3. Motor Current
4. Calculated Motor Torque
5. Calculated Motor Power
6. DC Bus Voltage
7. Output Voltage
8. Heatsink Temperature
9. Analog Input Values
10. Keypad Reference Values
11. Elapsed Time Meter
12. kWh Meter

The AFD shall have the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in complete words (alpha-numeric codes are not acceptable).

1. Overcurrent trip 200% of the AFD's variable torque current rating.
2. Overvoltage trip 130% of the AFD's rated voltage.
3. Undervoltage trip 60% of the AFD's rated voltage.
4. Overtemperature +70 degrees C.
5. Ground Fault.
6. Adaptable Electronic Motor Overload (I^2t). The Electronic Motor Overload protection shall protect the motor based on speed, load curve, and external fan parameter. Circuits which protect the motor only at full speed are unacceptable.

Speed Command Input shall be via:

1. Keypad or manual speed potentiometer; as selected by the user.
2. Two Analog inputs, each capable of accepting a 0-20mA, 4--20mA, 0-10V, 2-10V signal. Input shall be isolated from ground, and programmable via the keypad for different uses.

Analog inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The analog input should be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed. The minimum and maximum values (gain and offset) shall be adjustable within the range of 0-20mA and 0-10 Volts.

3. Floating point input shall accept a three-wire input from a Dwyer Photohelic (or equivalent type) instrument.

Accessories to be furnished and mounted by the drive manufacturer.

1. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in Hand, Auto or Bypass.
2. Door interlocked disconnect switch; padlockable in the "Off" position.
3. Manual transfer to line power via contactors. Include motor thermal overload and fuse or circuit breaker protection while in bypass operation. A three position selector switch to control the bypass contactor and the drive output contactor is to be mounted on the enclosure door. When in the "Normal" mode, the bypass contactor is open and the drive output contactor is closed. In the "Test" position both contactors are open, and in the "Bypass" position, the drive output contactor is open, and the bypass contactor is closed. The drive output contactor shall also open when a stop command is given, isolating the motor from the drive. Start/stop signals and safety interlocks will work in drive and bypass modes. An automatic bypass shall allow the motor to be switched to bypass automatically when the drive goes into a fault condition, and will not automatically reset.
4. Service contactor (drive input contactor) which provides the ability to service the drive (electrically isolate the drive while in bypass operation without having to remove power from the motor). The service contactor shall open when the drive is switched to bypass, and also be controlled by a switch which is mounted inside the drive enclosure so that its access is limited to service personnel only.
5. A class 20 bimetallic thermal motor overload relay shall be provided to protect the motor in bypass.

Compliance to IEEE 519-1981

1. The AFD manufacturer shall provide calculations, specific to this installation, showing total harmonic voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the AFD manufacturer to ensure compliance with IEEE standard 519-1981, Guide for Harmonic Control and reactive Compensation for Static Power Converters. The acceptance of this calculation must be completed prior to AFD installation.

2. Prior to installation, the AFD manufacturer shall provide the estimated total harmonic distortion (THD) caused by the AFD's. The results shall be based on a computer aided circuit simulation of the total actual system, with information obtained from the power provider and the user.
3. If the voltage THD exceeds 5%, the AFD manufacturer is to recommend the additional equipment required to reduce the THD to an acceptable level.

Certified factory start-up shall be provided for each drive by a factory authorized service center. A certified start-up form shall be filled out for each drive with a copy provided to the Architect/Engineer, and a copy kept on file at the manufacturer.

Warranty shall be 24 months from the date of start-up, not to exceed 30 months from the date of shipment. The warranty shall include all parts, labor, travel time, and expenses.

The Adjustable Frequency Drives shall be Asea Brown Boveri (ABB), Graham, Magnetek, Reliance Electric, Toshiba, Trane, Yaskawa, York or equal.

1.06 CONDENSING UNIT:

Furnish and install a condensing unit where shown on the Drawings. Unit shall be complete with compressors, condensers, condenser fans and motors, louvered coil guards, low ambient lockout, and operating and safety controls. Unit shall be ARI Certified and Underwriter's Laboratories Listed.

Unit frame shall be a one-piece welded assembly of heavy gauge zinc-coated steel. Exterior surfaces shall be phosphatized, epoxy primed and finished with air-dry, enamel paint.

Compressor may be serviceable, semihermetic designed for 1,750 rpm operation including spring-loaded discharge valve cages, removable cylinder heads, nonreflexing ring plate valves, forced feed lubrication with strainers, magnetic plugs and centrifugal cleaning, removable heads, replaceable cylinder liners with hardened valve seats, cylinder unloaders for capacity modulation, and built-in crankcase heater. Protective thermostats shall be located in the motor windings.

The compressors shall be digital scroll compressors. Scroll compressors shall include three dimensional compliance, centrifugal oil pump, inlet dirt separator, rolling element bearings, crankcase heater, oil sight glass and solid internal suspension. The crankcase heater shall be removable and there shall be a standard oil charging valve. 3-D compliance shall allow the scroll plates to separate so that liquid refrigerant can pass without damage to the compressor.

Condenser fan and motors shall be vertical discharge direct-drive fans statically and dynamically balanced. Motors shall be three-phase with permanently lubricated ball bearings and built-in current and thermal overload protection.

Condenser coil shall be air-cooled. The configured aluminum fin secondary surface shall be mechanically bonded to the primary surface of 3/8-inch OD seamless copper tubing. The unit shall have two refrigerant circuits with separate subcooling circuits factory-tested at 450 psig air pressure underwater and vacuum dehydrated.

Unit control shall be a factory-provided 115-volt control circuit including fusing and control power transformer. Unit shall be wired with magnetic contactors for compressor and condenser motors, three-leg, solid-state compressor overload protection, high and low pressure cutouts. Differential oil pressure control with continuous solid-state memory to detect fluctuating and/or low oil pressure. Charge isolation, reset relay and anti-recycle compressor timer shall be provided.

Shop drawings of the refrigerant piping shall be submitted as specified in Division 1 of the Contract. The shop drawings shall incorporate the following:

Diagrammatic layout of the piping showing the general arrangement of the refrigerant piping length, fittings, equipment and elevations.

Refrigerant piping sizes.

The Contractor shall verify the acceptability of the refrigerant piping arrangement and sizes with the refrigeration equipment supplier/manufacturer and shall submit shop drawings. See Specification Section 15010.

The Condensing Unit shall be from the same manufacturer as the air handling unit.

1.07 REFRIGERANT PIPING AND SPECIALTIES:

The Contractor shall furnish and install refrigeration piping, as detailed on the Drawings and as required.

Insulate suction piping with 1/2 inch of fire and smoke rated Armaflex, or equal. The insulation shall not exceed ratings of 25 Flame Spread and 50 Smoke Developed as rated by UL 723. All insulation exposed to outdoor weather conditions shall be additionally covered with a 20 mil PVC jacket sealed watertight. The PVC cover shall have solvent welded joints and seams. Piping support brackets shall be B-Line Model B2417 or equal. The insulation shall run continuous through the brackets with hanger shields.

The Contractor shall follow recommendations of the equipment manufacturer when piping, installing, and starting the systems.

Specialties shall include a charging valve, flexible connectors, condenser plunge valve and condenser shut-off valve on each system, as required for operation. Provide sight glasses, dryers, strainers, solenoid valves, expansion valves, etc., as noted on the Drawings and/or as required for proper operation.

Accessories shall be Henry, Sporlan, Alco, or equal.

Refrigerant piping shall be type "L" copper tubing, hard drawn with wrought copper solder type fittings suitable for connection with silver solder. The piping shall be charged with dry nitrogen while constructing the joints. A removable type dryer strainer shall be installed in the liquid line. A three valve bypass shall be provided for the strainer. After the refrigerant piping has been completed, the refrigerant system shall be pressure tested at a pressure of 300 psi (high side) and 150 psi (low side). While the system is being pressure tested, an electronic leak detector shall be used to check for leaks. Pressure shall be maintained on the system for a minimum of 12 hours. The system shall be evacuated when the surrounding ambient air is not less than 60 degrees F. A minimum vacuum of 5.2 MM of mercury absolute shall be pulled on the system and maintained

for 24 hours. The vacuum pressure displacement shall be not less than 5 cfm. The vacuum shall be checked with an electronic gauge. All pipe shall be supported from the building structure in a neat and workmanlike manner and wherever possible, parallel runs of horizontal piping shall be grouped together on trapeze type hangers. The use of wire or perforated metal to support piping will not be permitted. Hanging piping from other piping will not be permitted. Spacing of pipe supports shall not exceed 8 feet for pipes up to 1-1/4 inches and 10 feet on all other piping. Hangers shall pass around the insulation and an 18 gauge steel protective band, 12 inches long shall be inserted between the hangers and the insulation.

1.08 REFRIGERATION SYSTEMS (except precharged systems):

Piping Tests: After the refrigeration piping and fittings have been assembled, all flux shall be removed from connections and all lines shall be clean. The piping system shall be blown out with dry nitrogen to remove any free water or dirt which might be present. The refrigerant lines shall be charged with dry nitrogen and proven tight at minimum gauge pressures of 300 psi on the high side and 150 psi on the low side. The system shall hold these pressures for a period of 24 hours without pressure drop except for pressure change due to temperature differential.

Evacuation and Dehydration: After the piping system has been proven tight by the pressure test, evacuation and dehydration of the system shall be accomplished using the double evacuation method described in the following paragraphs.

Equipment and Conditions: The Contractor shall provide a two-stage, high vacuum pump capable of pumping down to 100 microns or lower while evacuating the system, and of adequate displacement to evacuate the various systems within a reasonable period of time based upon maximum vacuum of 5.16 millimeters of mercury absolute. He shall also provide a wet-bulb vacuum indicator, a supply of 100 percent methyl alcohol for use with this instrument and a temperature-pressure conversion chart for 100 percent methyl alcohol. The evacuation shall be done only when the ambient air temperature is 50 degrees F. or higher. The Contractor is cautioned to go no lower than 5.16 millimeters of mercury absolute on the evacuation procedure to prevent the formation of ice in the piping system.

Primary Evacuation: This procedure begins after the vacuum pump and wet-bulb vacuum indicator have been properly attached to the piping system. The vacuum pump is operated continuously until the pressure within the system reaches 5.16 millimeters of mercury absolute at which point the pump is stopped.

Secondary Evacuation: Using the same dry refrigerant with which the system is to be charged, break the vacuum and bring the system pressure to a point slightly above atmospheric pressure. Start the vacuum pump and using the wet-bulb vacuum indicator, evacuate the system to 5.16 millimeters of mercury absolute. Stop the vacuum pump and charge the system with a full charge of dry refrigerant.

Operating Tests: The systems shall be operated as near as possible to design conditions for 48 hours, not necessarily continuous. During this time sufficient data shall be logged to provide proof of satisfactory operation. The collected data shall be submitted to the Architect/Engineer for approval. The Architect/Engineer shall be given advanced notice of the testing period so he may be present for observation of same should he desire. At the expiration of the test period all systems shall be fully charged and free of leaks.

1.09 HEPA FILTER UNITS:

- Furnish and install HEPA Filter Units where shown on the Drawings. Units shall be complete with housing, hanger eyebolts, filter, and perforated face plate. Fan powered units shall include a fan assembly, disconnect switch and speed controller.
- Hood sizes, efficiencies, capacities and construction options shall be as scheduled or noted on the Drawings.
- Module sizes, electrical characteristics, efficiencies, capacities and options shall be as scheduled on the drawings.
- The room sound level shall be less than 55 dBA, when measured at 30 inches from filter face at 90 FPM (average face velocity) in accordance with IEST RP-CC0022.2, Recommended Practice for Unidirectional Flow Clean-Air Devices.
- The unit shall be able to provide filtered air at an average velocity of 90 FPM (+/-15 FPM) measured 12" from the face of the unit.
- The housing shall be constructed of .063 inch aluminum with all straight seams of the module continuously welded. All other joints and seams shall be intermittently welded and/or sealed with RTV sealant. The housing shall be designed for flush installation into a T-bar ceiling. Units shall be factory sealed and tested to assure leakage is consistent with the filter.
- Modules shall be furnished with HEPA high efficiency filters. Filters shall be framed in extruded aluminum and provided with a gel blade edge seal. The filter frame shall incorporate filter blade guides and stops to facilitate filter installation and prevent the blade from bottoming out in the gel track of the filter. The filter shall have a perimeter channel filled with sealant. When the filter is positioned in the housing the blade-edge in the housing shall penetrate the gel and form a leak tight seal. The filter shall be held in place with four (4) retainers that are turned 90 degrees.
- The filters shall be installed in the frames with direction from the filter manufacturer. The Contractor must be present for the filter certification and shall be prepared to replace filters that fail the certification test at no additional cost.
- Units shall be provided with aluminum perforated laminar flow face with quarter-turn fasteners.
- The grille shall be easily removed from room side.
- Fans shall be direct drive with ECM style motors, single phase 115V. Solid state speed control shall be provided.
- UL 507 units shall be lined with urethane foam for additional noise attenuation.
- UL 1995 units shall be lined with plenum rated polymer foam.
- The housing shall be equipped with an aerosol dispersion nozzle to inject a challenge aerosol upstream of the filter when testing the filters for leaks. The inlet connection shall

be a plug with a 1/2 inch full coupling located in the edge of the module and not in the filter. The challenge aerosol shall be released through an aerosol dispersion apparatus located upstream of a solid distribution plate.

- HEPA Filter Units shall be manufactured by Envirco, Flanders, Price, Titus or equal.

1.10 POWER ROOF VENTILATORS:

Furnish and install power roof ventilators as shown and scheduled on the Drawings and/or as listed in this specification, or equal. Ventilators shall be centrifugal rooftop type with automatic backdraft dampers, bird screens, and aluminum housings, unless noted otherwise. All ventilators of 300 cfm or less may be direct drive while all units over 300 cfm shall be adjustable belt drive. All centrifugal impellers shall be backward curved type with non-overloading characteristics and tip speed shall not exceed 3,500 fpm, unless noted otherwise. All units shall have AMCA certified capacities at the specified static pressure and shall operate at acceptable sound levels at design conditions.

All power roof ventilators shall have either integral motor overload protection and a disconnect switch or a manual motor starter with thermal overloads. All motors shall be mounted on vibration isolators.

Unless noted otherwise, all units shall be mounted on prefabricated sound absorbing curbs a minimum of 8 inches in height above the finished roof line. Curbs shall be provided by the ventilator manufacturer and all curbs shall have 2 inch thermal insulation and shall be sized to allow roof flashing to extend up and under unit on all sides.

Backdraft Damper shall be Ruskin Model BD2/A1, American Warming and Ventilating Model BD-42, Greenheck Model VBD-160 or equal.

Fan capacities shall be as listed in the schedule on the Drawings.

Power Roof Ventilators shall be Penn, Cook, Carnes, Greenheck or equal.

1.11 COMBINATION FIRE AND SMOKE DAMPERS:

Furnish and install Underwriter's Laboratories classified (UL555 and UL555S) combination fire and smoke dampers where shown on the Drawings. Damper shall be built to comply with NFPA Bulletin 90A and have a 1-1/2 hour rating and shall have a Class II leakage classification.

Motor operated damper assemblies shall consist of a motor listed, labeled and tested for use with a Underwriter's Laboratories labeled fire damper. Total assembly shall also be Underwriter's Laboratories classified and labeled as a motorized fire damper for use with smoke detection equipment. Units shall be capable of functioning in either a vertical or horizontal position. The damper operator shall be factory mounted.

Motor shall be a 24 volt or 115 volt AC stall type motor coordinated with the Section 230900 Contractor. On activation of the fire alarm, damper blades shall be tightly closed by a stainless steel closure spring. Unit shall be equipped with fusible links and a stainless steel locking clip.

Dampers shall be sized to match the sheet metal dimensions of internally insulated ductwork and the outside dimensions of ductboard installations. Round fire/smoke dampers should be installed in round ductwork.

Combination Fire and Smoke Dampers shall be American Warming and Ventilating Co., Advanced Air, Ruskin, ACT, Greenheck, Air Balance, Nailor, Pottorff or equal.

1.12 MANUAL DAMPERS:

Furnish and install splitter dampers and balancing dampers in the ductwork where shown and wherever required to accurately balance the system. Splitter dampers shall be minimum of 20 gauge, rigid to prevent vibration and held securely in place at any setting with heavy lock quadrant.

Balancing dampers in rectangular ductwork shall be Ruskin Model No. MD-35 or equal complete with rigid frame, 16 gauge galvanized steel blades, 8 inch maximum blade width, synthetic bearings and heavy lock quadrant with position indicator.

Manual dampers at branch duct tees shall have integral spin-in fittings. Branch duct dampers and tees of equal or greater size to the main duct shall have an integral shoe type fitting. Balancing dampers shown in round ductwork shall be heavy gauge with a locking quadrant on one side and a shaft extending through the other side of the duct. Manual dampers with integral takeoff fittings shall be as manufactured by Cardinal Supply, Sheet Metal Connectors, Inc. or equal.

Manual Balancing Dampers shall be Ruskin, Greenheck, Air Balance, Pottorff or equal.

1.13 DUCT MOUNTED HEATING COILS:

Furnish and install duct mounted heating coils which shall be sized as shown in the schedule on the Drawings. Coils shall be Trane Type T, ST, or Type W, or equal, designed for hot water and suited for duct installation. Coils shall be single tube seamless copper 5/8 inch OD. Tubes and U-bends shall be combined in a single tube using silver brazing. Supply and return connections shall be 3/4 inch internal thread. Casings shall be constructed of heavy galvanized steel with provision for fastening securely in the ductwork. Bronze, spring type turbulators shall be furnished, if required to meet capacities needed where water velocities are 4 feet per second or less. Coils shall be tested at 250 psi air pressure under water.

Design criteria for the duct mounted heating coils shall be as shown in the schedule on the Drawings.

Duct Mounted Heating Coils shall be Trane, McQuay, York, Temptrol, Dunham Bush or equal.

1.14 PRV BACKDRAFT DAMPERS:

Furnish and install Ruskin Model BD2/A1, American Warming and Ventilating Model BD-42, Greenheck Model EM-10 or equal backdraft dampers in power roof ventilator curbs where shown on the Drawings. Dampers shall consist of 6063T5 extruded aluminum. Frame thickness shall be 0.09 inches and blade thickness shall be 0.025 inches. Damper blades shall have extruded vinyl edge seals and it shall have zytel bearings. Blades shall be linked to work in unison with blade stops top and bottom. The pressure drop through the backdraft damper shall not exceed 0.10 inches w.c. Pressure drop data shall be submitted with the fan shop drawings.

Damper shall have mill finish unless otherwise noted.

Backdraft Dampers shall be Ruskin, American Warming and Ventilating, Greenheck, Cesco or equal.

1.15 AUTOMATIC TEMPERATURE CONTROL:

Install the automatic temperature control dampers, air flow monitoring devices, openings for air flow switches, alarms and control devices as provided by the Automatic Temperature Control Contractor.

These dampers and devices shall be installed under the direct supervision of the Section 230900, AUTOMATIC TEMPERATURE CONTROL Contractor and in strict accordance with the manufacturer's recommendations.

Caulk around all sides of high efficiency damper frames.

1.16 VAV/REHEAT TERMINALS (DDC):

Furnish and install variable air volume terminals and reheat terminals of sizes and capacities as shown on the Drawings.

At minimum cooling the VAV terminal shall be 30 percent of design cfm unless designated otherwise in the schedule on the Drawings.

All performance shall be ARI certified.

The terminal manufacturer shall provide a flow cross or two (2) pipe sensor suitable for interfacing with a differential pressure transducer. The flow sensor shall include auxiliary taps for use by the Balancing Contractor. The transducer shall be supplied by the temperature control contractor.

The casing shall be constructed of coated steel meeting SMACNA or ASHRAE Standards. Internal insulation shall meet the requirements of NFPA Bulletin 90A.

Heating coils where required shall be factory mounted and sized as shown in the schedule on the Drawings. Coils shall be designed for hot water. Coils shall be single tube seamless copper 5/8 inch OD. Tubes and U-bends shall be combined in a single tube using silver brazing. Supply and return connections shall be 3/4 inch internal threaded. Casings shall be constructed of heavy galvanized steel and shall have 12 inch long by 6 inch wide access panels on the inlet of the heating coil. The access panels shall be gasketed and screwed to the bottom of the heating coil section. Bronze, spring type turbulators shall be furnished, if required to meet capacities needed where water velocities are 4 feet per second or less. Coils shall be tested at 250 psi air pressure under water.

VAV Terminals shall be Carnes, Enviro-Tec, Krueger, Nailor, Price, Titus, Trane, Tuttle and Bailey, York or equal.

1.17 TESTS:

General:

The Contractor shall furnish a competent individual familiar with the installation to assist the Balancing Company and make the necessary mechanical equipment adjustment as directed by the Balancing Company. The Contractor shall also furnish the necessary ladders, scaffolding, etc., needed for access to test and balance all systems.

The Contractor shall provide replacement pulleys, etc. as required to properly balance the ventilation equipment.

The following tests shall be performed on the respective systems. Tests shall be repeated until each system is proven acceptable.

Heating and Cooling:

The Contractor shall employ an independent testing and balancing company to properly balance the water flow to and from all coils and equipment and make any adjustments necessary in balance valves, etc., to meet the required flows.

The Contractor shall furnish to the Architect/Engineer three (3) typewritten copies of tabulations of the water flows. This tabulation shall include unit number, room number, gpm for all connections, showing both design gpm and actual gpm. The Contractor shall tabulate all pump pressure differentials, gpm and pump motor current and voltage readings taken after all terminals and equipment have been balanced. List the bypass gpm on 3-way valves. The Contractor shall operate the controls (thermostat, etc.) to verify that the gpm changes from no flow to design flow and shall designate the results in the report.

Ventilation and Air Conditioning:

The Contractor shall make thorough tests of the following systems.

Air Systems:

The Contractor shall make a thorough test of all air systems. He shall employ an independent testing and balancing company to properly balance the air flow to and from all openings and make any adjustments necessary in fan speeds, etc., to meet the required air volume.

The Contractor shall furnish to the Architect/Engineer three (3) typewritten copies of tabulations of the air volumes. This tabulation shall include unit number, room number, supply, return, or exhaust CFM's for all openings, showing both required CFM and calculated CFM, grille size, minimum cooling VAV terminal CFM, heating VAV terminal CFM and maximum VAV terminal CFM. The Contractor shall also submit a tabulation of all fan RPM's, static pressure, CFM's and fan motor current and voltage readings taken after the terminals have been balanced.

Independent Testing and Balancing Company:

Testing and balancing work shall be executed under the direct supervision of a registered professional engineer having an experience record of not less than five (5) years in the mechanical contracting industry, engaged in testing, balancing and adjusting of air and hydronic mechanical systems for not less than two (2) years of that time; or, under the direct supervision of a qualified testing, adjusting and balancing supervisor, possessing certification from the National

Environmental Balancing Bureau (NEBB). Testing and balancing work shall not be done by the installing contractor.

Comply with the applicable procedures in the chapter on Testing, Adjusting and Balancing in the latest ASHRAE Edition of the Systems Handbook.

Calibration and maintenance of instruments shall be in accordance with manufacturer's standards and recommendations, and calibration histories for each instrument shall be available for examination.

Accuracy of measurements shall be in accordance with the applicable measurement means as listed in the chapter on Measurement and Instruments in the latest edition of ASHRAE Fundamentals Handbook.

Allowable Tolerances:

Tolerances of adjustment for air handling systems are plus or minus 5% for supply systems and plus or minus 10% for return and exhaust systems from figures shown on the Drawings.

Tolerances of adjustment for hydronic systems, are plus or minus 10% of design conditions shown on the Drawings.

Rebalancing and adjustments found necessary to maintain and to achieve satisfactory operating conditions during the contract guarantee period shall be performed by the Testing and Balancing Subcontractor.

Acceptable Testing and Balancing Companies meeting the above requirements are as follows:

Balancing Professionals, Inc.
Precision Test and Balance
ReCom, Inc.
Systems Management and Balancing, Inc.
Tab, Inc.

Independent testing and balancing companies not listed above must submit for approval prior to the Bid.

END OF SECTION 230800

SECTION 230900 - AUTOMATIC TEMPERATURE CONTROL/BUILDING AUTOMATION SYSTEM

1.01 SCOPE:

The GENERAL, SUPPLEMENTAL and other CONDITIONS of the Contract and the GENERAL REQUIREMENTS (Division 1) are hereby made part of this Section.

Section 230100, General Provisions, in its entirety, including references to the General Construction Specifications, are hereby adopted and made part of these Specifications

The work involved in this specification and the accompanying drawings consists of performing all labor and furnishing of all materials, fixtures and equipment necessary to install complete automatic temperature control systems, as described herein and/or shown on the Drawings. This includes all piping, wiring and materials obviously necessary for complete systems though not specifically mentioned or shown.

Furnish and install an Automatic Temperature Control/Building Automation System (ATC/BAS) as manufactured by Johnson Controls (Metasys), KMC, Schneider Electric (TAC/IA Series), or Siemens (Apogee), Siemens (Talon), or DDC

The ATC/BAS shall be installed by the manufacturer's trained personnel. The Contractor shall be a Factory Authorized Distributor or Branch Office certified to engineer, install and service the brand of temperature control equipment specified herein. The Contractor shall have represented the brand of control equipment for the proposed installation for a minimum period of 5 years. Installation by mechanical contractors will not be allowed.

ATC/BAS components shall be the manufacturer's latest standard design that complies with the specification requirements and in conformance with the following applicable standards for products specified:

- A. American Society for testing and materials, ASTM
- B. Institute of Electrical and Electronic Engineers, IEEE
- C. National Electrical Manufacturers Association, NEMA
- D. Underwriters Laboratory, UL (UL 916)
- E. FCC Regulation, Part 15, Section 156
- F. National Fire Protection Association, NFPA
- G. Local building codes

1.02 WORKMANSHIP:

Installation workmanship must be the highest quality.

Panels must be amply sized to allow all components to be permanently mounted with ample space for wiring between components and around the panel perimeter. Groups and bundles of control wiring shall be in a gutter system with a removable cover.

Control wiring shall be cut with spare length at both ends to allow for connections at both ends with ample wire length and no splices adjacent to the connection. Control wiring shall not be spliced inside control panels. All wiring shall terminate on labeled terminal blocks or device

mounted terminals under screws. All wires terminating under a common screw should be the same wire gauge or diameter.

All components must be permanently fastened inside control panels. Components shall be permanently labeled for the systems they serve and their function.

Control wiring must be routed parallel along and perpendicular to structural members.

Control wiring must be routed utilizing the cable tray system where cable tray systems are available.

Control wiring shall be installed in conduit in exposed locations, i.e., Mechanical Rooms and areas with exposed structure (no ceiling). Final connections to control components (valve actuators, damper actuators, etc.) must be by flexible conduit from a J-box set adjacent to the control component.

Control conduit ends must have insulated throats.

1.03 SUBMITTALS:

The ATC/BAS Contractor shall provide an equipment submittal that includes manufacturers' catalog data describing each item of control equipment or component to be provided and installed on the project.

The Contractor shall submit CAD generated schematic drawings for the entire control system for review and approval before beginning installation of the control system. Included in the submittal drawings shall be a one page diagram depicting the system architecture complete with a communications riser. Drawings shall include point-to-point wiring diagrams and must show: all controls, start-stop arrangement for each piece of equipment, equipment interlocks, wiring terminal numbers and any special connection information required for properly controlling the mechanical equipment. The submittal shall include a bill of material reference list as well as equipment sequences of operation.

The Contractor shall submit all software logic flowcharts and graphics for the control system for review and approval before programming shall begin.

1.04 PROTECTION OF SOFTWARE RIGHTS:

Prior to delivery of software, the Owner and the party providing the software will enter into a software license agreement with provisions for the following:

- A. Limiting use of software to equipment provided under these specifications.
- B. Limiting copying.
- C. Preserving confidentiality.
- D. Prohibiting transfer to a third party.

1.05 ELECTRICAL INSTALLATION:

The ATC/BAS Manufacturer shall be responsible for installation of all of the control wiring to provide for a complete operating system. This electrical wiring shall include but not be limited to the following:

- A. The term "control wiring" is defined to include the providing of wire, conduit, and miscellaneous materials as required for the mounting and connecting of electric or electronic control devices. Control wiring includes but is not limited to the line and low voltage communications and power wiring necessary for the proper operation of the DDC controllers as described herein. Control wiring shall be grouped and tied together along building lines parallel with and perpendicular to structural members. Control wiring shall be routed in the cable tray system when such a system is provided by Division 26 - Electrical.
- B. All exposed wiring, low and line voltage, shall be run in conduit. Line and low voltage wiring shall be run in separate conduits. Concealed but accessible wiring, except in mechanical rooms and areas where other conduit and piping are exposed shall run in UL plenum rated cable as approved by local codes unless expressly restricted by requirements in the Division 26 specification. Plenum cable shall be installed high enough to provide adequate clearance for ceiling tile removal.
- C. All power wiring shall be run by the Contractor from circuit breakers provided by the Division 26 electrician to the respective DDC controller (s). This includes the terminal box ASC controllers provided under this section of the specifications.
- D. All wiring shall be installed in accordance with local and national codes as defined in the Division 26 specifications.
- E. Numbered or color-coded conductors shall be used to allow for future identification and servicing of the control system.
- F. All wall mounted sensors/thermostats shall be roughed in using a standard electrical box with conduit in the wall extended to the accessible ceiling area. They shall be mounted in accordance with and at a height to comply with The American's With Disabilities Act (ADA), unless noted otherwise on the Drawings. Mounting sensors with anchors or toggle bolts is not permitted.

1.06 INSTALLATION OF CONTROL VALVES, DAMPERS AND DEVICES:

All automatic control valves, water monitoring devices, flow switches, alarms and control devices shall be furnished by the ATC/BAS supplier and installed under his direct supervision by the Division 22 Contractor as noted in Section 220600 - HEATING.

All automatic control dampers, air flow monitoring devices, flow switches, alarms and control devices shall be furnished by the ATC supplier and installed under his supervision by the Division 23 Contractor as noted in Section 230800 – VENTILATION AND AIR CONDITIONING.

Furnish and install all switches, relays, contactors, etc. required for a complete operating system as specified in the Sequence of Operation.

1.07 FREEZE PROTECTION:

Furnish and install a manual reset freeze protection thermostat on the discharge of each heating coil of each system with a fresh air connection which will shut off the fan motor, fully close the fresh air damper and open the coil valves to full flow whenever the coil outlet air temperature falls below its setting. This device shall be hard wired to the motor starter/contactors.

1.08 PACKAGED UNIT REMOTE CONTROL PANELS:

Remote control panels furnished by the heating ventilation and air conditioning equipment manufacturers shall be wired and tested by this Contractor. Remote control panels furnished by the heating ventilation and air conditioning manufacturers shall be mounted respectively under Section 22600 and Section 23800 of these Specifications.

1.09 PRODUCTS:

Temperature Sensors:

Temperature sensors shall be linear precision elements with ranges appropriate for application, accurate within 1°F over normal operating range.

- A. Space sensors shall be available with concealed setpoint adjustment and override switch. Space sensor shall have a portable service tool jack. Setpoint adjustment shall be capable of being overridden through software. Provide metal sensor guards where shown on the Drawings.
- B. Duct mounted averaging sensors shall utilize a sensing element incorporated in a copper capillary with a minimum length of 20 feet. The sensor shall be installed according to manufactures recommendation and looped and fastened at a minimum of every 36 inches and changes in direction.
- C. Sunshields shall be provided for outside air sensors.
- D. Thermowells for all immersion sensors shall be stainless steel or brass as required for application.

Humidity Sensors:

Humidity sensors shall have a range of 0% to 100% with an accuracy of +/-3%.

Air Velocity Sensors:

The sensor shall have a repeatability within 1% of reading and an accuracy of +/-5% of range.

Differential Pressure Sensor:

The differential pressure sensor shall have an accuracy of +/-2% of range.

Outdoor Pressure Reference Sensor:

Outdoor pressure reference sensors shall be Dwyer Model No. A306. Install in strict accordance with the manufacturer's recommended installation instructions.

Occupancy Sensor:

Occupancy sensor shall be of the passive infrared or ultrasonic receiver type. As a minimum the occupancy sensor shall provide adjustments for timed-on delay and sensor sensitivity.

Terminal Unit Velocity Sensors:

Sensor shall have an installed accuracy of +/-5% of range and repeatability of +/-25 FPM.

Low Temperature Protection Thermostats:

Shall be the manual reset type. The thermostat shall operate in response to the coldest one foot length of the 20-foot sensing element, regardless of the temperatures at other parts of the element. The element shall be properly supported to cover the entire downstream side of the coil with a minimum of three loops. Separate thermostats shall be provided for each 25 square feet of coil face area or fraction thereof. The thermostat shall be adjustable down to 15°F.

Differential Pressure Switches:

Pressure differential switches shall have SPDT change-over contact, switching at an adjustable differential pressure setpoint. Repeatability shall be better than +/-0.02" H₂O.

Current Sensing Relays:

Current sensing relays shall have setpoint adjust, trip indication and five year unconditional warranty.

Flow Switches:

Flow switches shall be of the paddle type equipped with SPDT contacts to establish proof of flow. Flow switches shall be of the vapor-proof type.

Electric Thermostats:

Thermostats shall have SPDT contacts with a concealed setpoint adjustment from 55 to 85°F. Provide metal thermostat guards where shown on the Drawings.

Control Valves:

Valves shall be selected to meet the individual systems design pressure, temperature and medium. Valves on equipment with outside air capability shall fail open unless noted otherwise. Converter valves and boiler isolation valves shall fail closed. Two way valves of 440 CV or less, and three way valves of 91 CV or less, shall be industrial quality ball valves with Belimo actuators as assembled by Delta Control Products or equal. Valves assemblies shall have a minimum resolution of 250 to 1 and be rated for 250 psi working pressure and 450 F working temperature. Water valves shall be sized for a 2 psi pressure drop except where noted otherwise and low pressure steam valves (< 15 psi) shall be sized for 80% pressure drop of inlet pressure. Valves 2 1/2 inches and larger shall be flanged with a turndown ratio of 40 to 1. Butterfly valves shall be as assembled by Delta Control Products or equal.

Terminal Unit Fan Speed Controllers:

Fan speed controller shall be capable of controlling the speed of single phase terminal fan motors with power factors of between 0.7 and .95 inductive and operating amperage less than 5 amps. The fan speed controller shall be rated for 120 VAC or 277 VAC. The fan speed controller shall bear a UL508 listing.

Control Dampers:

Automatic control dampers shall be Ruskin Model No. RCD46/CD356 or equal and have 16 gauge galvanized steel blades with integral structural reinforcing running full length of the blade. The frame shall consist of 16 gauge galvanized steel. There shall be no blade over 8 inches in width, 48 inches in length, without support, and all damper bearings shall be synthetic type. Blade edge seals shall be EPDM rubber or PVC coated polyester fabric suitable for -25°F to 180°F mechanically locked into the blade edge and jamb seals shall be of the flexible metal compression type. Dampers shall be AMCA certified for leakage not greater than 6 cfm per square foot at a 4 inch w.g. pressure differential (24 inch wide). Modulating dampers shall be opposed blade.

Round control dampers shall be of the butterfly type consisting of a circular blade mounted to a shaft. Inside frame surface shall be clean and smooth with no blade stops or similar inward projections. Frames shall include rolled stiffener beads to allow easy sealing of spiral ductwork joints. Dampers shall include a firm, closed-cell neoprene seal sandwiched between two blades. Leakage through the damper in the closed position shall not exceed 0.15 scfm per inch of blade circumference at a pressure differential of 4" w.g. Leakage through the bearings shall be less than 0.25 cfm at 4" static pressure. Damper frame and blade shall be fabricated from galvanized steel. All parts not protected shall be given one coat of aluminum paint.

All automatic control dampers shall be furnished by the ATC supplier and installed under his supervision by the Contractor as noted in Section 23800.

Damper Actuators:

Damper actuators shall be Belimo or equal. Actuators shall be built for modulating operation with ample power for the service required. All AHU damper actuators and outside air damper actuators shall be spring return unless noted otherwise.

VAV/Reheat Terminal Actuators:

Actuators shall be of the rotary type capable of permanent stall operation without damage. The actuator shall also have adjustable stop for stroke limit. Actuators shall utilize metal housing with nickel steel gears, oil impregnated for lifetime operation, and fit directly over the damper shaft.

Local Controls Panels:

All relays, switches, transducers and other field interface devices, for equipment located within the mechanical equipment rooms, shall be panel mounted. All electrical devices within the panels shall be wired to a numbered terminal strip. All wiring within the panel shall be run in accordance with NEMA and UL standards, and shall meet all local codes. Panels shall be NEMA type suitable for

applications as required. Each panel shall have a final as-built control drawing, reduced, laminated and mounted inside of the panel door.

Control Labels:

All temperature control devices in the Mechanical Rooms shall be provided with plastic laminate nameplates indicating their purpose in operation fastened with screws or rivets. Embossed/printed tape labels are not acceptable. This shall include all thermometers, switches, gauges, etc., mounted in the face of the control panels, all control devices mounted inside the control panels, and all miscellaneous control devices mounted remote from the control panels.

Each control panel shall be properly identified to indicate the system or systems which it serves. The corresponding equipment shall also be similarly identified.

Thermostat/Sensor Guards:

Where shown on the Drawings or in vestibules, corridors, toilet rooms and other unsupervised areas, provide sturdy (wire or cast aluminum) thermostat guards. Provide guards with a substantial base plate securely anchored to the wall. Thermostat/sensor access shall be by tamperproof screws or keyed lock. Recessed sensors with flush wall cover plate (flat plate) sensors may be provided in lieu of sensor guards.

Miscellaneous:

The ATC/BAS Contractor shall furnish all electric relays. All electric control devices shall be of a type to meet current, voltage, and switching requirement of their particular application. Relays shall be provided with 24 VAC coils and contacts shall be rated at 10 amps minimum.

Low temperature protection thermostats and high limit duct static pressure switches shall be hard wired to the fan motor starter.

Outdoor pressure reference sensors shall be Dwyer Model No. A306. Install in strict accordance with the manufacturer's recommended installation instructions.

1.10 APPLICATION SPECIFIC CONTROLLER (ASC) HARDWARE :

General:

The Application Specific Controller(s) (ASC) shall be a stand-alone controller. The controller shall include all hardware and software required for communications with the BAS. An ASC shall be dedicated for each zone terminal device VAV. The ASC is to be mounted remotely from the room sensor.

Programs:

The control program shall reside in the ASC. The application program shall be maintained in ROM. The default database, i.e., setpoints and configuration information, shall be stored in EEPROM, or minimum of 72-hour battery backup shall be provided.

Stand-Alone:

Controllers requiring the application or database to be downloaded from a host or share processing with a "master controller" shall not be acceptable. After a power failure the ASC must run the control application using the current setpoints and configuration.

Communications:

Communication shall be at a minimum of 2400 baud.

Input:

All inputs shall be provided with a calibrate function to eliminate sensing errors.

Output:

Digital output pairs controlling a tri-state motor/transducer or pulse width modulation shall not be utilized for analog control without a matching analog position feedback input.

1.11 APPLICATION SPECIFIC CONTROLLER (ASC) SOFTWARE :

ASC shall have the following minimum capabilities:

- A. DDC Control
- B. Heating/Cooling Setpoint
- C. Occupied & Unoccupied Setpoint Pairs
- D. Terminal and Perimeter Hydronic or Electric Heat Control
- E. Off-Hours Tenant Override
- F. Auto-Calibrate
- G. Remote Setpoint Adjust
- H. Standby Mode

ASC VAV shall have the following additional capabilities:

- A. Dual Minimum, Maximum and Accessory Volume Control

1.12 DIRECT DIGITAL CONTROLLER (DDC) HARDWARE:

General:

The Direct Digital Controllers (DDC) shall be a local control loop microprocessor-based controller installed at each mechanical system; (i.e., air handling units, heating plants, chiller plants, etc.). It shall be acceptable to control more than one system from a DDC as long as there are 25% spare inputs and outputs. Each DDC shall execute local control sequences, independent of a network controller or workstation. All DDC's shall be able to share analog and digital values. All control software and time programs shall be stored in EEPROM or other non-volatile field reprogrammable memory. Controllers with volatile memory shall have a battery for 72 hour database backup. Each controller shall be individually addressable by a system workstation or a portable service tool.

- A. The controller network shall be able to handle up to 16 controllers. The controller

network shall be true “peer to peer” communication and shall not experience degradation of communication even if any number of controllers go off line due to power loss for example.

- B. The controller network shall be able to communicate at a minimum rate of 9600 baud.
- C. The controller network shall be able to extend up to 7800 feet, hardwired, without any communication degradation.
- D. The controller network distance shall be able to be extended by using fiber optics or RS232 line drivers.
- E. Each controller shall be able to control independently.
- F. Controller wiring can be daisy-chained or star configuration connected while allowing the controller network to communicate independently if one controller is disconnected or losses power.
- G. Each controller shall have at minimum a 12-bit processor.
- H. Each DDC shall have a local communication connector through which a portable computer can be interfaced. The controller shall not have to be removed from the network system in order for this local communication to take place.

Database:

All DDC database shall be entered, changed or downloaded to the general application controllers via a portable service workstation or system workstation.

Input/Output Modules:

Provide the following input/output capabilities:

- A. Provide analog inputs which can accept industry standard analog signals such as 4-20 mA, 0-5 VDC, and 0-10 VDC.
- B. Provide digital inputs which accept binary contact closures.
- C. Digital outputs may be latched or momentary contact type. Digital output pairs controlling a tri-state motor/transducer or pulse width modulation shall not be utilized for analog control without a matching analog position feedback input.
- D. Analog outputs shall have a .5% resolution over total output span to 100%.
- E. Controller hardware shall be flexible to handle I/O expansions by hardware additions or by being able to download existing control logic into a higher density controller.
- F. The analog-digital and the digital-analog conversion shall be accomplished with 12-bit resolution as a minimum.

- G. Optional hand/off/auto switches and LED status indication can be provided for inputs and outputs.

Operating Environment:

The DDC shall be capable of operating in an environment of 32 to 122 °F and 10 to 90% relative humidity non-condensing.

Power Loss/Restart:

The DDC shall be tolerant of power failures. When a power failure has occurred and power (normal or emergency) is restored, the BAS shall execute these restart procedures, automatically and without operator intervention:

- A. Come on line.
- B. Update all monitored functions.
- C. Implement special building start-up strategies as required.
- D. Resume operation based on current time and status.

Peripheral Interface:

BAS shall be able to operate the following peripherals simultaneously.

- A. Local on-line System Workstation
- B. Dial-in remote System Workstation(s)
- C. Local on-line reports and alarm printer
- D. Remote dial-out alarm printer

Data integrity:

Data integrity shall be maintained by using cyclic redundancy checking (CRC). In the event of a CRC mismatch, communication shall be automatically retransmitted up to three times. If CRC mismatch continues for three attempts, the failure shall be audibly and visually annunciated on a System Workstation.

1.13 DIRECT DIGITAL CONTROLLER (DDC) SOFTWARE :

General:

Provide complete DDC software to execute all mechanical system local loop controls functions. Each controller type/model shall have the same software functions available. The programming software shall be able to bundle software logic (macroing) to simplify control sequencing. The software shall have the ability to have a clear indication of the control operating mode. All inputs, outputs, output override, setpoints, parameters and calculated values shall have three levels of operator security.

Control Parameters:

The software in the DDC shall produce all of the necessary reverse acting or direct acting, PID signals as required by the control sequence. The proportional integral and derivative values which make up

the PID output value shall be readable and modifiable at a workstation or portable service workstation.

Networking:

Each input, output, or calculation result shall be capable of being shared with another controller on the network and able to pass these values to a higher level system network if necessary.

Control Functions:

Each DDC shall execute local control sequences, independent of a workstation. Control functions shall include but not be limited to the following:

- A. Selection of minimum/maximum values
- B. Serial Load Staging
- C. Binary Load Staging
- D. Analog Load Staging
- E. Master-Submaster Routines
- F. Anti-Windup for Integrated Loops
- G. Enthalpy control
- H. Energy recovery logic
- I. Safety output interlock logic
- J. Hysteresis logic to absorb minor instabilities reducing unnecessary output changes.
- K. Time or Event Based Scheduling
- L. Adaptive Optimum Start/Stop
- M. Chiller and Boiler Reset/Optimization
- N. Demand Limiting/Load Shedding
- O. Tenant/Cost Center Billing
- P. Hot Water/Outdoor Air Reset
- Q. Run Time Totalization
- R. Alarm Detection and Dial Out
- S. Night Setback
- T. Historical Trending
- U. Indoor Air Quality, Demand Ventilation

Alarms:

The DDC shall be capable of comparing analog and digital readings to predetermined high and low limits and enunciate each time a value enters or returns from an alarm condition. The system shall be capable of suppressing selected alarm reporting when the primary equipment from which the alarm point is based in the inactive state. The alarm features of the BAS software shall, as a minimum, provide the following:

- A. Digital, Analog, and Hi/Low settings and deadband
- B. Sliding Alarm Limits
- C. Conditional Alarming
- D. Alarm inhibiting through feedback loop
- E. Fluttering Alarm Suppression
- F. Separate Tailored Alarm Messages of no less than 70 characters each
- G. Auto-dial of any alarm condition to a minimum of 10 telephone numbers with a voice message.

Communication Diagnostics:

The DDC software shall be capable of self-diagnosing failure automatically without a query by the operator. In the event of communications failure or limited power failure, the system shall be capable of both notifying a local operator of the specific occurrence, as well as auto dialing the condition to a remote site. Auto-dial out shall be configurable to repeat the alarm while the situation remains unattended and unacknowledged. In addition to automatic self-diagnostics, communication statistics for the ASC's and DDC's communication shall be maintained. These statistics shall tabulate total communications attempted versus successful and unsuccessful communications by unit number. The option to reset communication statistics to zero (0) at any time shall be provided.

Trending:

The ATC/BAS shall have the capability to pre-assign trend requirements for all analog or calculated or digital points in the system. Adjustable sampling intervals for each trend, from 1 second to 24 hours, shall be provided. ATC/BAS shall have the capability to simultaneously trend a minimum of 500 combined analog, calculated and digital points. All sampled trend data shall contain an indication(s) of when the data is not valid, whether from sensing or communication disruptions or other causes. Each trend shall be capable of being automatically started or stopped, based on time of day, externally sensed points, alarms, or a calculated value. Printout or upload of trend data to the System Workstation shall be operator-selectable to automatically occur at any time during the sampling period. The software shall allow analog and digital values and calculations to be graphically plotted in real-time or historical format. Uploaded trend data shall be fully compatible with MS-Excel, Lotus 1-2-3, MS-Access.

Control Logic Verification:

The control logic software shall have built-in logic that can be activated on demand to verify logic with digital and analog setpoints that can simulate actual operating conditions.

WEB- BASED OPERATORS INTERFACE:

Web Browser Clients:

The system shall have a web-based operator interface. The system shall be capable of supporting 16 clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™. Systems requiring additional software (to enable a standard Web browser) to be resident on the client machine are only acceptable if 16 licensed copies of the client machine software are provided, installed, and tested.

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., in order to allow the Web browser to function with the FMCS, shall only be acceptable if 16 workstations or workstation hardware upgrades are provided.

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, are not be accepted.

1.14 DDC OPERATOR TERMINAL/SERVICE TOOL:

Provide with the ATC/BAS the hardware and software necessary to allow commissioning, adjustment, and diagnosis of the ASC's, and DDC's. All programming shall utilize English language descriptors. A handheld service tool or laptop computer with software shall be provided.

1.15 REMOTE INTERFACE:

A remote operator shall be able to perform all control functions and all data base generation and modification functions as described for local work station. ATC/BAS shall have ability to automatically place calls to provide remote alarm indication.

1.16 SYSTEM WORKSTATION HARDWARE:

System Workstation(s) shall include the following, as a minimum:

- A. Processor: Pentium, 733 MHz Operation
- B. Memory: 256 Mbytes
- C. Floppy Drive: One, 1.44 Mbytes
- D. Hard Disk: 20 Gbytes
- E. CD: 48X
- F. Ports: Two RS-232 Serial Ports, One Parallel Port, One USB Port
- G. Monitor: VGA Color Monitor 17"
- H. Mouse: Microsoft Bus Mouse or equivalent
- I. Printer: Color Ink Jet Printer
- J. Modem: 56,000 baud Modem

Supply interconnecting data cables, power cords and surge-suppressing (fused) power strips, as required for a complete Work Station installation.

1.17 SYSTEM WORKSTATION SOFTWARE:

Operating System:

The operating system shall be based on Microsoft Windows. The ATC/BAS shall be capable in future of communicating with other systems using BACnet or LONTALK protocol through a software interface or gateway.

Operators:

Multiple System Workstation operators shall be able to access the system simultaneously. Systems which do not provide multi-tasking, multi-user operating systems are not acceptable.

Graphical User Interface:

Provide a color graphics editor which shall allow the user to generate custom dynamic graphics for graphical representation of system design and system parameters. The graphics editor shall allow zones of the building mechanical systems, floor plans, etc., to be custom generated for the project.

Graphics Creation:

The editing menu shall provide help menus for selecting graphics, choosing colors, copying previous graphics, and selecting data points. A set of standard HVAC symbols shall be provided to allow operators to select from the graphics library for graphic generation.

Display:

Information on the color graphic display shall be dynamic and automatically updated. Dynamic field data, such as analog values and equipment status' shall be displayed on graphics within 1 second of the time the field data is received by the System Workstation.

Decluttering:

The same graphic shall appear in simplified form to a non-sophisticated operator through the use of display suppression called "Decluttering". Decluttering shall allow graphics to be displayed to meet the needs of different operators with different levels of expertise. The level of display sophistication shall be automatic upon entry of the user's password. All graphic symbols, equipment, lines, etc., shall be assignable to classification groups. Displays shall be capable of being decluttered by individual or multiple classification groups by the operator.

Custom User Symbol Library:

A library of ASHRAE, ISA and logic symbols shall be provided to build the graphics database. It shall be possible to group any collection of symbols so that they may be copied and used repetitively as a group.

The ATC/BAS Contractor shall create and include a graphic diagram for each equipment item included on this project.

Reference Card:

A user reference card shall be provided. The user reference card shall allow the user to create multiple lines of site/system/equipment - specific text information. The reference card shall be invocable by an operator at any time and at any menu option. When invoked, the reference card shall appear on the System Workstation and display specific reference, explanatory, instructional or other information for the current time and menu option position.

Manual Control:

A manual control menu shall be provided, which will allow the operator to turn points on or off, adjust values of control loops, set points to local mode or release points to automatic mode.

Alarms:

Alarm directives shall be provided around the border of the graphic display so as not to impact the display information. The border display shall change color upon the occurrence of an alarm condition. The ATC/BAS shall also have the capability: to display alarm directives in popup windows on workstations, store them on disk, direct them to printers and re-route them based on time of day, day of week, etc. throughout the ATC/BAS network and to different receivers though

phonelines and jump to alarm display on graphic. Alarms shall be routed to a workstation based on a combination of alarm priority and alarm class. A minimum of eight alarm priorities shall be available. Alarm classes shall be determined by the user such as HVAC, fire, security, etc. The System Workstation software shall be capability of defining up to 100 alarm classes on the system. Each alarm may be routed to workstation screen, disk file, printer or any combination thereof. The alarm message shall contain appropriate information such as date or value, point description, and a minimum of 80 characters alarm message. If an alarm is routed to a workstation display screen, a pop-up window will be displayed on alarm occurrence with the alarm information in the window. The operator shall be able to acknowledge the alarm with a single keystroke or mouse button depression.

Reporting:

The system shall have the ability to provide status reports for the categories of functions noted below:

- A. Name:
All points and point information with the same English name assigned or portion of the same English name assigned.
- B. Type:
All points and point information with the type specifications such as analog or digital.
- C. Address:
List of ASC and DDCs that are within a specified address range.
- D. Status:
All points and point information with a specific status, i.e., all zones in heating, all zones in cooling, all zones unoccupied, or all zones in manual override control.
- E. Value:
All points greater to, equal to, or less than a specified value. For example, report on all zones with temperature greater than 76°F.

Control Summary:

The system shall have the capability to summarize control strategies for any point within the ATC/BAS.

The control summary shall dynamically show all values and point acronyms that make up the control sequence from the input values to the output. These control summaries shall be loggable to a printer for hardcopy.

ASC/DDC Control Configuration:

The operator shall be able to connect directly to a ASC or DDC. Once connected directly to a controller, the operator shall be able to completely configure the controller using a separate window on the workstation. The current configuration of the controller shall be uploaded into the workstation and displayed on the screen. Using menus and prompts the operator shall be able to modify the configuration and re-download the configuration to the connected controller.

ASC/DDC control configurations shall be able to be cloned at the workstation and the same configuration used for other controllers.

Passwords:

The access software shall provide a minimum of 5 levels of passwords. Each level shall be user definable.

1.18 GRAPHICS:

Floor layouts showing rooms and room numbers will be supplied by the school district. By clicking on the Temperature icon, information on the VAV box, AHU, unit heater, etc. serving that area shall be displayed.

The Graphics shall include but will not be limited to the following features:

Home page

Site Plan with link to floors or zones that are color coded to the individual zones. Links to the Chiller and chilled water pumps (CWS), boiler and hot water pumps (HWS). Link to Power monitoring page. Link to Modes and Schedules. Outdoor air temp with current time and date. Outdoor lighting commendable and schedule

Floor or zone graphic page

Page will show the Room number and room temperature. The link to the associated room equipment, i.e. VAV box, cabinet unit heater, AHU, etc shall be the room number. The exhaust fan icon for the associated will link to an exhaust fan page.

Power Page

Real time Building KW and Voltage power factor. Outdoor air temperature
Link to KW Graph for the last 24 hours and link for last 3 days.
Link to Voltage graph for the last 24 hours and link for the last 3 days.

Equipment pages

VAV boxes:

Day / Night Status
Heat / Cool mode
Room temperature
Room temperature set point
Fan Status with flashing alarm
Htg Vlv Comd
Htg Vlv Set point
Damper position
Damper command
Discharge air temperature
Radiant heat valve
Radiant heat valve comd

CFM Minimum
CFM Maximum
Unoccupied Htg Set point FP boxes only

Boiler Page (HWS)

All boiler commands, with status and alarms (flashing). Heating enable set point, Boiler water supply and return temperatures. HWS reset schedule (adjustable). Boiler leads / lags with indicator as to which boiler is lead commendable. Hot water pump VFD status with adjustable set point Pump lead / lag with indicator as to which pump is lead. Hot water system pressure differential status with adjustable set point. Any changeover valves if applicable with position indicators. Domestic Hot water pump with zone and status and water temperature indication. Combustion air damper with position indication. Outdoor air temperature

AHU page

Single Zone AHU shall have room temp and heating/cooling (adj.) set points to include unoccupied heat and cooling, and the summer set point.

All AHU's

Economizer set point and status. Outdoor air temperature
Htg valve position and set point commendable
Clg stages and set point commendable
Mixed damper position and set point commendable
Discharge air temp, with discharge air set point and reset schedule, adjustable
Mixed air temp with mixed air set point, adjustable
Return air temp
Freeze stat status and alarm (flashing)
VFD position and command
Duct pressure, with set point, adjustable
Fan with status, alarm (flashing) commendable
Building pressure status and set point with associated dampers and or exhaust fans.
Smoke damper operation (when applicable)
Duct high limit status and alarm (flashing)
Day / Night or summer status
Morning warm-up mode and set point
Link to Occupied / unoccupied page.

Occupied/Unoccupied/Summer Mode page

Unit or Zone status able to command occupied / unoccupied from page
Link to summer schedule
Master Holiday link. Link to schedule all zones/equipment to unoccupied schedule by calendar day.

Exhaust Fan Page

All Exhaust Fan

Status and Alarms
Occupied / unoccupied zone and schedule

Notes

All set points to be commendable
All valves pumps dampers, AHUs, Boilers to be commendable under highest password only
All alarms to be flashing
All Valves and dampers 0% to fully closed 100% to be fully open.

1.19 SYSTEM ACCEPTANCE:

When the ATC/BAS has been demonstrated to meet the requirements of the Drawings and Specifications the system will be accepted. The warranty period will start at this time.

Operation and Maintenance Manuals:

Submit two (2) copies of operation and maintenance manuals. Include the following in each manual:

- A. Manufacturer's catalog data and specifications on all sensors, transmitters, controllers, control valves, damper actuators, gauges, indicators, terminals, and any miscellaneous components used in the system.
- B. An Operator's Manual which will include detailed instructions for all operations of the system.
- C. An Operator's Reference Table listing the addresses of all connected input points and output points. Settings shall be shown where applicable.
- D. A Programmer's Manual which will include all information necessary to perform programming functions.
- E. A language manual which will include a detailed description of the language used and all routines used by the system.
- F. Flow charts of the software programs utilized in the Control System.
- G. Complete program listing file and parameter listing file for all programs.
- H. A copy of the warranty.
- I. Operating and maintenance cautions and instructions.
- J. Recommended spare parts list.
- K. After a successful acceptance demonstration, the Contractor shall include record drawings of the completed project for final approval. After receiving final approval, supply three

(3) complete record drawing sets, together with Cad diskettes to the owner.

1.20 TRAINING:

BAS manufacturer shall provide to the engineer a training class outline prior to any scheduled training.

Training sessions shall be provided for the Owner's personnel by factory trained control engineers and technicians. The ATC/BAS Contractor shall conduct one (1) eight hour and two (2) four hour training courses for the designated owners' personnel in the maintenance and operation of the control system. One class shall be given upon system acceptance and the others within one year after the warranty commences.

The courses shall include instruction on specific systems and instructions for operating the installed system to include as a minimum:

- A. HVAC system overview.
- B. Operation of Control System
- C. Function of each Component
- D. System Operating Procedures
- E. Programming Procedures
- F. Maintenance Procedures

1.21 WARRANTY:

Warranty:

The entire control system shall be warranted to be free from defects in both material and workmanship for a period of two (2) years of normal use and service.

1.22 TESTING AND ADJUSTING:

The Control Contractor shall furnish a competent individual familiar with the installation to assist the Balancing Company and make the necessary control adjustments as directed by the Balancing Contractor.

1.23 SEQUENCE OF OPERATION:

General:

All setpoints shall be adjustable. Deadband settings shall be used where appropriate to minimize cycling of equipment. Minimum on/off times shall be used where appropriate to minimize cycling of equipment.

Occupied/unoccupied Zones:

The BAS shall provide separate occupied/unoccupied zone signals for each of the following systems:

- 1. RAHU-1

Hot Water Reset Control:

The BAS shall reset the hot water supply temperature at an inverse ratio to the outside air temperature by cycling the boiler burners and modulating the three-way mixing valve. The reset schedule shall be fully adjustable from the operator's workstation but shall originally be set to maintain the hot water supply temperature as follows:

$$\begin{aligned} -10^{\circ}\text{F OAT} &= 1700^{\circ}\text{F HWS} \\ 60^{\circ}\text{F OAT} &= 140^{\circ}\text{F HWS} \end{aligned}$$

The BAS shall provide an additional control sequence to prevent the water temperature in each boiler from resetting below 140 degrees F. (adj.). If the hot water temperature in any boiler falls below 140 degrees F. (adj.), or the system hot water supply temperature is more than 10 degrees F. (adj.) lower than the BAS reset schedule is calling for, an alarm shall be initiated at the operator's workstation. Provide a temperature sensor in each boiler and system hot water supply and hot water return temperature sensors with remote temperature indication at the operator's workstation.

Hot Water Heating Pumps:

The lead hot water heating pump shall be started by the BAS during heating operation below 60 degrees F (ADJ.) outside air temperature. The BAS shall modulate the variable frequency drive for the lead pump to maintain the desired system differential pressure according to a differential pressure sensor located as directed by the Engineer. The second pump shall operate below 10°F (adj.).

Each of the two hot water heating pumps shall have a current switch or differential pressure switch to prove pump operation. If flow is not proven after the BAS has commanded the lead pump to start, an alarm shall be initiated at the operator's workstation and the lag pump shall be started and its variable frequency drive shall be modulated by the BAS to maintain the desired system differential pressure. The BAS Contractor shall provide the necessary programming to lead/lag and alternate the pumps.

Steam Humidification:

The BAS shall control the humidifier through DDC Application Specific Controllers (ASC). The DDC controllers shall be networked into the BAS to allow for remote adjustments and remote monitoring at the operator's workstation.

The BAS with its humidity sensor located in the return air shall modulate the steam humidifier valve to maintain a 30% RH (ADJ) return air humidity level. The BAS with its high limit humidity sensor located in the discharge air shall prevent the discharge air humidity from rising above 85% RH (ADJ). Whenever the AHU fan is off, the humidifier valve shall be closed.

Hot Water Radiant Ceiling Panels:

The BAS shall maintain the desired space temperature through a DDC controller by

modulating a two-way control valve as required. The DDC controllers shall be networked into the BAS to allow for remote adjustments, remote monitoring, and remote temperature indication at the operator's workstation. The DDC controllers shall be Application Specific Controllers (ASC).

Hot Water Cabinet Unit Heaters and Unit Heaters:

The BAS shall maintain the desired space temperature through a DDC controller by cycling the unit fan and two position, three way control valve upon a call for heat in the space. The BAS shall prevent the fan from operating unless 120 degree F. (adj.) hot water is available. The DDC controllers shall be networked into the BAS to allow for remote adjustments, remote monitoring, and remote temperature indication at the operator's workstation, the DDC controllers shall be Application Specific Controllers (ASC).

Toilet Room Exhaust Fans:

This Contractor shall provide an interlock with the BAS so that the exhaust fans run continuously when their respective zones are in the occupied mode of operation and are off when their zones are in the unoccupied mode of operation. Provide a current switch or differential pressure switch across the fan to prove fan operation. If operation is not proven after the BAS has commanded the fan to start, an alarm shall be initiated at the operator's workstation and BAS alarm printer.

VAV AHU Control

The AHU fan shall run continuously as determined by the Building Automation System (BAS)

The BAS shall maintain the desired discharge air temperature by modulating in sequence the outside air and return air dampers, the DX cooling stages and the three-way hot water valve. The BAS shall reset the discharge air temperature from 55 degrees F. to 65 degrees F (adj.) based on space temperature demands. Provide an interlock to prevent the DX cooling from operating until air flow has been proven by a differential pressure or current switch across the AHU fan.

The BAS with its sensor located in the mixed air shall modulate the outside air and return air dampers to prevent the mixed air temperature from falling below 35 degrees F (adj.). The BAS shall return the outside air damper to its minimum position whenever the outside air temperature rises above 75 degrees F (adj.).

The BAS shall maintain building pressure by modulating the adjustable frequency drive on the return/exhaust fan .

The BAS with its sensor located as directed by the Engineer in the supply air ductwork, shall maintain the supply air static pressure by modulating the adjustable frequency fan drive on the AHU. The BAS shall monitor the VAV terminal damper positions and reset the control pressure setpoint to maintain air flow for the most critical zone.

High limit duct static pressure switches with manual reset located close to the fan in the supply and return air ductwork shall stop the AHU fan, index the system to its unoccupied cycle of

operation and send an alarm to the operator's workstation if the duct static pressure exceeds 2.5" W.G. (adj.).

Provide a differential pressure sensor across the filters. Whenever the pressure differential across the filters exceeds the setpoint, an alarm shall be initiated at the operator's workstation.

Provide a current switch or differential pressure switch across the AHU fan to prove fan operation. Provide a freeze protection thermostat as previously specified located on the discharge side of the heating coil which will send an alarm to the operator's workstation and through the auxiliary contacts, shut off the fan motor, fully close the outside air damper and open the heating coil valve to full flow through the coil whenever the coil outlet air temperature falls below its setting.

VAV Terminals with Hot Water Reheat:

The BAS shall control the VAV terminals through DDC Application Specific Controllers (ASC). The DDC controllers shall be networked into the BAS and shall provide remote adjustments, remote monitoring, remote terminal discharge temperature and remote space temperature indication at the operator's workstation. Provide a discharge air sensor downstream of the heating coil to monitor leaving air temperature.

During occupied operation, the ASC shall control the variable air volume terminal unit to maintain the desired space temperature. The ASC shall modulate the supply air damper and two-way reheat coil valve as required to maintain the heating or cooling setpoint. The supply air volume will be limited by the minimum and maximum heating and cooling air volume settings. The reheat coil valve shall not open until the space temperature has dropped below the heating setpoint. When heating water is available, the reheat valve approaches full open and the heating requirements continues to increase, the heating cfm shall be modulated open to the scheduled heating cfm. When commanded by the BAS to change over to the unoccupied mode, the ASC shall raise the cooling setpoint and decrease the heating setpoint as appropriate to operator determined values.

Smoke Damper Control:

On interruption of power to an AHU by the fire alarm system, the actuators on the respective system combination fire/smoke damper assemblies shall close the dampers. When power is returned by the reset of the fire alarm system, the dampers shall be opened. Provide all electrical interlocks. The smoke dampers in the ductwork of a particular system shall close whenever that system's fan is not operating. Allow for the dampers to open before the fan is energized. Wiring the smoke dampers is the responsibility of this Contractor. Coordinate the proper electrical characteristics with the Section 15800 Contractor.

Point Trending: These points need to be set up for trending and through a link shall be shown in graph form. Trending shall be in 15 minute intervals and have 48 hours (min.) of data.

VAV

1. Room Temp
2. Discharge Air Temp
3. Air Flow

Unit Heaters, Cabinet Unit Heaters and Radiation

1. Room Temp

AHUs

1. Discharge Air Temp
2. Mixed Air Temp
3. Duct Static
4. VFD position
5. Fan Command
6. Zone Temperature

AHU inlet and Outlet Static Pressure Limit Control:

High limit duct static pressure switches with manual reset located close to the fan in the supply and return air ductwork shall stop the AHU fan, index the system to its unoccupied cycle of operation and send an alarm to the operator's workstation if the duct static pressure exceeds 2.5" W.G. (adj.).

END OF SECTION 230900

SECTION 260100 – COMMON ELECTRICAL REQUIREMENTS

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. In certain instances where the terms of this Division of the Specifications conflict with the terms of the General Conditions, or Special Conditions, this Division of the Specifications shall govern.
- B. Note that the complete electrical installation for this project falls under three specification divisions: Division 26, Division 27, and Division 28.
- C. The project shall be bid as one complete package with the final electrical construction bid containing all costs for Divisions 26, 27, and 28.
- D. The general requirements shown here in this Division 26 section shall also apply to Divisions 27 and 28.
- E. Where M.C. or Mechanical Contractor is referenced in Division 26, 27, or 28 specifications or on the electrical drawings, it refers to the general trade. Coordinate in field with the proper Fire Suppression, Plumbing, or HVAC Contractor based on the information in the specification or note.

1.2 SUMMARY

- A. This Section shall include everything in Divisions 26, 27, and 28 of the Specifications and everything indicated on the Drawings that are complementary to these Divisions of the Specifications. Refer to the Index of Drawings to determine what Drawings apply directly to this section.
- B. Where “Contractor” is referred to in this Division of the Specifications it shall mean Contractor and/or Sub-Contractors responsible for all or any part of the electrical installation specified in Divisions 26, 27, and 28 and/or as shown on the Contract Drawings.
- C. Where the specifications in subsequent Sections of Divisions 26, 27, or 28 conflict with requirements of this Section, the specifications in the subsequent Sections shall govern.
- D. The contractor shall provide all items, articles, materials, operations or methods listed, mentioned or scheduled on the Drawings and/or herein specified, including all labor, materials, equipment, accessories, wiring, and incidents necessary to be installed in accordance with manufacturer’s recommendations except as otherwise approved.

1.3 INTENT OF PLANS AND SPECIFICATIONS

- A. The intent of the plans and specifications are for the complete installation of the system described so that at the conclusion of the construction, the systems will be turned over to the owner complete and ready for safe and efficient operation. The plans and specifications cannot

deal individually with the many incidental items which may be required by the nature of the systems. The contractor shall be obliged to furnish and install all such items normally included on systems of this type, which while not mentioned directly in the drawings and specifications are obviously essential to the installation and operation of the system and which are normally furnished on quality installations of this type.

- B. The contractor shall make a thorough inspection of the conditions and be familiar with all conditions affecting the extent and cost of this work. Claims for extra payments as a result to examine the conditions will not be allowed.

1.4 PERMITS AND SERVICE CHARGES

- A. All permits and service charges necessary for execution of the work under this Contract shall be obtained by and be paid for by the Contractor. It shall be the responsibility of the Contractor to determine the permit requirements of the local authorities and utility companies and the cost of required permits, service charges, tap fees and development fees shall be included in the Contractor's bid.
- B. All work shall be executed in accordance with all local, state, and national rules, regulations, codes, etc., which are applicable and shall be subject to inspection by the proper authorities.

1.5 CODES AND STANDARDS

- A. All work performed and all equipment furnished under this Division of the Contract shall be manufactured and installed in strict accordance with all applicable codes and standards, including the applicable provisions of the following codes and standards.
 1. Local and State Codes, Standards, and Regulations.
 2. NFPA 70, National Electrical Code, Current Addition.
 3. National Board of Fire Underwriters (NBFU).
 4. National Electrical Manufacturers Association (NEMA).
 5. Underwriters Laboratories (UL).
 6. Electrical Testing Laboratory (ETL).
 7. Illuminating Engineering Society (IES).
 8. American National Standards Institute (ANSI).
 9. National Fire Protection Association (NFPA).
 10. International Building Code (IBC).
 11. International Fire Code (IFC).
- B. Compliance:
 1. Where specific requirements of any code vary with the requirements of another code, the higher standard as determined by the Architect/Engineer shall govern the installation. Contractors shall familiarize themselves with local codes and regulations which affect their work in any way. Extra payment will not be allowed for changes required by local codes and regulations.
 2. All equipment manufactured in accordance with the provisions of the above codes and standards shall bear the label of the respective association bureau thereon.

1.6 DRAWINGS AND MEASUREMENTS

- A. In general, the Drawings of the electrical systems and equipment are to scale. However, to determine exact locations of walls and partitions, the Contractor shall consult the architectural and/or structural drawings which are dimensioned. Drawings shall not take precedence over field measurements.
- B. Drawings of fixtures and devices, although shown on scale drawings, are diagrammatic only. They are intended to indicate size and/or capacity where stipulated, approximate location and/or direction, and approximate general arrangement of one phase of work to another, but not the exact detail or exact arrangement of construction. If it is found, before installation of any or all construction phases, that a more convenient, suitable or workable arrangement of any or all phases of the project would result by varying or altering the arrangement indicated on the Drawings, the Architect/Engineer may require the Contractor to change the location or arrangement of the work without additional cost to the Owner. Such rearrangement shall be in accordance with directions from the Architect/Engineer.
 - 1. Install light fixtures and wiring devices at heights specified in the Electrical Symbol Legend or as shown on the drawings. All measurements are to center unless noted otherwise. Device heights indicated on architectural elevations shall take precedence over symbol legend.
- C. Where discrepancies are discovered after certain portions or phases of the work have been installed, the Architect/Engineer reserves the right to require the Contractor to make changes in conduit, fixture or equipment locations or arrangements to avoid conflicts with work at no additional cost to the Owner.
- D. Because the Drawings are to a relatively small scale to show as large a portion as is practical, the fact that only certain features of the systems are indicated does not mean that other similar or different features or details will not be required. The Contractor shall furnish all incidental labor, material or equipment for the systems so that each system is a complete and operating one unless otherwise specifically stipulated in the detailed body of the specifications.
- E. The Contractor, Subcontractor's and their respective trades shall cooperate in laying out their work so it will fit properly into the space provided. Promptly report to the Architect/Engineer any delay or difficulties encountered in the installation of this work which might prevent prompt and proper installation, or make it unsuitable to connect with or receive the work of others. Failure to so report shall constitute an acceptance of the work of other trades as being fit and proper for the execution of this work.

1.7 SUBSTITUTIONS AND PRODUCT OPTIONS

- A. The Contractor and equipment suppliers shall read and familiarize themselves with articles concerning substitution of materials, as indicated in the Instructions to Bidders. Material and equipment substitutions will be handled as follows:
- B. Materials or equipment specified by name of manufacturer, brand, trade name or catalog reference, shall be furnished under the contract unless changed by Addenda or a Contract modification. Where two (2) or more materials are named, the choice of these shall be optional with the Contractor.

- C. Material or equipment followed by the phrase "or equal" shall establish a standard of required function, dimension, appearance and quality to be met by any proposed substitute. No substitution will be considered unless written request for substitution has been submitted by the bidder and has been received by the Architect/Engineer at least seven days prior to the date for receipt of bids. The Architect/Engineer's decision on a proposed substitute shall be final. If the Architect/Engineer considers any proposed substitution equal, such will be set forth in an Addendum. Bidders shall not rely upon substitutions made in any other manner.
- D. Whenever an item of material or equipment is identified on the drawings or specifications by reference to brand name or catalog number, it shall be understood that the reference is made for the purpose of defining the performance or other salient requirements and that other products of equal capacities, quality, or function may be considered.
- E. The listing of any manufacturer preceded by the phrase "or equal by" does not imply automatic approval. It is the sole responsibility of the Contractor to ensure that any price quotations received and submittals made are for products which meet or exceed the specifications included herein. The Contractor must judge that such items of substitution are of equal quality and character to the specified items and it is physically adaptable for installation within the allotted space with all required service clearances. The cost of any changes to other trades as a result of use of the substitution material or equipment must be borne by the Contractor submitting such material or equipment.
- F. Should the Contractor wish to use materials or equipment other than those specified or listed as equal by Addenda, he shall attach his proposed substitution along with full descriptive and technical data for the proposed item with the appropriate add or deduct to the Contract amount, should the substitution be accepted. Substitutions proposed by the Contractor will not be considered in the award of the Contract.
- G. After the award of the Contract, any request for a substitution must be made in writing by the Contractor (not the material supplier or subcontractor). Such request shall state the name of the product specified, the name of the product proposed for substitution, the reason for requesting the substitution, and any change to the Contract amount resulting from the substitution. No such substitution shall be made until an appropriate Contract modification has been issued and approved.

1.8 SUBMITTALS

- A. Schedule of Materials and Equipment:
 - 1. The Contractor shall submit a complete list of proposed equipment manufacturers for major systems and a list of Sub-Contractors, for the Engineer's review. This list shall be submitted for review within 15 days after the contract award and before ordering any material or equipment.
 - a. Review of the list shall in no way relieve the Contractor from the responsibility of submitting complete shop drawings nor shall it constitute approval should the shop drawings be found to be partially or completely not in full compliance with the specification requirements.
- B. Schedule of Values:
 - 1. The Contractor shall submit an itemized schedule of values for the various portions of the work, including separation of labor and materials for each item, to the Engineer before submission of the first Request for Payment. The schedule of values shall be divided so as to facilitate the Engineer's analysis of the various costs for the purpose of approval of

the payment requests. The submittal shall meet the approval of the Engineer before any progress payment will be provided. The following are required categories for the cost breakdown.

- a. Service and Distribution Equipment.
- b. Lighting.
- c. Wiring Devices.
- d. Equipment Connections.
- e. Basic Materials.
- f. Special Systems.

C. Shop Drawings:

1. Refer to the requirements of the General Conditions. Unless indicated otherwise in the General Conditions, submit to the Architect/Engineer seven (7) copies (minimum) of Shop Drawings for each item of equipment to be installed under this contract with two (2) copies to be retained by the Architect/Engineer. Furnish additional Shop Drawings as required for coordination with General Contractor and other Subcontractors. Furnish Shop Drawings as follows:
 - a. For all major items of equipment or materials, regardless of whether the item is to be furnished as specified.
 - b. For all equipment, systems or devices where Shop Drawings are specifically called for.
 - c. For all minor items of equipment or materials where the Contractor proposes to deviate from the specified and/or scheduled manufacturer or material.
 - d. Shop drawings shall include manufacturer, catalog number, voltage and current characteristics, wire sizes, construction, and rough-in data of all materials to be used. Each product data sheet shall clearly indicate the proposed product.
 - e. Major components of Divisions 26, 27, and 28 shall be submitted at one time. All such literature shall be bound in amply sized three-ring binders with table of contents and tabbed sections separating and identifying the sections of the shop drawings. Tabbed sections shall correspond with Divisions 26, 27, and 28 specification sections.
2. The Contractor shall check all Shop Drawing submittals for compliance with Contract Documents, for size, capacity, arrangement, connection locations, materials, finish, color, electrical characteristics, accessories, and shall so note the Shop Drawings prior to submittal to the Architect/Engineer. Any deviation from the Drawings and Specifications shall be indicated.
 - a. Each shop drawing shall be certified as being checked and approved by the Contractor before submittal. Shop drawings not indicated as being approved by the Contractor will be returned without review.
3. Shop Drawings will be reviewed by the Architect/Engineer, and copies of Shop Drawings will be returned to the Contractor. Shop Drawings shall be submitted sufficiently in advance of the construction schedule to allow time for checking Drawings, resubmittal and rechecking when necessary.
4. Any equipment or material which is installed without authorization by properly processed Shop Drawings will be subject to removal by the Contractor and reinstallation as directed, without cost to the Owner. All cost for repair for damages as may be incurred to the structure as a result of the above correction shall be paid by this Contractor.
5. Shop drawing material quantities will not be checked by the Architect/Engineer, and review of Shop Drawings by the Architect/Engineer shall not be construed to be verification of the material quantities and sizes shown on the Shop Drawings. Quantities, sizes, dimensions and locations shown on the Drawings and as specified shall determine material requirements.

6. The Contractor shall maintain two (2) copies of approved shop drawings to be submitted with the Operating and Maintenance Manuals.

1.9 QUALITY ASSURANCE

- A. Materials and equipment shall be new and of the best quality, of the type best suited for the purpose intended, and be made by nationally recognized and substantially established manufacturers. The type and weight of material used for each purpose shall be as herein specified, and material shall conform to the requirements of the latest standard specifications of the "ASTM" for that particular material.
- B. All materials and equipment shall be listed, labeled, or certified by a nationally recognized testing laboratory to meet Underwriters Laboratories, Inc., standards where test standards have been established.
 1. Equipment and materials which are not covered by UL Standards will be accepted provided equipment and material is listed, labeled, certified, or otherwise determined to meet safety requirements of a nationally recognized testing laboratory.
 2. Equipment of a class which no nationally recognized testing laboratory accepts, certifies, lists, labels, or determines to be safe, will be considered if inspected or tested in accordance with national industrial standards, such as NEMA, or ANSI. Evidence of compliance shall include certified test reports and definitive shop drawings.
- C. The installation work included in this specification shall be performed in a neat workmanlike manner by persons experienced and skilled in the Electrical trade. Only the best quality workmanship will be accepted. All exposed parts of the electrical wiring systems such as exposed conduits, flush plates, cabinet trims, fixtures, etc., shall be square and true with the building construction.

1.10 COORDINATION OF WORK

- A. The Mechanical and Electrical Contractors and their Subcontractors shall have coordination meetings to facilitate the installation of equipment, ducts, pipes, electrical panels and equipment, and other miscellaneous equipment. The Mechanical Contractor and Electrical Contractor shall coordinate the location of all equipment during the coordination meetings to prevent interferences between equipment of different systems. Any conflicts that may be discovered during the coordination meetings shall be brought to the immediate attention of the Engineer.
- B. The Contractor shall order equipment and materials in a timely manner and shall be responsible for close correlation of the work with that of all other Contractors on this project so that it will not interfere with or delay the work of other Contractors. The Contractor shall confer and cooperate with all other Contractors on this project and shall arrange the work in proper relation to the work of others.

1.11 RECORD DRAWINGS AND OPERATING AND MAINTENANCE MANUALS

- A. Record Drawings:
 1. The Contractor shall keep a complete set of all electrical drawings in the jobsite office for purpose of showing the installation of electrical systems and equipment. This set of drawings shall be used for no other purpose. Where any materials equipment or system

components are installed different from that shown on the Architect/Engineer's drawings, such differences shall be clearly and neatly shown on this set of drawings using ink or indelible pencil. At the completion of the project, the record set of drawings shall be turned over to the Architect/Engineer and shall become his property.

- a. Incorporate all changes made by addendum, shop drawing review, change order, and field orders.

B. Operating and Maintenance Manuals:

1. The Contractor shall furnish the Owner with two (2) sets of complete catalog data (approved shop drawings), manufacturer's literature and detailed manuals covering the operation and maintenance of all equipment specified under this Division.
 - a. Comply with Division 1 requirements.
 - b. The manual shall indicate the Contractor's name, address, and phone number and include a list of all Subcontractors, including company name, address, and telephone number.
 - c. The manual shall include, but not be limited to, the following: Installation instructions; maintenance and overhaul instructions; procedures for start, operation, and shut down of equipment and systems; complete wiring and control diagrams; cleaning of lighting fixtures lenses and other equipment; safety precautions; diagrams and illustrations; manufacturers' name and catalog data; test procedures; name and address of authorized service organizations; and parts distributor for all material and equipment installed. Include all special warranty statements for all special warranties required by contract documents.
 - d. The manual shall include a complete inventory list of all extra materials which are specified to be provided in the Contract.
 - e. All such literature shall be bound in an amply sized three-ring binder with table of contents and tabbed sections separating and identifying the sections of the manual.
2. The Contractor shall supervise the initial operation of all equipment and instruct the Owner's designated operator or maintenance representative in such operation as to acquaint the operator thoroughly with the equipment.

C. Testing:

1. Work which is required to be placed within the construction or concealed shall be carefully tested and inspected before being permanently concealed.
2. The Contractor shall provide all testing instruments, equipment, and all materials, connections, labor, etc., required to perform tests.
3. Test all circuits, fixtures, equipment, and systems for proper operation and freedom from grounds, shorts, and open circuits before acceptance is requested.
4. Provide complete operational sequence checkout to verify all modes of operation both normal and alarm for each system. Test all control systems that interact with each other as a complete system to demonstrate that all interconnections and interactions are correct and that all interconnect wiring is functional.
5. Perform all tests required by local authorities, such as tests of life safety systems, in addition to tests specified herein. Perform tests required by other specification sections.
6. Tests shall be made in the presence of the Engineer and the Owner, and shall meet with their approval. The Contractor shall notify the Engineer at a time sufficiently prior to the performance of any test to allow time for the engineer to be present for the test.
7. The entire system shall be subject to a test at full operating and under normal usage conditions. This shall include voltage and current checks, resistance measurements, and equipment operation. Failure of any phase of system operation shall constitute failure of the system. Correct failures and retest system. Repeat until the system is operating to required specifications.

- a. Submit dated "Electrical System Test Reports" indicating all tests performed and demonstrating conformance with the required system performance criteria in tabular form.
8. After testing the apparatus, the entire system shall be operated for one week under normal conditions.
9. The final testing shall be performed as soon as possible after the work is entirely completed.

1.12 FINAL INSPECTION

- A. Upon completion of the work, the Contractor shall notify the Architect and/or Engineer and make arrangements for a final inspection. The Contractor shall submit the operation and maintenance manuals prior to the final inspection; the Engineer will not schedule nor perform a final inspection without successful submittal of operating and maintenance manuals by the Contractor.
 1. During the final inspection and subsequent follow-up final inspection, the Contractor and all major Sub-Contractors shall have the foreman of the project present.
- B. After the Engineer's final inspection is made, the Contractor will receive a list of items requiring adjustment, correction, replacement, or completion.
- C. The Contractor shall comply completely with all the listed requirements within thirty (30) days of receipt of the list. Should the Contractor fail to perform within this time limit, the Owner reserves the right to have the work completed by others and the cost deducted from the contract price.
- D. The Contractor shall notify the Architect and/or Engineer once all listed requirements are completed, that the Contractor is ready for a follow-up final inspection. The written notice shall contain explanations for those known items not completed and a schedule for completing them.
- E. The Architect and/or Engineer shall schedule a follow-up final inspection to confirm completion of all listed requirements. Repeated inspection trips required of the Engineer due to the Contractor's inability to complete the project satisfactorily will require the Contractor to reimburse the engineer for all incurred costs after the follow-up final inspection.

1.13 GUARANTEE

- A. The Contractor shall assume responsibility for any defects which may develop in any part of his work caused by faulty workmanship, material or equipment, and agrees to replace, repair, or alter, at the Contractors expense, any such faulty workmanship, material, or equipment that has been brought to the Contractors attention during a period of one year from the date of the final certificate for payment. Acceptance of the work shall not waive this guarantee.
 1. Refer to Divisions 26, 27, and 28 Specifications for additional special equipment warranties.

END OF SECTION 260100

SECTION 260500 - BASIC ELECTRICAL MATERIALS AND METHODS

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.
- B. In certain instances where the terms of this Division of the Specifications conflict with the terms of the General Conditions, or Special Conditions, this Division of the Specifications shall govern.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Supporting devices for electrical components.
 - 2. Electrical identification.
 - 3. Concrete equipment bases.
 - 4. Firestopping
 - 5. Cutting and patching for electrical construction.
 - 6. Touchup painting.

1.3 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

- A. Product Data: Include manufacturer product data sheets for underground warning tape, and firestopping materials to be utilized on this project.

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.

1.6 COORDINATION

- A. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.
 - 1. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- B. Sequence, coordinate, and integrate installing electrical materials and equipment for efficient flow of the work. Coordinate installing large equipment requiring positioning before closing in the building.
- C. Coordinate electrical service connections to components furnished by utility companies.
 - 1. Coordinate installation and connection of exterior underground and overhead utilities and services.
 - 2. Comply with requirements of authorities having jurisdiction and of utility company providing electrical power and other services.
- D. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."
- E. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- F. Where electrical identification markings and devices will be concealed by acoustical ceilings and similar finishes, coordinate installation of these items before ceiling installation.

PART 2 - PRODUCTS

2.1 SUPPORTING DEVICES

- A. Material: Cold-formed steel, with corrosion-resistant coating acceptable to authorities having jurisdiction.
- B. Metal Items for Use Outdoors or in Damp Locations: Hot-dip galvanized steel.
- C. Slotted-Steel Channel Supports: Flange edges turned toward web, and 9/16-inch- (14-mm-) diameter slotted holes at a maximum of 2 inches (50 mm) o.c., in webs.
 - 1. Channel Thickness: Selected to suit structural loading.
 - 2. Fittings and Accessories: Products of the same manufacturer as channel supports.
- D. Raceway and Cable Supports: Manufactured clevis hangers, riser clamps, straps, threaded C-clamps with retainers, ceiling trapeze hangers, wall brackets, and spring-steel clamps or click-type hangers. Wire hangers shall not be utilized for supporting raceway or boxes (except for

supporting raceways installed within steel stud walls where raceways are supported from the studs).

- E. Pipe Sleeves: ASTM A 53, Type E, Grade A, Schedule 40, galvanized steel, plain ends.
- F. Cable Supports for Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug for non-armored electrical cables in riser conduits. Plugs have number and size of conductor gripping holes as required to suit individual risers. Body constructed of malleable-iron casting with hot-dip galvanized finish.
- G. Expansion Anchors: Carbon-steel wedge or sleeve type.
- H. Toggle Bolts: All-steel springhead type.

2.2 ELECTRICAL IDENTIFICATION

- A. Identification Devices: A single type of identification product for each application category. Use colors prescribed by ANSI A13.1, NFPA 70, and these Specifications.
- B. Colored Adhesive Marking Tape for Raceways: Self-adhesive vinyl tape, not less than 1 inch wide by 3 mils thick (25 mm wide by 0.08 mm thick).
- C. Underground Warning Tape: Permanent, bright-colored, continuous-printed, vinyl tape with the following features:
 - 1. Not less than 6 inches wide by 4 mils thick (150 mm wide by 0.102 mm thick).
 - 2. Compounded for permanent direct-burial service.
 - 3. Embedded continuous metallic strip or core.
 - 4. Printed legend that indicates type of underground line.
- D. Tape Markers for Wire and Cables: Vinyl or vinyl-cloth, self-adhesive, wraparound type with preprinted numbers and letters.
- E. Color-Coding Cable Ties: Type 6/6 nylon, self-locking type. Colors to suit coding scheme.
- F. Engraved-Plastic Labels, Signs, and Instruction Plates: Engraving stock, melamine plastic laminate punched or drilled for mechanical fasteners 1/16-inch (1.6-mm) minimum thickness for signs up to 20 sq. in. (129 sq. cm) and 1/8-inch (3.2-mm) minimum thickness for larger sizes. Engraved legend in black letters on white background.
- G. Interior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Preprinted, aluminum, baked-enamel-finish signs, punched or drilled for mechanical fasteners, with colors, legend, and size appropriate to the application.
- H. Exterior Warning and Caution Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145. Weather-resistant, non-fading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm), galvanized-steel backing, with colors, legend, and size appropriate to the application. 1/4-inch (6-mm) grommets in corners for mounting.
- I. Fasteners for Nameplates and Signs: Self-tapping, stainless-steel screws or No. 10/32 stainless-steel machine screws with nuts and flat and lock washers.

2.3 CONCRETE BASES

- A. Concrete Forms and Reinforcement Materials: As specified in Division 3 Section "Cast-in-Place Concrete."
- B. Concrete: 3000-psi, 28-day compressive strength as specified in Division 3 Section "Cast-in-Place Concrete."

2.4 FIRESTOPPING

- A. Conduit, cable penetrations, and any other electrical equipment penetrations of fire rated construction, equipment rooms, and/or where designated on the Drawings shall be sealed with a fire retardant sealant similar to:
 - 1. Specified Technologies, Inc. (STI) SpecSeal Series SSS Intumescent Sealant.
 - 2. STI SpecSeal Series LCI Intumescent Sealant.
 - 3. STI SpecSeal Series SST Firestop Putty.
 - 4. STI SpecSeal Series SSB Firestop Pillows.
 - 5. STI Pensil 200 Silicone Foam.
 - 6. STI EZ-PATH Fire Rated Pathway or Hilti Speed Sleeve.
- B. Fire sealants shall be Specified Technologies, Inc., 3M Fire Protection Products, A/D Fire Protection Systems, Inc., Hilti Inc., Nelson Firestop Products, or equal.
 - 1. Firestopping materials shall be low VOC.
- C. Obtain through-penetration firestop systems from a single manufacturer with experienced installers having the necessary experience, staff, and training to install manufacturer's products per project requirements.

2.5 TOUCHUP PAINT

- A. For Equipment: Equipment manufacturer's paint selected to match installed equipment finish.
- B. Galvanized Surfaces: Zinc-rich paint recommended by item manufacturer.

PART 3 - EXECUTION

3.1 ELECTRICAL EQUIPMENT INSTALLATION

- A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction
- B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.
- C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide the maximum possible headroom.

- D. Equipment Rooms: Line walls where electrical equipment is to be mounted with ¾” plywood backboards. Paint backboards with two coats of low VOC gray fire retardant paint.
 - 1. Where equipment is installed in rooms being used as return air plenums, electrical equipment shall be mounted to Hoover Treated Wood Products Pyro-Guard backboards.
- E. Mount panelboards, contactors, and other electrical equipment on backboards, unless otherwise indicated.
- F. Materials and Components: Install level, plumb, and parallel and perpendicular to other building systems and components, unless otherwise indicated.
- G. Equipment: Install to facilitate service, maintenance, and repair or replacement of components. Connect for ease of disconnecting, with minimum interference with other installations.
- H. Right of Way: Give to raceways and piping systems installed at a required slope.

3.2 ELECTRICAL SUPPORTING DEVICE APPLICATION

- A. Damp Locations and Outdoors: Hot-dip galvanized materials or nonmetallic, U-channel system components.
- B. Dry Locations: Steel materials.
- C. Support Clamps for PVC Raceways: Click-type clamp system.
- D. Selection of Supports: Comply with manufacturer's written instructions.
- E. Strength of Supports: Adequate to carry present and future loads, times a safety factor of at least four; minimum of 200-lb (90-kg) design load.

3.3 SUPPORT INSTALLATION

- A. Install support devices to securely and permanently fasten and support electrical components.
 - 1. Wire hangers are not an acceptable support component for supporting raceways and boxes (except for supporting raceways installed within steel stud walls where raceways are supported from the studs).
 - 2. Nothing shall rest on, or depend for support on, suspended ceilings (tiles, lath, plaster, as well as splines, runners, bars, and the like in the plane of the ceiling).
 - 3. Support raceways at intervals no greater than ten feet and with one support within three feet of each coupling, box, fitting, or outlet box. Provide one support within three feet of each elbow or bend.
- B. Install individual and multiple raceway hangers and riser clamps to support raceways. Provide U-bolts, clamps, attachments, and other hardware necessary for hanger assemblies and for securing hanger rods and conduits.
- C. Support parallel runs of horizontal raceways together on trapeze- or bracket-type hangers.

- D. Size supports for multiple raceway installations so capacity can be increased by a 25 percent minimum in the future.
- E. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- F. Install 1/4-inch- (6-mm-) diameter or larger threaded steel hanger rods, unless otherwise indicated.
- G. Spring-steel fasteners specifically designed for supporting single conduits or tubing may be used instead of malleable-iron hangers for 1-1/2-inch (38-mm) and smaller raceways serving lighting and receptacle branch circuits above suspended ceilings and for fastening raceways to slotted channel and angle supports.
- H. Arrange supports in vertical runs so the weight of raceways and enclosed conductors is carried entirely by raceway supports, with no weight load on raceway terminals.
- I. Simultaneously install vertical conductor supports with conductors.
- J. Separately support cast boxes that are threaded to raceways and used for fixture support. Support sheet-metal boxes directly from the building structure or by bar hangers. If bar hangers are used, attach bar to raceways on opposite sides of the box and support the raceway with an approved fastener not more than 24 inches (610 mm) from the box.
- K. Install metal channel racks for mounting cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices unless components are mounted directly to structural elements of adequate strength.
- L. Install sleeves for cable and raceway penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable and raceway penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls.
- M. Securely fasten electrical items and their supports to the building structure, unless otherwise indicated. Perform fastening according to the following unless other fastening methods are indicated:
 - 1. Wood: Fasten with wood screws or screw-type nails.
 - 2. Masonry: Toggle bolts on hollow masonry units and expansion bolts on solid masonry units.
 - 3. New Concrete: Concrete inserts with machine screws and bolts.
 - 4. Existing Concrete: Expansion bolts.
 - 5. Steel: Welded threaded studs or spring-tension clamps on steel.
 - a. Field Welding: Comply with AWS D1.1.
 - 6. Welding to steel structure may be used only for threaded studs, not for conduits, pipe straps, or other items.
 - 7. Light Steel: Sheet-metal screws.
 - 8. Fasteners: Select so the load applied to each fastener does not exceed 25 percent of its proof-test load.

3.4 IDENTIFICATION MATERIALS AND DEVICES

- A. Install at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Coordinate names, abbreviations, colors, and other designations used for electrical identification with corresponding designations indicated in the Contract Documents or required by codes and standards. Use consistent designations throughout Project.
- C. Self-Adhesive Identification Products: Clean surfaces before applying. Self adhesive identification products are not approved for electrical equipment enclosure labels.
- D. Tag and label circuits. Identify source and circuit numbers in each cabinet, pull and junction box, and receptacle outlet box. Color-coding may be used for voltage and phase identification. Neatly mark junction box covers (outside of box where concealed in building finishes or in unfinished spaces, inside of box in finished public spaces) with voltage, source and circuit numbers with permanent black marker.
 - 1. Feeder and Power Circuit Identification: Use plasticized card stock for cables, feeders, and power circuits in pull boxes and electrical rooms.
 - a. Legend: ¼" steel letter and number stamping or embossing with legend corresponding to indicated circuit designations.
 - b. Fasten tags with nylon cable ties, fasten bands using integral ears.
 - 2. Apply identification to conductors as follows:
 - a. Multiple Power or Lighting Circuits in the Same Enclosure: Identify each conductor with source, voltage, circuit number, and phase. Use color coding for voltage and phase indication of secondary circuit.
 - b. Multiple Control or Communications Circuits in the Same Enclosure: Identify each conductor by its system and circuit designation. Use a consistent system of tags, color coding, or cable marking type.
- E. Equipment Identification: Apply equipment identification labels of engraved plastic laminate on each major piece of equipment. This includes communication, signal, and alarm systems, unless units are specified with their own self-explanatory identification. Provide labels for the following types of equipment.
 - 1. Switchboards, distribution panels, panelboards, and electrical enclosures.
 - 2. Access doors and panels for concealed electrical items.
 - 3. Enclosed controllers, indicate which motor or piece of equipment the unit is serving.
 - 4. Enclosed switches and circuit breakers, indicate which motor or piece of equipment the unit is serving.
 - 5. Service Equipment: Service equipment in other than dwelling units shall be legibly marked in the field with the maximum available fault current. The field marking(s) shall include the date the fault current calculation was performed.
 - 6. Lighting control panels and contactors.
 - 7. Transformers.
 - 8. Fire alarm control panel.
 - 9. Paging Intercom and Sound system equipment racks.
- F. Install continuous underground warning tape during trench backfilling, for exterior underground power, control, signal, and communication lines, locate marker directly above power and communication lines. Locate approximately 8 inches below finished grade. If width of

multiple lines installed in a common trench or concrete envelope does not exceed 16 inches (400 mm), overall, use a single line marker.

- G. Color-code 208/120-V system secondary service, feeder, and branch-circuit conductors throughout the secondary electrical system as follows:
 - 1. Phase A: Match existing.
 - 2. Phase B: Match existing.
 - 3. Phase C: Match existing.
- H. Install warning, caution, and instruction signs where required to comply with 29 CFR, Chapter XVII, Part 1910.145, and where needed to ensure safe operation and maintenance of electrical systems and of items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.
- I. Install engraved-laminated emergency-operating signs with white letters on red background with minimum 3/8-inch- (9-mm-) high lettering for emergency instructions on power transfer, load shedding, and other emergency operations.

3.5 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 2 inches larger, in both directions, than supported unit. Follow supported equipment manufacturer's anchorage recommendations and setting templates for anchor-bolt and tie locations, unless otherwise indicated. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."
- B. The Electrical Contractor shall size and provide the concrete and installation associated with the following items as called out elsewhere in the plans and specifications:
 - 1. Utility Transformer Pad.
 - 2. Dry-Type Transformer Pads.
 - 3. Switchboard Pads.
 - 4. Light Pole Bases.
 - 5. Exterior Grade Mounted Light Fixtures.
- C. Provide "house keeping pads" for all floor mounted electrical components, including transformers, switchboards, distribution boards, and motor controls centers. Pads shall be a minimum of 4" thick and comply with parts 2 and 3 of this specification section.

3.6 FIRESTOPPING

- A. Apply firestopping to cable and raceway penetrations of fire-rated floor and wall assemblies to achieve fire-resistance rating of the assembly.

3.7 CUTTING AND PATCHING

- A. Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces required to permit electrical installations. Perform cutting by skilled mechanics of trades involved.

- B. Repair and refinish disturbed finish materials and other surfaces to match adjacent undisturbed surfaces. Install new fireproofing where existing firestopping has been disturbed. Repair and refinish materials and other surfaces by skilled mechanics of trades involved.

3.8 FIELD QUALITY CONTROL

- A. Inspect installed components for damage and faulty work, including the following:
 - 1. Supporting devices for electrical components.
 - 2. Electrical identification.
 - 3. Concrete bases.
 - 4. Firestopping materials.
 - 5. Cutting and patching for electrical construction.
 - 6. Touchup painting.

3.9 REFINISHING AND TOUCHUP PAINTING

- A. Refinish and touch up paint. Paint materials and application requirements are specified in Division 9 Section "Painting."
 - 1. Clean damaged and disturbed areas and apply primer, intermediate, and finish coats to suit the degree of damage at each location.
 - 2. Follow paint manufacturer's written instructions for surface preparation and for timing and application of successive coats.
 - 3. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 4. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

3.10 CLEANING AND PROTECTION

- A. On completion of installation, including outlets, fittings, and devices, inspect exposed finish. Remove burrs, dirt, paint spots, and construction debris.
- B. Protect equipment and installations and maintain conditions to ensure that coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

END OF SECTION 260500

SECTION 260600 - GROUNDING AND BONDING

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 grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Product Data: For the following:
 - 1. Ground rods.

1.4 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. Comply with UL 467.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Grounding Conductors, Cables, Connectors, and Rods:
 - a. Chance/Hubbell.
 - b. Copperweld Corp.
 - c. Erico Inc.; Electrical Products Group.
 - d. ILSCO.
 - e. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - f. Raco, Inc.; Division of Hubbell.

- g. Superior Grounding Systems, Inc.
- h. Thomas & Betts, Electrical.

2.2 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section "Conductors and Cables."
- B. Equipment Grounding Conductors: Insulated with green-colored insulation.
- C. Grounding Electrode Conductors: Stranded copper cable, #4 AWG minimum.
- D. Underground Conductors: Bare, tinned, stranded copper, unless otherwise indicated.
- E. Bare Copper Conductors: Comply with the following:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Assembly of Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
- F. Copper Bonding Conductors: As follows:
 - 1. Bonding Cable: Minimum size of 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch (6.4 mm) in diameter.
 - 2. Bonding Conductor: Minimum size of No. 6AWG, stranded copper conductor.
 - 3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; minimum size of 1-5/8 inches (42 mm) wide and 1/16 inch (1.5 mm) thick.
- G. Grounding Bus: Bare, annealed copper bars of rectangular cross section, with insulators.

2.3 CONNECTOR PRODUCTS

- A. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Bolted Connectors: Bolted-pressure-type connectors, or compression type.
- C. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

2.4 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Multiple Disconnecting Means Enclosures: Comply with NEC article 250.64(D).
- B. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
- C. In raceways, use insulated equipment grounding conductors.
- D. Exothermic-Welded Connections: Use for connections to structural steel and for underground connections, except those at test wells.
- E. Equipment Grounding Conductor Terminations: Use bolted pressure clamps.
- F. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Use insulated spacer; space 1 inch (25.4 mm) from wall and support from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
- G. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches (600 mm) below grade or bury 12 inches (300 mm) above duct bank when installed as part of the duct bank.

3.2 EQUIPMENT GROUNDING CONDUCTORS

- A. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
- B. Install equipment grounding conductors in all feeders and branch circuits.
 - 1. Bond the grounding conductor to each pullbox, junction box, outlet box, cabinets, and other enclosure through which the ground conductor passes.
- C. Nonmetallic Raceways: Install an equipment grounding conductor in nonmetallic raceways unless they are designated for telephone or data cables.
- D. Air-Duct Equipment Circuits: Install an equipment grounding conductor to duct-mounted electrical devices operating at 120V and more, including air cleaners and heaters. Bond conductor to each unit and to air duct.
- E. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and antifrost heating cable. Bond conductor to heater units, piping, connected equipment, and components.

- F. Signal and Communication Systems: For telephone, alarm, voice and data, and other communication systems, provide No. 6 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 (6.4-by-50-by-300-mm) grounding bus.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

3.3 INSTALLATION

- A. Ground Rods: 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.
 - 1. Drive ground rods until tops are 2 inches (50 mm) below finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductors. Use exothermic welds, except at test wells and as otherwise indicated. Make connections without exposing steel or damaging copper coating.
- B. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- C. Bonding Straps and Jumpers: Install so vibration by equipment mounted on vibration isolation hangers and supports is not transmitted to rigidly mounted equipment. Use exothermic-welded connectors for outdoor locations, unless a disconnect-type connection is required; then, use a bolted clamp. Bond straps directly to the basic structure taking care not to penetrate any adjacent parts. Install straps only in locations accessible for maintenance.
- D. Electrical Utility Service: Provide grounding and bonding at Utility Company's metering equipment and pad-mounted transformer in accordance with Utility Company's requirements.
- E. Metal Water Service Pipe: Provide 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 by grounding clamp connectors. Where a dielectric main water fitting is installed, connect grounding conductor to street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
- F. Water Meter and Filter Piping: Use braided-type bonding jumpers to electrically bypass water meters, filters or other serviceable equipment. Connect to pipe with grounding clamp connectors.
- G. Bond interior metal piping systems and metal air ducts to equipment grounding conductors of associated pumps, fans, blowers, electric heaters, and air cleaners. Use braided-type bonding straps.
- H. Bond each aboveground portion of gas piping system upstream from equipment shutoff valve.
- I. Bond metal water piping systems in accordance with NEC Article 250.104.

- J. Bond the grounding electrode system to the structural steel of building, if any, using exothermic weld. Coordinate work with the General Contractor.
- K. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NEC Article 250, using a minimum of **20 feet (6 m)** of bare copper conductor not smaller than No. 4 AWG. If concrete foundation is less than **20 feet (6 m)** long, coil excess conductor within the base of the foundation. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to a grounding electrode external to concrete. Coordinate work with the General Contractor.
- L. See grounding detail on the drawings.

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact. Remove all point from points of contact prior to making connections.
 - 3. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
- B. Exothermic-Welded Connections: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
- E. Tighten screws and bolts for grounding and bonding 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.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
1. After installing grounding system but before permanent electrical circuitry has 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, and at ground test wells. Measure ground resistance not less than two full days after the last trace of precipitation, and without the 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. Perform tests, by the fall-of-potential method according to IEEE 81.
 3. Measure ground resistance from the system neutral connection at the service entrance to convenient ground reference point using suitable ground testing equipment. Resistance shall not exceed 5 ohms.
 4. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

3.6 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil, fertilizer, lime, seed, sod, sprig, and mulch. Comply with Division 32 Section "Turf and Grasses." Maintain restored surfaces. Restore disturbed paving as indicated.

END OF SECTION 260600

SECTION 261200 - CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes building wires and cables and associated connectors, splices, and terminations for wiring systems rated 600 V and less.

1.3 SUBMITTALS

- A. Product Data: For heat trace cables and controls.
- B. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Listing and Labeling: Provide wires and cables specified in this Section that are listed and labeled.
 - 1. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
 - 2. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.
- B. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver wires and cables according to NEMA WC 26.

1.6 COORDINATION

- A. Coordinate layout and installation of cables with other installations.
- B. Revise locations and elevations from those indicated, as required to suit field conditions and as approved by Architect.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Wires and Cables:
 - a. American Insulated Wire Corp.; Leviton Manufacturing Co.
 - b. BICC Brand-Rex Company.
 - c. Carol Cable Co., Inc.
 - d. Senator Wire & Cable Company.
 - e. Southwire Company.
 - 2. Connectors for Wires and Cables:
 - a. AMP Incorporated.
 - b. General Signal; O-Z/Gedney Unit.
 - c. Square D Co.; Anderson.
 - d. 3M Company; Electrical Products Division.

2.2 BUILDING WIRES AND CABLES

- A. UL-listed building wires and cables with conductor material, insulation type, cable construction, and rating as specified in Part 3 "Wire and Insulation Applications" Article.
- B. Thermoplastic Insulation Material: Comply with NEMA WC-70 (ICEA S-95-658).
- C. Cross-Linked Polyethylene Insulation Material: Comply with NEMA WC-70 (ICEA S-95-658).
- D. Ethylene Propylene Rubber Insulation Material: Comply with NEMA WC-70 (ICEA S-95-658).
- E. Conductor Material: Copper, except feeders and services larger than 80 amps may be aluminum AA-8000.
- F. Stranding: Solid conductor for No. 12 AWG and smaller; stranded conductor for No. 8 AWG and larger. No. 10 AWG to be either solid or stranded (contractor's option).

2.3 CONNECTORS AND SPLICES

- A. UL-listed, factory-fabricated wiring connectors of size, ampacity rating, material, type, and class for application and service indicated. Comply with Project's installation requirements and as specified in Part 3 "Wire and Insulation Applications" Article.

- B. All branch circuit wiring connections shall be made using wire nut connectors which provide direct wire to wire contact. Connectors which utilize insulation displacement, intermediate metal or spring compression connection are not acceptable.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine raceways and building finishes receiving wires and cables for compliance with requirements for installation tolerances and other conditions affecting performance of wires and cables. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 WIRE AND INSULATION APPLICATIONS

- A. Feeders: Type THHN/THWN, in raceway.
- B. Branch Circuits: Type THHN/THWN, in raceway.
- C. Fire Alarm Circuits: Power-limited, fire-protective, signaling circuit cable, in raceway.
- D. Fire Alarm Circuits: Type THHN/THWN, in raceway.
- E. Class 1 Control Circuits: Type THHN/THWN, in raceway.
- F. Class 2 Control Circuits: Power-limited cable, concealed in building finishes or in raceway where installed exposed in finished public spaces.

3.3 INSTALLATION

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
- B. Unless otherwise noted or shown on the drawings, a maximum of three circuits (three phase conductors, neutrals, and ground) shall be allowed in a single home run raceway.
- C. Multiwire Branch Circuits: Sharing of neutrals is not allowed, provided dedicated neutral for each branch circuit.
- D. Rooftop Circuits: Where conduits are installed exposed on rooftops, apply additional temperature adjustments listed in the NEC table 310.15(B)(2)(c) to ambient temperature correction factors listed in NEC table 310.16.
- E. Wire size on 120 volt, 20 ampere branch circuit home run conductors over 75 feet in length (from the closest wiring device at the home run designation to the associated panelboard shown on the electrical drawing sheets), shall be increased to No. 10 AWG (minimum) to limit excessive voltage drop.
- F. All corridor lighting branch circuits shall be increased to No. 10 AWG (minimum) through-out to limit excessive voltage drop.

- G. All exterior lighting branch circuits shall be increased to No. 10 AWG (minimum) through-out to limit excessive voltage drop.
- H. All lighting branch circuit home run conductors shall be increased to No. 10 AWG (minimum) (from the last light fixture at the home run designation shown on the electrical drawing sheets to the associated panelboard) to limit excessive voltage drop.
- I. Pull Conductors: 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.
- J. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage cables or raceway.
- K. Install exposed cables, parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- L. Support cables according to Division 26 Section "Basic Electrical Materials and Methods."
- M. Seal around cables penetrating fire-rated elements according to 260500 and Division 7 Section "Firestopping."
- N. Identify wires and cables according to Division 26 Section "Basic Electrical Materials and Methods."

3.4 CONNECTIONS

- A. Conductor Splices: Keep to minimum.
- B. Install splices and tapes that possess equivalent or better mechanical strength and insulation ratings than conductors being spliced.
- C. Use splice and tap connectors compatible with conductor material.
- D. Wiring at Outlets: Install pigtail conductor at each outlet, with at least 8 inches of slack. Where multiple sets of conductors enter a box, provide 8" pigtails to devices and make connections such that the continuity of the branch circuit conductors is not dependent upon device connections and the continuing load is not routed through the device. All unused device terminal screws shall be turned completely in, provide two full wraps of electrical tape around all device terminals. On 20 amp circuits where #10 AWG conductors are required for home runs, provide #12 AWG solid pigtails for connection to device.
- E. Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer.
- F. 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.

3.5 FIELD QUALITY CONTROL

- A. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection test stated in NETA ATS, Section 7.3.
- B. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

END OF SECTION 261200

SECTION 261300 - RACEWAYS AND BOXES

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 raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

1.3 SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

1.4 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.

1.5 COORDINATION

- A. Coordinate layout and installation of raceways, boxes, enclosures, cabinets, and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Electrical Contractor shall furnish and install embedded electrical conduit, electrical box assemblies, and required hardware into the precast wall panels. The Electrical Contractor will provide locations on the precast shop drawing submittal and tradesmen in the precast production plant for this scope of work. Precast Supplier will provide coordination and production schedule with dates for each individual panel requiring electrical so the Electrical Contractor can schedule their workforce accordingly.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

- A. Manufacturers: Subject to compliance with requirements, provide products one of the following:

1. AFC Cable Systems, Inc.
2. Alflex Inc.
3. Anamet Electrical, Inc.; Anaconda Metal Hose.
4. Electri-Flex Co.
5. Grinnell Co./Tyco International; Allied Tube and Conduit Div.
6. LTV Steel Tubular Products Company.
7. Manhattan/CDT/Cole-Flex.
8. O-Z Gedney; Unit of General Signal.
9. Shamrock Steel.
10. Wheatland Tube Co.

B. Rigid Steel Conduit: ANSI C80.1.

C. IMC: ANSI C80.6.

D. PVC Coated Rigid Steel Conduit: NEMA RN 1.

E. EMT and Fittings: ANSI C80.3.

1. Fittings: Steel, set-screw or compression type with insulated bushings for protection of conductors. Diecast fittings are not approved.

F. FMC: Zinc-coated steel.

G. LFMC: Flexible steel conduit with PVC jacket.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American International.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corp.
4. Cantex Inc.
5. Certainteed Corp.; Pipe & Plastics Group.
6. Condux International.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT/Cole-Flex.
11. RACO; Division of Hubbell, Inc.
12. Spiralduct, Inc./AFC Cable Systems, Inc.
13. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Schedule 40 and Schedule 80 PVC.

C. RNC Fittings: NEMA TC 3; match to conduit or tubing type and material.

D. LFNC: UL 1660.

2.3 METAL WIREWAYS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hoffman.
 - 2. Square D.
 - 3. Mono Systems, Inc.
- B. Material and Construction: Sheet metal sized and shaped as indicated, NEMA 1.
- 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. Select features, unless otherwise indicated, as required to complete wiring system and to comply with NFPA 70.
- E. Wireway Covers: Screw-cover type.
- F. Finish: Manufacturer's standard enamel finish.

2.4 SURFACE RACEWAYS

- A. Surface Metal Raceways: Galvanized steel with snap-on covers. Finish with manufacturer's standard prime coating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Airey-Thompson Sentinel Lighting; Wiremold Company (The).
 - b. Thomas & Betts Corporation.
 - c. Mono-Systems, Inc.
 - d. Walker Systems, Inc.; Wiremold Company (The).
 - e. Wiremold Company (The); Electrical Sales Division.
- B. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways.

2.5 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. Emerson/General Signal; Appleton Electric Company.
 - 3. Erickson Electrical Equipment Co.
 - 4. Hoffman.
 - 5. Hubbell, Inc.; Killark Electric Manufacturing Co.
 - 6. O-Z/Gedney; Unit of General Signal.
 - 7. RACO; Division of Hubbell, Inc.

8. Robroy Industries, Inc.; Enclosure Division.
 9. Scott Fetzer Co.; Adalet-PLM Division.
 10. Spring City Electrical Manufacturing Co.
 11. Thomas & Betts Corporation.
 12. Walker Systems, Inc.; Wiremold Company (The).
 13. Woodhead, Daniel Company; Woodhead Industries, Inc. Subsidiary.
- B. Outlet boxes shall be galvanized steel standard electrical type with knockout openings as required.
 - C. Outlet boxes shall be at least 1-1/2" deep, single or gang style type of sized to accommodate devices noted. Outlet boxes in masonry walls may be special masonry type. Outlet boxes on exposed conduit runs in unfinished areas and equipment rooms shall be 4" square or multi-gang boxes with matching raised covers. Outlet boxes on exposed conduit runs in finished areas or where indicated, shall be cast FS type.
 1. Outlet boxes for communications outlets shall be a minimum of 2-1/8" deep.
 - D. Exterior outlet boxes shall be cast aluminum type with weatherproof cover and gasket. Outlet boxes for receptacle devices shall be provided with grounding lead lug or screw.
 - E. Outlet boxes installed in plaster, plasterboard, acoustic tile, or paneled surfaces shall be provided with plaster rings, except 4" octagonal ceiling boxes. Outlet boxes installed in masonry, tile, or concrete surfaces shall be provided with square corner type extension rings where special masonry boxes are not used.
 - F. Outlet boxes noted as WP (weatherproof) shall be a flush or surface (as noted) FS type box with at least 4 machine screw connections for a gasketed device or cover.
 - G. Sheet Metal Outlet and Device Boxes: NEMA OS 1.
 - H. Cast-Metal Outlet and Device Boxes: NEMA FB 1, Type FD, with gasketed cover.
 - I. Nonmetallic Outlet and Device Boxes: NEMA OS 2.
 - J. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
 - K. Cast-Metal Pull and Junction Boxes: NEMA FB 1, cast aluminum with gasketed cover.
 - L. Provide wall plates for all unused outlet and device boxes. Wall plates shall comply with section 261400.
 - M. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous hinge cover and flush latch.
 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Provide backplate and grounding as required by the authority having jurisdiction for installation of indicated equipment.
 - N. Cabinets: NEMA 250, Type 1, galvanized steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel. Hinged door in front cover with flush latch and concealed hinge. Key latch to match panelboards. Include metal barriers to separate wiring of different systems and voltage and include accessory feet where required for freestanding equipment.

2.6 FACTORY FINISHES

- A. Finish: For raceway, enclosure, or cabinet components, provide manufacturer standard paint applied to factory-assembled surface raceways, enclosures, and cabinets before shipping.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. ENT – Electrical Non-metallic Tubing is not acceptable for use anywhere on this project.
- B. Outdoors:
 - 1. Exposed: Rigid steel or IMC.
 - 2. Concealed: Rigid steel or IMC.
 - 3. Underground, Single Run: RNC, see installation for additional requirements.
 - 4. Underground, Grouped: RNC, see installation for additional requirements.
 - 5. Underslab: RNC, see installation for additional requirements.
 - 6. Embedded in slab: Rigid steel.
 - 7. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 8. Boxes and Enclosures: NEMA 250, Type 3R.
- C. Indoors:
 - 1. Exposed: EMT.
 - 2. Concealed: EMT.
 - 3. Underslab: RNC, see installation for additional requirements.
 - 4. Embedded in slab: Rigid steel.
 - 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: Rigid steel conduit.
 - 7. Boxes and Enclosures: NEMA 250, Type 1, except as follows:
 - a. Damp or Wet Locations: NEMA 250, Type 4, nonmetallic.
- D. Minimum Raceway Size: ½-inch trade size (DN16), except home runs from the closest wiring device or light fixture at the home run designation to the associated panelboard shown on the electrical drawing sheets shall be ¾-inch (minimum) trade size (DN21).
- E. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Intermediate Steel Conduit: Use threaded rigid steel conduit fittings with insulated bushings, unless otherwise indicated.
 - 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings approved for use with that material. Patch all nicks and scrapes in PVC coating after installing conduits.

3.2 INSTALLATION

- A. Install raceways, boxes, enclosures, and cabinets as indicated and in accordance to manufacturer's written instruction.
1. Keep raceways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
 2. Install raceways level and square and at proper elevations. Provide adequate headroom.
 3. Complete raceway installation before starting conductor installation.
 4. Support raceways as specified in Division 26 Section "Basic Electrical Materials and Methods."
 5. Install temporary closures to prevent foreign matter from entering raceways.
 6. Protect stub-ups from damage where conduits rise through floor slabs. Arrange so curved portions of bends are not visible above the finished slab. Install a metal sleeve or concrete curb to provide a 4 inch high watertight barrier.
 7. Make bends and offsets so ID is not reduced. Keep legs of bends in the same plane and keep straight legs of offsets parallel, unless otherwise indicated.
 8. Metal-corrugated sheet roof decking: Install and support so that nearest outside surface of the raceway or box is not less than 1.5" from the nearest surface of the roof decking. In addition, cables, raceways, and enclosures shall not be installed in concealed locations of metal-corrugated sheet decking type roofing. Spacing from roof decking doesn't apply to rigid metal conduit or intermediate metal conduit.
 9. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.
 - a. Install concealed raceways with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
 10. Exterior raceways:
 - a. Install a minimum 24 inches below grade.
 - b. Where multiple conduit runs are indicated, they shall be installed in the same trench.
 - c. Where raceways stub into sub-grade levels, utilize installation methods to prevent migration of water into the building interior spaces.
 - d. All 90 degree ells must be rigid steel conduit.
 - e. Transition to rigid steel conduit before the conduit is exposed.
 - f. Metallic conduit exterior or within building limits, that is in contact with earth, shall be galvanized rigid conduit with factory applied vinyl plastic coating or galvanized rigid conduit painted with heavy coat of bitumastic paint. Couplings shall be painted after assembly. Nicks in plastic coated conduit shall be painted with plastic material as recommended by the manufacturer. Where bitumastic paint is applied, the paint must be thoroughly dry prior to backfilling.
 - g. Provide warning tape in accordance with specification section 260500.
 11. Raceways underground or under slabs:
 - a. All 90 degree ells must be rigid steel conduit.
 - b. Transition to rigid steel conduit before the conduit is exposed.
 - c. Metallic conduit exterior or within building limits, that is in contact with earth, shall be galvanized rigid conduit with factory applied vinyl plastic coating or galvanized rigid conduit painted with heavy coat of bitumastic paint. Couplings shall be painted after assembly. Nicks in plastic coated conduit shall be painted with plastic material as recommended by the manufacturer. Where bitumastic paint is applied, the paint must be thoroughly dry prior to backfilling.

- d. Provide expansion fittings where conduits cross building expansion joints or where a wide temperature differential exists.
- 12. Raceways Embedded in Slabs: Install in middle 1/3 of slab thickness where practical and leave at least 1 inch (25 mm) of concrete cover.
 - a. Secure raceways to reinforcing rods to prevent sagging or shifting during concrete placement.
 - b. Space raceways laterally to prevent voids in concrete.
 - c. Run conduit larger than 1-inch trade size (DN 27) parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
 - d. Provide expansion fittings where conduits cross building expansion joints or where a wide temperature differential exists.
- 13. Install exposed raceways parallel or at right angles to nearby surfaces or structural members and follow surface contours as much as possible.
 - a. Run parallel or banked raceways together on common supports.
 - b. Make parallel bends in parallel or banked runs. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
- 14. Outlet boxes shall be concealed except where shown or noted otherwise. Outlet boxes, plaster rings or extension rings shall be installed flush with the finished surface.
- 15. Where applicable, outlet boxes for controls and operating mechanisms shall be installed to comply with ADA mounting height requirements.
- 16. Junction and Pull Boxes
 - a. Where necessary to terminate, tap-off, or redirect multiple conduit runs, provide and install appropriately sized junction boxes. Furnish and install pull boxes where necessary in the raceway system to facilitate conductor installation. Provide pull boxes to limit conduit runs to less than 150 feet and to contain no more than the equivalent of three right angle bends.
 - b. Use outlet boxes as junction boxes and pull boxes wherever possible and allowed by applicable codes. Make all boxes accessible and do not install boxes in finished areas. Mount all boxes plumb and level. Use flush mounted boxes with concealed conduits and make edges of boxes flush with the final surface.
 - c. Install boxes supported independently of conduit by attachment to the building structure or a structural member.
- 17. Join raceways with fittings designed and approved for that purpose and make joints tight.
 - a. Make raceway terminations tight. Use bonding bushings or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - b. Use insulating bushings to protect conductors.
- 18. Tighten set screws of threadless fittings with suitable tools.
- 19. Terminations:
 - a. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against box. Use two locknuts, one inside and one outside box.
 - b. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into hub so end bears against wire protection shoulder. Where chase nipples are used, align raceways so coupling is square to box; tighten chase nipple so no threads are exposed.
- 20. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.
- 21. Telephone and Signal System Raceways for free air cabling technique. 2 Inch Trade Size (DN 53) and smaller. Provide minimum $\frac{3}{4}$ inch conduit from outlet box to 8 inches above accessible lay-in ceiling system, terminate with insulated bushing. Provide empty

- conduits, appropriately sized for the application, through floors and walls, above hard ceilings, and at exposed ceiling structure locations to provide clear and smooth pathways for cabling. Coordinate cable pathway requirements with data and voice cabling contractor.
22. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with UL-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:
 - a. Service entrance conduits.
 - b. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - c. Where conduits enter or exit the building.
 - d. Where otherwise required by NFPA 70.
 23. Stub-up Connections: Extend conduits through concrete floor for connection to freestanding equipment. Install with an adjustable top or coupling threaded inside for plugs set flush with finished floor. Extend conductors to equipment with rigid steel conduit; FMC may be used 6 inches (150 mm) above the floor. Install screwdriver-operated, threaded plugs flush with floor for future equipment connections.
 24. Flexible Connections: Use maximum of 72 inches (48 inches in ducts and plenums) of flexible conduit for recessed and semi-recessed lighting fixtures; for equipment subject to vibration, noise transmission, or movement; and for all motors. Use LFMC in damp or wet locations. Install separate ground conductor across flexible connections.
 25. Do not utilize aluminum conduit.
 26. Surface Raceways: Install a separate, green, ground conductor in raceways from junction box supplying raceways to receptacle or fixture ground terminals.
 - a. Select each surface raceway outlet box, to which a lighting fixture is attached, to be of sufficient diameter to provide a seat for the fixture canopy.
 - b. Where a surface raceway is used to supply a fluorescent lighting fixture having central-stem suspension with a backplate and canopy (with or without extension ring), no separate outlet box is required.
 - c. Provide surface metal raceway outlet box, backplate, and canopy at the feed-in location of each fluorescent lighting fixture having end-stem suspension.
 - d. Where a surface metal raceway extension is made from an existing outlet box on which a lighting fixture is installed, no additional surface-mounted outlet box is required. Provide a backplate slightly smaller than the fixture canopy.
 27. Set floor boxes level and flush with finished floor surface.
 28. Install hinged-cover enclosures and cabinets plumb. Support at each corner.
 29. Direct Buried Conduit Backfill: Comply with Division 2 requirements.

B. Location of Outlets and Equipment.

1. Outlets shall be installed at the heights and approximate designated positions as shown on the Drawings and symbol legend, unless otherwise directed. Outlets in similar rooms shall be installed in the same relative location in each room. Outlets shall not be installed back to back but shall be offset approximately 6 inches.
2. Outlets shall be located to clear piping, ductwork, and other obstructions. Switch outlets shall be on the latch side of door except where type of construction dictates otherwise. Outlets in masonry or tile shall be located as far as practical adjacent to horizontal and vertical mortar joints to minimize cutting.
3. Verify locations and dimensions of electrical equipment, particularly in the case of door swings, heights of cabinets and counters, shelves, and location of equipment installed by the Owner or other trades.
4. Mounting heights indicated on the drawings shall be to center line of outlet unless indicated otherwise. Heights may be adjusted to align with mortar joints as specified

above, however, all similar outlets in a given area shall be adjusted to the same height unless specifically noted at the outlet.

5. Receptacle outlets indicated to be installed "A.C." (above counter) shall be mounted not less than 3 inches higher than the top of the counter backsplash or at heights indicated.
6. All similar equipment such as panelboards, motor starters, disconnect switches, etc., shall be installed at the same heights throughout the building.

3.3 PROTECTION

- A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial 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.

3.4 CLEANING

- A. After completing installation of exposed, factory-finished raceways and boxes, inspect exposed finishes and repair damaged finishes.

END OF SECTION 261300

SECTION 261400 - WIRING DEVICES

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 receptacles, connectors, switches, and finish plates.

1.3 SUBMITTALS

- A. Product Data: For each product specified.
- B. Shop Drawings: Legends for receptacles and switch plates.
- C. Maintenance Data: For materials and products to include in maintenance manuals specified in Division 1.

1.4 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.
- B. Comply with NEMA WD 1.
- C. Comply with NFPA 70.

1.5 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: Subject to compliance with requirements, provide products by one of the following:

1. Wiring Devices:

- a. Bryant Electric, Inc.
- b. Eagle Electric Manufacturing Co., Inc.
- c. GE Company; GE Wiring Devices.
- d. Hubbell, Inc.; Wiring Devices Div.
- e. Killark Electric Manufacturing Co.
- f. Leviton Manufacturing Co., Inc.
- g. Pass & Seymour/Legrand; Wiring Devices Div.
- h. Pyle-National, Inc.; an Amphenol Co.

2.2 RECEPTACLES

- A. Straight-Blade Receptacles: Hospital grade, minimum 20A rating, side wired.
- B. Tamper Resistant Straight-Blade Receptacles: Hospital grade, hard-use, minimum 20A rating, side wired, with either internal sliding-shutter barrier system requiring the presence of an object on both sides of the shutter to allow access to contacts or internal switching requiring the presence of an object in both contacts to energize the device.
- C. GFCI Receptacles: Feed-through type, with integral NEMA WD 6, Configuration 5-20R duplex receptacle arranged to protect connected downstream receptacles on same circuit. Design units for installation in a standard outlet box without an adapter.

2.3 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. 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.

2.4 SWITCHES

- A. Combination Switch and Receptacle: Both devices in a single gang unit with plaster ears and removable tab connector that permit separate or common feed connection.
 1. Switch: Heavy-duty grade, quiet type, 20A, 120/277-V ac.
 2. Receptacle: NEMA WD 6, Configuration 5-20R.
- B. Snap Switches: Heavy-duty, quiet type, 20A, 120-277 volt – AC, with back and side wired screw terminals; Pass & Seymour PS20AC-1 or equal. Single-pole or three-way to suit connections.

- C. Dimmer Switches: Modular, full-wave, solid-state units. Dimmers shall be equal to Lutron Nova Series, rated for 600W or 125% of the connected load, whichever is greater.
 - 1. Control: Preset dimmer with continuously adjustable slide switch. Single-pole or three-way switch to suit connections.
 - 2. Filters: Include electromagnetic filter to reduce interference with radio, audio, and video equipment.
 - 3. Voltage Compensation: Include voltage compensation to compensate light output for variation in the AC line-voltage.
 - a. LED Dimmers: Dimmers shall be compatible with LED lighting fixtures.
 - b. Fluorescent Lamp Dimmers: Modular; 120 or 277V as required for connected load, 60Hz. Dimmers shall be compatible with dimmer ballasts to ensure proper operation.

2.5 WALL PLATES

- A. Single and combination types match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: 0.04-inch- (1-mm-) thick, Type 302, satin-finished stainless steel.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Wet Locations: Heavy duty die-cast zinc.
 - a. Where required by the authority having jurisdiction, receptacle covers shall be “While in Use”, “Extra-Duty” type, equal to Intermatic WP3110MXD, or WP1030MXD, or WP1010HMXD series, consisting of heavy duty die cast construction with lockable hasp.
 - b. Switch covers shall be similar to Steel City SW series.

2.6 WIRING DEVICE FINISHES

- A. Color: Ivory, unless otherwise indicated or required by Code.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Switches shall be installed so that the handle is down when the switch in the off position.
- B. Receptacle and switch branch circuit wiring shall be terminated on the side wired screw terminals.
- C. In storage, mechanical, and electrical equipment rooms where the receptacle is located adjacent to the light switch at 46” AFF, the devices shall be installed in a combination cover-plate and back-box assembly.

- D. GFI Receptacles: Ground fault circuit-interruption for personnel shall be provided as required in the NEC 210.8(A) through (C). The ground-fault circuit-interrupter shall be installed in a readily accessible location.
- E. Wet Locations: All 15- and 20-ampere 125- and 250-volt non-locking receptacles shall be listed weather-resistant type.
- F. Mechanical Equipment: Install service receptacles on vertical building surfaces or mount receptacles on the steel tubing and u-channel support/backboard assembly provided for mounting the enclosed controllers and switches. Do not mount service receptacles directly to mechanical equipment housings.
- G. Install devices and assemblies level, plumb, and secure.
- H. Where applicable, devices for controls and operating mechanisms shall be installed to comply with ADA mounting height requirements.
- I. Provide tamper resistant receptacles in pediatric care areas of health care facilities, areas within dwelling units as required by the NEC articles 210.52 and 406.12, guest rooms and guest suites, child care facilities, and other areas as indicated on the drawings.
 - 1. Contractor shall note NEC article 406.2, definition of child care facility and verify with the AHJ areas of the facility requiring tamper resistant receptacles.
- J. Install wall plates when painting is complete.
- K. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.
- L. Provide a dedicated neutral for each branch circuit serving light fixtures connected to wall dimmers. Do not share neutral conductor on load side of dimmers.
- M. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.
 - 1. Exterior receptacles shall be installed with long dimension horizontal, mounting height of approximately 25" above finish grade.
- N. Orientation of Receptacles: Install with grounding terminal of receptacles on the top.
- O. Protect devices and assemblies during painting.

3.2 IDENTIFICATION

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods."
 - 1. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.
 - 2. Receptacles: Identify panelboard and circuit number from which served. Use durable wire markers or tags within outlet boxes.
 - 3. Where receptacles are supplied through a GFCI breaker or connected "downstream" of a GFCI receptacle, the receptacle shall be marked "GFCI Protected".

3.3 CONNECTIONS

- A. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor.
- B. Tighten electrical connectors and terminals according to manufacturer published torque-tightening values. If manufacturers torque values are not indicated, use those specified in UL 486A and UL 486B.
- C. Where multiple sets of conductors terminate at a box, provide pigtails to devices such that the continuity of the branch circuit conductors is not dependent upon device connections and the continuing load is not routed through the device. See section 261200 – Conductors and Cables.

3.4 FIELD QUALITY CONTROL

- A. Test wiring devices for proper operation, polarity and ground continuity.
- B. Test GFCI operation with both local and remote fault simulations according to manufacturer's written instructions.
- C. Replace damaged or defective components.

3.5 CLEANING

- A. Internally clean devices, device outlet boxes, and enclosures. Replace stained or improperly painted wall plates or devices.

END OF SECTION 261400

SECTION 261450 - LIGHTING CONTROL DEVICES

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 lighting control panels, time switches, photoelectric relays, occupancy sensors, and multi-pole lighting relays and contactors.

1.3 SUBMITTALS

- A. Product Data: Include dimensions and data on features, components, and ratings for lighting control devices.
- B. Maintenance Data: For lighting control devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for their indicated use and installation conditions by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with 47 CFR 15, Subparts A and B, for Class A digital devices.
- C. Comply with NFPA 70.

1.5 COORDINATION

- A. Coordinate features of devices specified in this Section with systems and components specified in other Sections to form an integrated system of compatible components. Match components and interconnections for optimum performance of specified functions. Include coordination with the following:
 - 1. Division 26 Section "Panelboards."
 - 2. Division 26 Section "Interior Lighting."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Contactors and Relays:
 - a. Automatic Switch Co.
 - b. Cutler-Hammer Products; Eaton Corporation.
 - c. Furnas Electric Co.
 - d. GE Lighting Controls.
 - e. Hubbell Lighting, Inc.
 - f. Siemens Energy and Automation, Inc.
 - g. Square D Co.; Power Management Organization.
 2. Time Switches:
 - a. General Electric
 - b. Intermatic, Inc.
 - c. Leviton Manufacturing.
 - d. Paragon Electric Co., Inc.
 - e. Tork, Inc.
 3. Photoelectric Relays:
 - a. Allen-Bradley/Rockwell Automation.
 - b. Area Lighting Research, Inc.
 - c. Intermatic, Inc.
 - d. Paragon Electric Co., Inc.
 - e. Tork, Inc.

2.2 GENERAL LIGHTING CONTROL DEVICE REQUIREMENTS

- A. Line-Voltage Surge Protection: Include in all 120- and 277-V solid-state equipment. Comply with UL 1449 and with ANSI C62.41 for Category A locations

2.3 TIME SWITCHES

- A. Description: Electromechanical-dial type complying with UL 917.
1. Two contacts, rated 30 A at 277-V ac, unless otherwise indicated.
 2. Two pilot-duty contacts, rated 2 A at 240-V ac, unless otherwise indicated.
 3. Seven-day program uniquely programmable for each weekday and holidays.
 4. Skip-day mode.

2.4 PHOTOELECTRIC RELAYS

- A. Description: Contacts rated to operate connected relay or contactor coils or microprocessor input, and complying with UL 773A.

- B. Light-Level Monitoring Range: 0 to 500 fc, with an adjustment for turn-on/turn-off levels.
- C. Fail mode shall be on.
- D. Time Delay: Prevents false operation.
- E. Outdoor Sealed Units: Weathertight housing, resistant to high temperatures and equipped with sun-glare shield and ice preventer.

2.5 MULTIPOLE CONTACTORS AND RELAYS

- A. Description: Electrically operated and mechanically held, and complying with UL 508 and NEMA ICS 2.
 - 1. Current Rating for Switching: UL listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballasts with 15 percent or less total harmonic distortion of normal load current).
 - 2. Control Coil Voltage: Match control power source.
 - 3. Two Wire Operation: Provide additional control relays as required for two wire operation associated with photocell and switching applications.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install equipment level and plumb and according to manufacturer's written instructions.
- B. Mount lighting control devices according to manufacturer's written instructions and requirements in Division 26 Section "Basic Electrical Materials and Methods."
- C. Mounting heights indicated are to bottom of unit for suspended devices and to center of unit for wall-mounting devices.

3.2 CONTROL WIRING INSTALLATION

- A. Install wiring between sensing and control devices according to manufacturer's written instructions and as specified in Division 26 Section "Conductors and Cables" for low-voltage connections and Division 26 Section "Voice and Data Systems" for digital circuits.
- B. Wiring Method: Install all wiring in raceway as specified in Division 26 Section "Raceways and Boxes," unless run in accessible ceiling space and gypsum board partitions. Wiring shall be listed and labeled for plenum installation in plenum locations.
- C. Bundle, train, and support wiring in enclosures.
- D. Ground equipment.
- E. Connections: 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.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."
- B. Lighting Control Enclosure Nameplates: Label each lighting control panel and contactor with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.

3.4 FIELD QUALITY CONTROL

- A. Schedule visual and mechanical inspections and electrical tests with at least seven days' advance notice.
- B. The lighting control system shall be programmed to execute and perform all functions required to effectively operate the site according to the owner and engineer requirements. Coordinate control system operation with engineer during shop drawing review.
- C. Inspect control components for defects and physical damage, testing laboratory labeling, and nameplate compliance with the Contract Documents.
- D. Check tightness of electrical connections with torque wrench calibrated within previous six months. Use manufacturer recommended torque values.
- E. Verify settings of photoelectric devices with photometer calibrated within previous six months.
- F. Electrical Tests: Use particular caution when testing devices containing solid-state components. Perform the following according to manufacturer's written instructions:
 - 1. Continuity tests of circuits.
 - 2. Operational Tests: Set and operate devices to demonstrate their functions and capabilities in a methodical sequence that cues and reproduces actual operating functions.
 - a. Include testing of devices under conditions that simulate actual operational conditions. Record control settings, operations, cues, and functional observations.
- G. Correct deficiencies, make necessary adjustments, and retest. Verify that specified requirements are met.
- H. Test Labeling: After satisfactory completion of tests and inspections, apply a label to tested components indicating test results, date, and responsible agency and representative.
- I. Reports: Written reports of tests and observations. Record defective materials and workmanship and unsatisfactory test results. Record repairs and adjustments.

3.5 CLEANING

- A. Cleaning: Clean equipment and devices internally and externally using methods and materials recommended by manufacturers, and repair damaged finishes.

3.6 DEMONSTRATION

- A. Coordinate with training for low-voltage, programmable lighting control system specified in Division 26 Section "Lighting Controls."
- B. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:
 - 1. Train Owner's maintenance personnel on troubleshooting, servicing, adjusting, and preventive maintenance. Provide a minimum of four hours' training.
 - 2. Training Aid: Use the approved final version of maintenance manuals as a training aid.
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.7 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested, to adjust light levels, make program changes, and adjust sensors and controls to suit actual conditions.

END OF SECTION 261450

SECTION 262310 - PACKAGED ENGINE GENERATORS

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 packaged diesel-engine generator sets with the following features and accessories:
 - 1. Battery charger.
 - 2. Day tank.
 - 3. Engine generator set.
 - 4. Muffler.
 - 5. Exhaust piping external to set.
 - 6. Outdoor enclosure.
 - 7. Remote annunciator.
 - 8. Remote stop switch.
 - 9. Starting battery.

1.3 DEFINITIONS

- A. Standby Rating: Power output rating equal to the power the generator set delivers continuously under normally varying load factors for the duration of a power outage.
- B. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.
- C. Steady-State Voltage Modulation: The uniform cyclical variation of voltage within the operational bandwidth, expressed in Hertz or cycles per second.

1.4 SUBMITTALS

- A. Product Data: Include data on features, components, ratings, and performance. Include the following:
 - 1. Dimensioned outline plan and elevation drawings of engine generator set and other components specified.
 - 2. Thermal damage curve for generator.
 - 3. Time-current characteristic curves for generator protective device.
 - 4. Certified fuel consumption curves or charts.

- B. Shop Drawings: Indicate fabrication details, dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 1. Wiring Diagrams: Detail wiring for power and control connections and differentiate between factory-installed and field-installed wiring.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- D. Maintenance Data: For each packaged engine generator and accessories to include in maintenance manuals specified in Division 1. Include the following:
 - 1. List of tools and replacement items recommended to be stored at the Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - 2. Detail operating instructions for both normal and abnormal conditions.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of emergency maintenance and repairs at the Project with eight hours' maximum response time.
- B. Source Limitations: Obtain packaged engine generator and auxiliary components specified in this Section through one source from a single manufacturer.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- D. Comply with NFPA 70.
- E. Comply with NFPA 99.
- F. Comply with NFPA 110 requirements for Level 1 emergency power supply system.
- G. Comply with UL 2200, unless requirements of these Specifications are stricter.
- H. Engine Exhaust Emissions: Engine shall be EPA certified by the manufacturer and shall comply with applicable state and local government requirements.
- I. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of the installation.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver engine generator set and system components to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.7 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace packaged engine generator and auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

1.8 MAINTENANCE SERVICE

- A. Maintenance: At Substantial Completion, begin 12 months' full maintenance by skilled employees of the manufacturer's designated service organization. Include quarterly exercising to check for proper, starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Maintenance agreements shall include parts and supplies as used in the manufacture and installation of original equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Caterpillar, Inc.; Engine Div.
 - 2. Cummins Onan.
 - 3. Detroit Diesel.
 - 4. Generac.
 - 5. Katolight.
 - 6. Kohler Co; Generator Division.

2.2 ENGINE GENERATOR SET

- A. Furnish a coordinated assembly of compatible components.
- B. Safety Standard: Comply with ASME B15.1.
- C. Nameplates: Each major system component is equipped with a conspicuous nameplate of component manufacturer. Nameplate identifies manufacturer of origin and address, and model and serial number of item.

- D. **Power Output Ratings: 100kW, 125kVA standby rating, 208-volts, 3-phase, 4-wire, 0.8PF, 60Hz. The output ratings shall be provided at specified ambient temperature range and altitude.**
- E. Skid: Adequate strength and rigidity to maintain alignment of mounted components without depending on a concrete foundation. Skid is free from sharp edges and corners. Lifting attachments are arranged to facilitate lifting with slings without damaging any components.
- F. Rigging Diagram: Inscribed on a metal plate permanently attached to skid. Diagram indicates location and lifting capacity of each lifting attachment and location of center of gravity.

2.3 GENERATOR-SET PERFORMANCE

- A. Steady-State Voltage Operational Bandwidth: 2 percent of rated output voltage from no load to full load.
- B. Steady-State Voltage Modulation Frequency: Less than 1 Hz.
- C. Transient Voltage Performance: Not more than 10 percent variation for 50 percent step-load increase or decrease. Voltage recovers to remain within the steady-state operating band within three seconds.
- D. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
- E. Steady-State Frequency Stability: When system is operating at any constant load within rated load, there are no random speed variations outside the steady-state operational band and no hunting or surging of speed.
- F. Transient Frequency Performance: Less than 3 percent variation for a 50 percent step-load increase or decrease. Frequency recovers to remain within the steady-state operating band within one second.
- G. Output Waveform: At no load, harmonic content measured line to line or line to neutral does not exceed 3 percent total and 2 percent for single harmonics. The telephone influence factor, determined according to NEMA MG 1, shall not exceed 50.
- H. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, the system will supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to any generator system component.
- I. Start Time: Comply with NFPA 110, Type 10, system requirements.

2.4 SERVICE CONDITIONS

- A. Environmental Conditions: Engine generator system withstands the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 - 1. Ambient Temperature: Minus 30 to plus 40 deg C.

2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1900 feet.

2.5 ENGINE

- A. Comply with NFPA 37.
- B. Rated Engine Speed: 1800 rpm.
- C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).
- D. Lubrication System: Pressurized by a positive-displacement pump driven from engine crankshaft. The following items are mounted on engine or skid:
 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 2. Thermostatic Control Valve: Controls flow in system to maintain optimum oil temperature. Unit is capable of full flow and is designed to be fail-safe.
 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps or siphons or special tools or appliances.
- E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment.

2.6 GOVERNOR

- A. Type: Adjustable isochronous, with speed sensing.

2.7 ENGINE COOLING SYSTEM

- A. Description: Closed loop, liquid cooled, with radiator factory mounted on engine generator-set skid and integral engine-driven coolant pump. Radiator shall be rated for specified coolant.
 1. Radiator Core Tubes: Nonferrous-metal construction other than aluminum.
 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 3. Fan: Driven by totally enclosed electric motor with sealed bearings.
- B. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
- C. Expansion Tank: Constructed of welded steel plate and equipped with gage glass and petcock.
- D. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

- E. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.
 - 1. Rating: 50-psig (345-kPa) maximum working pressure with 180 deg F (82 deg C) coolant, and non-collapsible under vacuum.
 - 2. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

2.8 DIESEL FUEL SUPPLY SYSTEM

- A. Comply with NFPA 30, NFPA 37, and UL142. Engine to operate satisfactorily on Fuel Oil Grade DF-2.
 - 1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
 - 2. Relief/Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- B. Base-Mounted Double-Wall Fuel Oil Tank: Factory-installed and -piped, UL listed and labeled fuel oil tank. Features include the following:
 - 1. Tank level indicator.
 - 2. Flammable and Combustible Liquids Containment Provisions: Comply with requirements of authorities having jurisdiction.
 - a. As required, provide fill alarm, flow restriction, and spill containment devices.
 - 3. Capacity: Fuel for seventy two hours' (72) continuous operation at 100 percent rated power output.
 - 4. Vandal-resistant fill cap.
 - 5. Mechanical Fuel Level Gauge.
 - 6. Standard 2" fitting, standard vent fitting, and emergency vent fitting.
- C. Interior Fuel Oil Piping: As specified in Division 22 Section "Fuel Oil Piping."

2.9 ENGINE EXHAUST SYSTEM

- A. Muffler: Critical type, sized as recommended by engine manufacturer. Measured sound level at a distance of 7 meters from exhaust discharge, is 84 dBA or less.
- B. Condensate Drain for Muffler: Schedule 40, black steel pipe connected to muffler drain outlet through a petcock.
- C. Connections from Engine to Exhaust System: Flexible section of corrugated stainless-steel pipe.
- D. Connection from Exhaust Pipe to Muffler: Stainless-steel expansion joint with liners.

2.10 COMBUSTION-AIR-INTAKE

- A. Description: Heavy-duty engine-mounted air cleaner with replaceable dry filter element and "blocked filter" indicator.

2.11 STARTING SYSTEM

- A. Description: DC battery voltage, with negative ground and including the following items:
1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Environmental Conditions" Paragraph in "Service Conditions" Article above.
 2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
 3. Cranking Cycle: As required by NFPA 110 for system level specified.
 4. Cranking Cycle: 60 seconds.
 5. Battery: Adequate capacity within ambient temperature range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article above to provide specified cranking cycle at least twice without recharging.
 6. Battery Cable: Size as recommended by generator set manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
 7. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater is arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in "Environmental Conditions" Paragraph in "Service Conditions" Article above. Include accessories required to support and fasten batteries in place.
 8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
 9. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit complies with UL 1236 and includes the following features:
 - a. Operation: Equalizing-charging rate of 10 A is initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit then automatically switches to a lower float-charging mode and continues operating in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjusts float and equalizes voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintains output voltage constant regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters indicate charging rates.

2.12 CONTROL AND MONITORING

- A. Functional Description: When the mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic-transfer switches initiate starting and stopping of the generator set. When the mode-selector switch is switched to the on position, the generator set manually starts. The off position of the same switch initiates generator-set shutdown. When the generator set is running, specified system or equipment failures or derangements automatically shut down the generator set and initiate alarms. Operation of a remote emergency-stop switch also shuts down the generator set.
- B. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages are grouped on a common control and monitoring panel mounted on the generator set. Mounting method isolates the control panel from generator-set vibration.

- C. Indicating and Protective Devices and Controls: Include those required by NFPA 110 for a Level 1 system, and the following:
- D. Indicating and Protective Devices and Controls: Include the following for a Level 1 system:
1. AC voltmeter.
 2. AC ammeter.
 3. AC frequency meter.
 4. DC voltmeter (alternator battery charging).
 5. Engine-coolant temperature gage.
 6. Engine lubricating-oil pressure gage.
 7. Running-time meter.
 8. Ammeter-voltmeter, phase-selector switch(es).
 9. Generator-voltage adjusting rheostat.
 10. Start-stop switch.
 11. Lamp test switch.
 12. Contacts for local and remote common alarm.
 13. Overcrank (fail to start).
 14. Low water temperature.
 15. High engine temperature pre-alarm.
 16. High engine temperature.
 17. Low lube oil pressure pre-alarm.
 18. Low lube oil pressure.
 19. Overspeed.
 20. Low fuel main tank.
 21. Low coolant level.
 22. EPS supplying load.
 23. Control switch not in automatic position.
 24. High battery voltage.
 25. Low cranking voltage.
 26. Low voltage in battery.
 27. Battery charger AC failure.
 28. Fuel tank derangement alarm.
 29. Fuel tank high-level shutdown of fuel supply alarm.
- E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices, and wiring required to support specified items. Locate sensors and other supporting items on engine, generator, or elsewhere as indicated. Where not indicated, locate to suit manufacturer's standard.
- F. Remote Alarm Annunciator: Comply with NFPA 99 and NPFA 110, include the following for a level 1 system. Labeled LEDs identify each alarm event. Common audible signal sounds for alarm conditions. Silencing switch in face of panel silences signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
1. Contacts for local and remote common alarm.
 2. Overcrank (fail to start).
 3. Low water temperature.
 4. High engine temperature pre-alarm.

5. High engine temperature.
6. Low lube oil pressure pre-alarm.
7. Low lube oil pressure.
8. Overspeed.
9. Low fuel main tank.
10. Low coolant level.
11. Control switch not in automatic position.
12. Low cranking voltage.
13. Audible alarm silencing switch.

- G. Remote Emergency-Stop Switch: Flush wall-mounted, unless otherwise indicated and prominently labeled. Push button is protected from accidental operation.

2.13 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 2. Trip Settings: Matched to generator thermal damage curve as closely as possible.
 3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.
 5. Auxiliary contact to close when circuit breaker is in the open position.
 6. A qualified manufacturer's representative shall set circuit breaker settings in the field to match generator ratings.
- B. Load Bank Circuit Breaker: Provide a circuit breaker sized for the full load of the generator for connection to a load bank.
1. Tripping Characteristic: Designed specifically for generator protection.
 2. Trip Rating: Matched to generator rating.
 3. Shunt Trip: Connected to automatic transfer switch auxiliary contact to trip the breaker should the automatic transfer switch require transfer due to power utility failure.
 4. Mounting: Adjacent to or integrated with control and monitoring panel.

2.14 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1 and specified performance requirements.
- B. Drive: Generator shaft is directly connected to engine shaft. Exciter is rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.
- E. Construction prevents mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

- F. Excitation uses no slip or collector rings, or brushes, and is arranged to sustain generator output under short-circuit conditions as specified.
- G. Enclosure: Drip-proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting rheostat on control and monitoring panel provides plus or minus 5 percent adjustment of output- voltage operating band.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

2.15 OUTDOOR GENERATOR-SET ENCLOSURE

- A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels are lockable and provide adequate access to components requiring maintenance. Panels are removable by one person without tools. Instruments and control are mounted within enclosure. Exhaust muffler is installed on the enclosure.
 - 1. Construction: Galvanized steel, metal-clad, framed with corner posts and bolted to the skid of the generator set.
 - 2. Access Doors: On both sides of the enclosure with open hinges to allow the doors to be removed. Handles will be the “D” style, flush mount and keyed alike.
 - 3. Ventilation: Louvers equipped with insect/rodent screens arranged to permit air circulation while excluding insects and rodents.
 - 4. Air openings shall include combination motorized dampers and fixed louvers sized to allow proper airflow for engine-generator cooling air requirements. The frames and blades shall be manufactured of extruded aluminum and the fronts shall be covered with expanded aluminum bird screen. Motorized dampers are to include bronze iolite pivots and shall spring open automatically upon utility failure and motor close when generator ends its running cycle. Louver/damper assemblies shall be designed to help prevent the entrance of driving snow and rainwater and shall include blade and jamb seals.
 - 5. For NFPA 110, level 1 applications, the manufacturer shall ensure that the ambient temperature within the enclosure shall be capable of being maintained at a minimum of 40°F while in the non-run status.
 - 1) Provide a thermostatically controlled space heater within the enclosure as required to meet this requirement.
 - 2) The walls, roof, and doors shall be lined with fiberglass insulation matching the wall thickness, complete with 22 gauge galvanized liner installed with pop rivet construction as required to meet this requirement.
 - 6. Sound Attenuation: Design sound levels shall be 78dBA, as measured at a distance of 7 meters around the enclosure in a free field environment. Additional wall and insulation thickness, plus air discharge & intake hoods or sound attenuators shall be installed to meet design sound levels.

7. Where access door panel handles, circuit breakers, or controllers are located more than 78" above finish grade elevations, service catwalk platforms shall be provided.

2.16 FINISHES

- A. Outdoor Enclosures: Two-coat enamel over corrosion-resistant pretreatment and compatible standard primer.

2.17 SOURCE QUALITY CONTROL

- A. Prototype Testing: Performed on a separate engine generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 1. Tests: Comply with those required for Level 1 energy converters in Paragraphs 3.2.1, 3.2.1.1, and 3.2.1.2 of NFPA 110.
 2. Generator Tests: Comply with IEEE 115.
 3. Components and Accessories: Items furnished with installed unit that are not identical to those on tested prototype have been tested to demonstrate compatibility and reliability.
- B. Project-Specific Equipment Tests: Factory test engine generator set and other system components and accessories before shipment. Perform tests at rated load and power factor. Include the following tests.
 1. Full load run.
 2. Maximum power.
 3. Voltage regulation.
 4. Transient and steady-state governing.
 5. Single-step load pickup.
 6. Safety shutdown.
- C. Observation of Factory Tests: Provide 14 days' advance notice of tests and opportunity for observation of test by Owner's representatives.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment foundations, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Examine roughing-in of cooling-system piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

3.2 CONCRETE BASES

- A. Install concrete bases of dimensions indicated for packaged engine generators. Refer to Division 3 Section "Cast-in-Place Concrete" and Division 26 Section "Basic Electrical Materials and Methods."

3.3 INSTALLATION

- A. Comply with packaged engine generator manufacturers' written installation and alignment instructions, and with NFPA 110.
- B. Set packaged engine generator set on concrete bases.
 - 1. Support generator-set mounting feet on rectangular metal blocks and shims or on metal wedges having small taper, at points near foundation bolts to provide $\frac{3}{4}$ to 1-1/2 inch gap between pump base and foundation for grouting.
 - 2. Adjust metal supports or wedges until generator is level.
- C. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- D. Install remote emergency-stop switch near the main electrical service to the facility unless it is shown at another location on the drawings.
- E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.
 - 1. Verify that electrical wiring is installed according to manufacturers' submittal and installation requirements in Division 26 Sections. Proceed with equipment startup only after wiring installation is satisfactory.

3.4 CONNECTIONS

- A. Electrical wiring and connections are specified in Division 26 Sections.
- B. Ground equipment.
 - 1. 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.

3.5 IDENTIFICATION

- A. Identify system components according to Division 26 Section "Basic Electrical Materials and Methods".

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections, and to assist in testing. Report results in writing.
- B. Testing: Perform field quality-control testing under the supervision of the manufacturer's factory-authorized service representative.
- C. Tests: Include the following:
 - 1. Tests recommended by manufacturer.
 - 2. InterNational Electrical Testing Association Tests: Perform each visual and mechanical inspection test stated in NETA ATS for emergency engine generator sets, except omit vibration baseline test. Certify compliance with test parameters for tests performed.
 - 3. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, the following:
 - a. Single-step full-load pickup test.
 - 4. Full Load Test:
 - a. Provide full load test utilizing portable test bank for a period of four hours minimum. Simulate power failure including operation of the associated transfer switch, automatic starting cycle, and automatic shutdown and return to normal power.
 - b. Record the following parameters in 20 minute intervals during the four hour load test. Provide results in writing.
 - 1) Kilowatts.
 - 2) Amperes.
 - 3) Voltage.
 - 4) Coolant Temperature.
 - 5) Room Temperature.
 - 6) Frequency.
 - 7) Oil Pressure.
 - 5. Battery Tests: Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery. Verify acceptance of charge for each element of battery after discharge. Verify measurements are within manufacturer's specifications.
 - 6. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 - 7. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Test alarm and shutdown circuits by simulating conditions. Check for air, exhaust, and fluid leaks.
 - 8. Exhaust Emissions Test: Comply with applicable government test criteria.
 - 9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations 10' from enclosure and compare measured levels with required values.

- D. Coordinate tests with tests for transfer switches and run them concurrently.
- E. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.
- F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.
- G. Test instruments shall have been calibrated within the last 12 months, traceable to standards of the National Institute for Standards and Technology, and adequate for making positive observation of test results. Make calibration records available for examination on request.

3.7 BATTERY EQUALIZATION

- A. Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.

3.8 FUELING

- A. Provide initial fill of diesel fuel and refill after load bank testing.

3.9 CLEANING

- A. On completion of installation, inspect system components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Clean components internally using methods and materials recommended by manufacturer.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators as specified below:
 - 1. Coordinate this training with that for transfer switches. Schedule training with Owner, through Architect, with at least seven days advance notice.
 - 2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 - 3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
 - 4. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 - 5. Minimum Instruction Period: Four hours.

END OF SECTION 262310

SECTION 262890 – SURGE PROTECTION DEVICES (SPD’s)

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 surge protection devices for low-voltage power, control, and communication equipment.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
- B. Product Certificates: Signed by manufacturers of surge protection devices, certifying that products furnished comply with the following testing and labeling requirements:
 - 1. UL 1283 certification.
 - 2. UL 1449 listing and classification (third edition).
- C. Maintenance Data: For surge protection devices to include in maintenance manuals specified in Division 1.
- D. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain surge protection devices and accessories through one source 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. Surge protection devices shall be designed in accordance with ANSI/IEEE C62.41.1-2002, C62.41.2-2002, and C62.45-2002.
- D. UL Compliance: Comply with Underwriters Laboratories ANSI/UL 1283, 5th Edition - "Electromagnetic Interference Filters" (applies to type 2 SPD’s).
- E. UL Compliance: Comply with Underwriters Laboratories ANSI/UL 1449 3rd Edition – “Surge Protective Devices”.

1.5 PROJECT CONDITIONS

- A. Placing into Service: Do not energize or connect service entrance equipment to the sources until the surge protective devices are installed and connected.
- B. Service Conditions: Rate surge protective 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 (0 to 50 deg C).
 - 3. Humidity: 0 to 85 percent, non-condensing.

1.6 COORDINATION

- A. Coordinate location of field-mounted surge protectors for maintenance clearance.

1.7 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace components of surge suppressors that fail in materials or workmanship for a period of not less than ten years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Manufacturers of a Broad Line of Surge Protection Devices:
 - a. Advanced Protection Technologies.
 - b. Eaton Corp.; Cutler-Hammer Products.
 - c. General Electric.
 - d. Intermatic.
 - e. Liebert/Emerson.
 - f. Square D by Schneider Electric.
 - 2. Manufacturers of Category A and Telephone/Data Line Suppressors:
 - a. EDCO (Emerson Network Power Surge Protection).
 - b. MCG Electronics, Inc.
 - c. NTE Electronics, Inc.
 - d. Telebyte Technology, Inc.

2.2 SERVICE ENTRANCE SURGE PROTECTION DEVICES

- A. Type 2 SPD's, comply with ANSI/UL 1283.
- B. Surge Protective Device Description: Modular type with the following features and accessories:
 - 1. The system shall be designed for easy servicing by a qualified field electrician, providing simple change out of any or all TVSS modules. Designs that require factory service are not acceptable. Any unit using "plug-in" type modules are not acceptable. All connections, conductors, and terminals must be appropriately sized for specified surge current capacity.
 - 2. LED indicator lights for power and protection status.
 - 3. Audible alarm, with silencing switch, to indicate when protection has failed.
 - 4. One set of dry contacts rated at a minimum of 2A and 24Vdc, for remote monitoring of protection status.
 - 5. Redundant suppression circuits.
 - 6. Minimum withstand rating of 20kA per mode.
 - 7. Redundant replaceable modules (if Surge Current Rating is above 200kA per phase).
 - 8. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
 - 9. Surge-event operations counter.
- C. Surge Current Rating: 120kA per mode, 240kA per phase.
- D. Connection Means: Permanently wired.
- E. Protection modes and UL 1449 voltage protection for grounded wye circuits with voltages of 208Y/120 V, three-phase, 4-wire circuits, shall be as follows:
 - 1. Line to Neutral: 800 V.
 - 2. Line to Ground: 800 V.
 - 3. Neutral to Ground: 800 V.
 - 4. Line to Line: 1200V.
- F. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the AIC rating of the associated switchboard or panelboard to which the SPD is being connected
- G. Nominal Discharge Current Rating:
 - 1. Surge protective devices must carry a minimum Nominal Discharge Current Rating of 20kA to meet the requirements of UL96A – Installation Requirements for Lightning Protection Systems.

2.3 ENCLOSURES

- A. NEMA 250, with type matching the enclosure of panel or device being protected.

PART 3 - EXECUTION

3.1 INSTALLATION OF SURGE PROTECTIVE DEVICES

- A. Install devices at service entrance on load side, with ground lead bonded to service entrance ground.
 - 1. Provide multipole circuit breaker as a dedicated disconnect for the SPD, unless otherwise indicated.
- B. Install devices for panelboard and auxiliary panels with conductors between SPD 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 60A/3P multi-pole circuit breaker as a dedicated disconnect for the SPD.

3.2 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.

3.3 FIELD QUALITY CONTROL

- A. Testing: Perform the following field quality-control testing:
 - 1. After installing surge protective devices, but before electrical circuitry has been energized, test for compliance with requirements.
 - 2. Complete startup checks according to manufacturer's written instructions.
 - 3. Perform each visual and mechanical inspection test stated in NETA ATS, Section 7.19.
- B. Repair or replace malfunctioning units. Retest after repairs or replacements are made.

3.4 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain surge protective devices.
 - 1. Train Owner's maintenance personnel on procedures and schedules for maintaining suppressors.
 - 2. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 - 3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 262890

SECTION 264100 - ENCLOSED SWITCHES

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 individually mounted enclosed switches used for the following:
 - 1. Motor and equipment disconnecting means.

1.3 SUBMITTALS

- A. Product Data: For each type of switch, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each switch and circuit breaker.
 - 1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
 - a. Mark each product data sheet with the tag number and equipment description indicated on the mechanical equipment schedule and/or power riser diagram.
 - b. Enclosure types and details for types other than NEMA 250, Type 1.
 - c. Current and voltage ratings.
 - d. Short-circuit current rating.
 - e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For enclosed switches and for components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for components.
 - 2. Manufacturer's written instructions for testing and adjusting switches.

1.4 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 NEMA AB 1 and NEMA KS 1.
- C. Comply with NFPA 70.

1.5 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 (minus 30 deg C) and not exceeding 110 deg F (43 deg C).
 - 2. Altitude: Not exceeding 1500 feet (450 m).

1.6 COORDINATION

- A. Coordinate layout and installation of switches 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.
- B. Coordinate features, accessories, and functions of each enclosed switch with ratings and characteristics of supply circuit, motor, required control sequence, and duty-cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Fusible and Non-fusible Switches:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Schneider Electric (Square D Co.)
 - d. Siemens Energy & Automation, Inc.
 - 2. Molded-Case Circuit Breakers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Division.
 - c. Schneider Electric (Square D Co.)

- d. Siemens Energy & Automation, Inc.

2.2 ENCLOSED SWITCHES

- A. Enclosed, Non-fusible Switch: NEMA KS 1, Type HD, with lockable handle.
- B. Enclosed, Fusible Switch, 1600 A and Smaller: NEMA KS 1, Type HD, with clips to accommodate specified fuses, lockable handle, and interlocked with cover in closed position.

2.3 ENCLOSURES

- A. NEMA AB 1 and NEMA KS 1 to meet environmental conditions of installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.4 FACTORY FINISHES

- A. Finish: Manufacturer standard paint applied to factory-assembled and -tested enclosures before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install enclosed switches in locations as indicated, according to manufacturer's written instructions. Verify that the installation will be accessible and will provide the clearances as required by the NEC article 110-26.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Mechanical Equipment: Install enclosed switches on vertical building surfaces or provide steel tubing and u-channel support/backboard assembly for mounting enclosed switches. Do not mount enclosed switches directly to mechanical equipment housings.
- D. Exterior Enclosures: Mount enclosures at elevations to maximize aesthetics and minimize viewing angles by the public.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."
- B. Enclosure Nameplates: Label each enclosed switch and circuit breaker with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall indicate the equipment being served.

3.4 CONNECTIONS

- A. Install equipment grounding connections for switches with ground continuity to main electrical ground bus.
- B. Install power wiring. Install wiring between switches and control and indication devices.
- C. 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.

3.5 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test continuity of each line- and load-side circuit.
- B. Testing: After installing enclosed switches and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection test indicated in NETA ATS, Section 7.5 for switches. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.6 CLEANING

- A. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION 264100

SECTION 264150 - TRANSFER SWITCHES

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 transfer switches rated 600 V and less, including the following:
 - 1. Automatic transfer switch.

1.3 SUBMITTALS

- A. Product Data: Include ratings and dimensioned plans, sections, and elevations showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
- B. Wiring Diagrams: Detail wiring for transfer switches and differentiate between manufacturer-installed and field-installed wiring. Show both power and control wiring.
- C. Product Certificates: Signed by manufacturer certifying that products furnished comply with requirements and that switches have been tested for load ratings and short-circuit closing and withstand ratings applicable to units for Project.
- D. Maintenance Data: For each type of product to include in maintenance manuals specified in Division 1. Include all features and operating sequences, both automatic and manual. List all factory settings of relays and provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain a service center capable of providing emergency maintenance and repairs at Project site with an eight-hour maximum response time.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, for emergency service under UL 1008, by a testing agency acceptable to authorities having jurisdiction.
- C. Comply with NFPA 70.
- D. Comply with NFPA 99.
- E. Comply with NFPA 110.

- F. Comply with UL 1008, unless requirements of these Specifications are stricter.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver transfer switch to their final locations in protective wrappings, containers, and other protection that will exclude dirt and moisture and prevent damage from construction operations. Remove protection only after equipment is safe from such hazards.

1.6 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty: Written warranty, executed by manufacturer agreeing to repair or replace packaged engine generator and auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Conventional Transfer Switches:
 - a. Caterpillar, Inc.; Engine Division.
 - b. Emerson Electric Co.; Automatic Switch Co. Subsidiary.
 - c. GE Zenith Controls
 - d. Generac Corp.
 - e. Kohler Co.
 - f. Onan Corp.; Electrical Products Division.
 - g. Spectrum Detroit Diesel.
 - h. Russelectric, Inc.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

- A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch AIC ratings cannot be met, provide a fused disconnect switch ahead of the transfer switch to provide required AIC ratings.
- C. Annunciation, Control, and Programming Interface Components: Devices at transfer switches for communicating with remote programming devices, annunciators, or annunciator and control panels have communications capability matched with remote device.
- D. Solid-State Controls: Repetitive accuracy of all settings is plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- E. Resistance to Damage by Voltage Transients: Components meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- F. Neutral Terminal: Solid and fully rated, unless otherwise indicated.
- G. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6; UL 508, unless otherwise indicated.
- H. Factory Wiring: Train and bundle factory wiring and label consistent with Shop Drawings, either by color code or by numbered or lettered wire and cable tape markers at terminations.
 1. Designated Terminals: Pressure type suitable for types and sizes of field wiring indicated.
 2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
- I. Electrical Operation: Accomplish by a non-fused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.
- J. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
 1. Switch Action: Double throw; mechanically held in both directions.
 2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units rated 225 A and greater have separate arcing contacts.

2.3 AUTOMATIC TRANSFER SWITCHES

- A. Comply with Level 1 equipment according to NFPA 110.
- B. Switching Arrangement: Double-throw type, incapable of intermediate position stops during normal functioning, unless otherwise indicated.
- C. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.
- D. Signal-before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 5 minutes.

- E. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase. Relay compares phase relationship and frequency difference between normal and emergency sources and initiates transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer is initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage.
- F. Motor Disconnect and Timing Relay: Controls designate starters so they disconnect motors before transfer and reconnect them selectively at an adjustable time interval after transfer. Control connection to motor starters is through wiring external to automatic transfer switch. Time delay for reconnecting individual motor loads is adjustable between 1 and 60 seconds, and settings are as indicated. Relay contacts handling motor-control circuit inrush and seal currents are rated for actual currents to be encountered.

2.4 AUTOMATIC TRANSFER-SWITCH FEATURES

- A. Undervoltage Sensing for Each Phase of Normal Source: Senses low phase-to-ground voltage on each phase. Pickup voltage is adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
- B. Time delay for override of normal-source voltage sensing delays transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
- C. Voltage/Frequency Lockout Relay: Prevents premature transfer to generator set. Pickup voltage is adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency is adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
- D. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes; factory set for 10 minutes. Provides automatic defeat of delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
- E. Test Switch: Simulates normal-source failure.
- F. Switch-Position Pilot Lights: Indicate source to which load is connected.
- G. Source-Available Indicating Lights: Supervise sources via transfer-switch, normal- and emergency-source sensing circuits.
 1. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 2. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
- H. Unassigned Auxiliary Contacts: Two normally open single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
- I. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

- J. Engine Starting Contacts: One isolated, normally closed and one isolated, normally open, rated 10 A at 32-V dc minimum.
- K. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes; factory set for five minutes. Initiates shutdown at remote engine-generator controls after retransfer of load to normal source.
- L. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine-generator set and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 30-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - 1. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - 2. Push-button programming control with digital display of settings.
 - 3. Integral battery operation of time switch when normal control power is not available.

2.5 FINISHES

- A. Enclosures: Manufacturer's standard enamel over corrosion-resistant pretreatment and primer.

2.6 SOURCE QUALITY CONTROL

- A. Factory Test Components, Assembled Switches, and Associated Equipment: Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Annunciator and Control Panel Mounting: Flush in wall, unless otherwise indicated.

3.2 WIRING TO REMOTE COMPONENTS

- A. Provide two interface points with the Building Automation System to indicate when the switch is in the emergency power position and to indicate prior (5 minutes) to when the switch is to transfer back to normal power source.
- B. Provide interface with the generator load bank circuit breaker to shunt trip the circuit breaker prior to transferring load to the generator.
- C. Match type and number of cables and conductors to control and communications requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."
- B. Transfer Switch Nameplates: Label each transfer switch with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.
 - 1. Each transfer switch label shall indicate the transfer switch name, voltage and phase, ampere rating, and where the transfer switch is fed from.

3.4 CONNECTIONS

- A. Ground equipment as indicated and as required by NFPA 70.

3.5 FIELD QUALITY CONTROL

- A. Testing: Test transfer-switch products by operating them in all modes. Perform tests recommended by manufacturer under the supervision of manufacturer's factory-authorized service representative. Correct deficiencies and report results in writing. Record adjustable relay settings.
- B. Testing: Perform the following field quality-control testing under the supervision of the manufacturer's factory-authorized service representative in addition to tests recommended by the manufacturer:
 - 1. Before energizing equipment, after transfer-switch products have been installed:
 - a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage; proper installation and connection; and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
 - 2. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.
 - a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.
 - c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
 - e. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown sequence.
- C. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.
 - 1. Assist in verifying grounding connections and locations and ratings of sensors.

2. Assist in observing reaction of circuit-interrupting devices when simulated fault current is applied at sensors.
- D. Coordinate tests with tests of generator plant and run them concurrently.
 - E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.6 CLEANING

- A. After completing equipment installation, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.
- B. Clean equipment internally, on completion of installation, according to manufacturer's written instructions.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's personnel to adjust, operate, and maintain transfer switches and related equipment as specified below:
 1. Coordinate this training with that for generator equipment.
 2. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment.
 3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.
 5. Provide a minimum of four hours of instruction.

END OF SECTION 264150

SECTION 264200 - ENCLOSED CONTROLLERS

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 ac general-purpose controllers rated 600 V and less that are supplied as enclosed units.

1.3 SUBMITTALS

- A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.
 - 1. Mark each product data sheet with the tag number and description indicated on the mechanical equipment schedule.
- B. Maintenance Data: For enclosed controllers and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Closeout Procedures," include the following:
 - 1. Routine maintenance requirements for enclosed controllers and all installed components.
 - 2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
- C. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.
- B. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer.
- C. 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.
- D. Comply with NFPA 70.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.
- B. If stored in areas subjected to weather, cover enclosed controllers to protect from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.6 COORDINATION

- A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
- B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3 Section "Cast-in-Place Concrete."
- C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."
- D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.
- E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Manual and Magnetic Enclosed Controllers:
 - a. Eaton Corp.; Cutler-Hammer Products.
 - b. General Electrical Distribution & Control.
 - c. Rockwell Automation Allen-Bradley Co.; Industrial Control Group.
 - d. Schneider Electric (Square D Co.)
 - e. Siemens/Furnas Controls.

2.2 MAGNETIC ENCLOSED CONTROLLERS

- A. Description: NEMA ICS 2, Class A, full voltage, non-reversing, across the line, unless otherwise indicated.
- B. Control Circuit: 120 V; obtained from integral control power transformer with secondary fuse protection. The control power transformer shall have sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
- C. Combination Controller: Factory-assembled combination controller and disconnect switch.
 - 1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.
 - 2. Non-fusible Disconnecting Means: NEMA KS 1, heavy-duty, non-fusible switch.
 - 3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- D. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
- E. Adjustable Overload Relay (shall be provided for all starters associated with 3 phase motors rated at 5HP or larger): Solid state, 3 to 1 adjustment for trip current, and protect motor against voltage and current unbalance and phase loss.

2.3 ENCLOSURES

- A. Description: Flush- or surface-mounted cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.4 MANUAL MOTOR CONTROLLERS

- A. Fractional Horsepower Manual Starters: NEMA ICS 2; AC general purpose Class A manually operated, 1 or 2 pole, full-voltage controller rated for 1 horsepower, with adjustable one-piece melting alloy type thermal overload unit rated for connected load, and toggle operator, suitable for flush mounting in finished spaces. NEMA 3R lockable controller for exterior locations.

2.5 ACCESSORIES

- A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.
- B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

- C. Furnish each controller with red-run and green-off LED type indicating lights, 2 auxiliary M contacts.
- D. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.
- E. Control Relays: Auxiliary and adjustable time-delay relays.

2.6 FACTORY FINISHES

- A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, drive, and load; and configuration of pilot device and control circuit affecting controller functions.
- B. Select horsepower rating of controllers to suit motor controlled.
- C. Use fractional horsepower manual controllers for single-phase motors, unless otherwise indicated.
- D. Use manual controllers for 3-phase motors up to 5 horsepower not requiring automatic or remote control.
- E. Push-Button Stations: In covers of magnetic controllers for manually started motors where indicated, start contact connected in parallel with sealing auxiliary contact for low-voltage protection.
- F. Hand-Off-Automatic Selector Switches: Provide in covers of manual and magnetic controllers of motors started and stopped by automatic controls or interlocks with other equipment.

3.2 INSTALLATION

- A. Install enclosed controllers in locations as indicated, according to manufacturer's written instructions. Verify that the installation will be accessible and will provide the clearances as required by the NEC article 110-26.
- B. See Division 26 Section "Basic Electrical Materials and Methods" for general installation requirements.
- C. Install independently mounted control devices according to manufacturer's written instructions.
- D. Locate controllers within sight of motors controlled, unless otherwise indicated.

- E. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Basic Electrical Materials and Methods."
- F. Mechanical Equipment: Install enclosed controllers on vertical building surfaces or provide steel tubing and u-channel support/backboard assembly for mounting enclosed controllers. Do not mount enclosed controllers directly to mechanical equipment housings.
- G. Exterior Enclosures: Mount enclosures at elevations to maximize aesthetics and minimize viewing angles by the public.
- H. Install freestanding equipment on concrete bases complying with Division 3 Section "Cast-in-Place Concrete."
- I. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."
- B. Enclosure Nameplates: Label each enclosed controller with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws. Label shall indicate the equipment being served.

3.4 CONTROL WIRING INSTALLATION

- A. Install wiring between enclosed controllers according to Division 26 Section "Conductors and Cables."
- B. Bundle, train, and support wiring in enclosures.
- C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
 - 1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
 - 2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.5 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.

3.6 FIELD QUALITY CONTROL

- A. Testing: After installing controllers and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements. Perform the following field quality-control testing:
 - 1. Perform each visual and mechanical inspection indicated in NETA ATS, Sections 7.5, 7.6, and 7.16.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.7 CLEANING

- A. Clean enclosed controllers internally, on completion of installation, according to manufacturer's written instructions. Vacuum dirt and debris; do not use compressed air to assist in cleaning.
- B. Remove paint splatters and other spots, dirt, and debris. Touch up scratches and mars of finish to match original finish.

3.8 STARTUP SERVICE

- A. Verify that enclosed controllers are installed and connected according to the Contract Documents.
- B. Verify that electrical wiring installation complies with manufacturer's submittal and installation requirements in Division 26 Sections.
- C. Complete installation and startup checks according to manufacturer's written instructions.

3.9 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain enclosed controllers.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 264200

SECTION 264420 - PANELBOARDS

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 load centers and panelboards, overcurrent protective devices, and associated auxiliary equipment rated 600 V and less for the following types:
 - 1. Lighting and appliance branch-circuit panelboards.
 - 2. Distribution panelboards.

1.3 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. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 2. Wiring Diagrams: Diagram power, signal, and control wiring and differentiate between manufacturer-installed and field-installed wiring.
- C. Maintenance Data: For panelboards and components to include in maintenance manuals specified in Division 1. In addition to requirements specified in Division 1 Section "Contract Closeout," include the following:
 - 1. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
 - a. Copies of panelboard schedules shall be provided in the operation and maintenance manuals in case circuit directories in the panelboards are lost.
- D. Panelboard Overcurrent Protection Device Arrangement: To the extent possible, coordinate with panelboard supplier for correct arrangement of overcurrent protection devices (OCPD's)

within panelboards to match panelboard schedules shown on the electrical drawings. The contractor shall rearrange OCPD's if necessary to match the schedules shown on the electrical drawings.

1.4 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 NEMA PB 1.
- C. Comply with NFPA 70.

1.5 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.

1.6 EXTRA MATERIALS

- A. Keys: Four spares of 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 Corp.; Cutler-Hammer Products.
 - b. General Electric Co.; Electrical Distribution & Control Div.
 - c. Schneider Electric (Square D Co.)
 - d. Siemens Energy & Automation, Inc.

2.2 FABRICATION AND FEATURES

- A. Enclosures: Surface-mounted cabinets. NEMA PB 1, Type 1, to meet environmental conditions at installed location.
 - 1. Outdoor Locations: NEMA 250, Type 3R.
 - 2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
 - 3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

- B. Covers:
 - 1. Provide hinged front trim cover with front trim hinged to box with standard circuit breaker access door within hinged trim cover. Provide flush latch with tumbler lock for circuit breaker access door.
- C. Finish: Manufacturer standard enamel finish over corrosion-resistant treatment or primer coat.
- D. Directory Card: With transparent protective cover, mounted inside metal frame, inside panelboard door.
- E. Phase, Neutral, and Ground Bus Material: Material shall be determined by the conductor material being used for this project. If copper conductors are being used, bus material shall be 98 percent conductivity copper. If aluminum conductors are being used, bus material shall be tin-plated, high-strength, electrical-grade aluminum alloy.
 - 1. If bus is aluminum, use copper or tin-plated aluminum for circuit-breaker line connections.
 - 2. If bus is copper, use copper for feeder circuit-breaker line connections.
- F. Main and Neutral Lugs: Mechanical type suitable for use with conductor material.
- G. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment ground conductors; bonded to box.
- H. Future Devices: Mounting brackets, bus connections, and necessary appurtenances required for future installation of devices.
- I. Feed-through Lugs: Mechanical type suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

2.3 PANELBOARD SHORT-CIRCUIT RATING

- A. Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.5 DISTRIBUTION PANELBOARDS

- A. Doors: Front mounted, except omit in fused-switch panelboards; secured with vault-type latch with tumbler lock; keyed alike.
- B. Main Overcurrent Protective Devices: Circuit breakers.
- C. Branch overcurrent protective devices shall be bolt-on style.

2.6 OVERCURRENT PROTECTIVE DEVICES

- A. 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.
- B. Molded-Case Circuit-Breaker Features and Accessories. Standard frame sizes, trip ratings, and number of poles.
 - 1. Lugs: Mechanical style, suitable for number, size, trip ratings, and material of conductors.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install panelboards and accessories according to NEMA PB 1.1.
- B. Mounting Heights: Top of trim 74 inches (1880 mm) above finished floor, unless otherwise indicated.
- C. Mounting: Surface mount panelboards shall be mounted to ¾" plywood backboards. Paint backboards with two coats of grey fire retardant paint.
- D. Mounting: Plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish.
- E. Circuit Directory: Create a directory to indicate installed circuit loads after balancing panelboard loads. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
 - 1. Room names or Owner's room numbers shall be used. Do not use plan room numbers unless approved by the owner.
 - 2. Spare circuit breakers shall be identified as such.
- F. Install filler plates in unused spaces.
- G. Provision for Future Circuits at Flush Panelboards: Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits into raised floor space or below slab not on grade.

3.2 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Basic Electrical Materials and Methods."
- B. Panelboard Nameplates: Label each panelboard with engraved metal or laminated-plastic nameplate mounted with corrosion-resistant screws.
 - 1. Lighting and Appliance Panelboards: Each lighting and appliance panelboard label shall indicate the panelboard name, voltage and phase, and where the panel is fed from.
 - 2. Distribution Panelboards: Label each distribution panelboard section and overcurrent protection device (OCPD). Each section label shall indicate distribution panelboard name, section, voltage and phase, and where the panel is fed from. Each OCPD label shall indicate the device being protected.

3.3 CONNECTIONS

- A. Install equipment grounding connections for panelboards with ground continuity to main electrical ground bus.
- B. Tighten electrical connectors and terminals according to manufacturer published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.4 FIELD QUALITY CONTROL

- A. Prepare for acceptance tests as follows:
 - 1. Test continuity of each circuit.
- B. Testing: After installing panelboards and after electrical circuitry has been energized, demonstrate product capability and compliance with requirements.
 - 1. Procedures: Perform each visual and mechanical inspection test indicated in NETA ATS, Section 7.5 for switches and Section 7.6 for molded-case circuit breakers.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

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 original finish.

END OF SECTION 264420

SECTION 264910 - FUSES

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 cartridge fuses, rated 600 V and less, for use in switches, panelboards, switchboards, controllers, and motor-control centers; and 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 adjusted.
 - 1. For each adjusted fuse, 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. Maintenance Data: For tripping devices to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Provide 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 (4.4 deg C) or more than 100 deg F (38 deg C), apply manufacturer's ambient temperature adjustment factors to fuse ratings.

1.6 COORDINATION

- A. Coordinate fuse ratings with HVAC and refrigeration equipment nameplate limitations of maximum fuse size.
- B. Coordinate fuse ratings for Type 2 protection of motor starters, contacts, and overload relays.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged in original cartons or containers and identified with labels describing contents.
 - 1. Fuses: Quantity equal to twenty percent of each fuse type and size, but not less than one set of three 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 Industries, Inc.; Bussmann Div.
 - 2. General Electric Co.; Wiring Devices Div.
 - 3. Gould Shawmut.
 - 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.

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. Motor Branch Circuits: Class RK5 or Class J, dual-element, time-delay.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.4 IDENTIFICATION

- A. Install labels indicating fuse replacement information on inside door of each fused switch.

END OF SECTION 264910

SECTION 265110 - INTERIOR LIGHTING

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 interior lighting fixtures, lighting fixtures mounted on exterior building surfaces, lamps, ballasts, emergency lighting units, and accessories.
- B. Related Sections include the following:
 - 1. Division 26 Section "Lighting Control Equipment" for programmable lighting control systems, time switches, additional photoelectric relays, power relays, and contactors.
- C. Utility Rebates:
 - 1. The electrical contractor and supplier(s) of luminaires shall work with the owner and electrical utility to obtain available rebates for lighting systems. Work shall include providing all required documentation and completing rebate application forms for the owner to receive available rebates.

1.3 SUBMITTALS

- A. Product Data: For each type of lighting fixture indicated, arranged in order of fixture designation. Include data on features, accessories, and the following:
 - 1. Dimensions of fixtures.
 - 2. Certified results of laboratory tests for fixtures and lamps for photometric performance.
 - 3. Emergency lighting unit battery and charger.
 - 4. Fluorescent and high-intensity-discharge ballasts.
 - 5. Types of lamps.
- B. Maintenance Data: For lighting fixtures to include in maintenance manuals specified in Division 1.

1.4 QUALITY ASSURANCE

- A. Fixtures, Emergency Lighting Units, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction.
- B. Comply with NFPA 70.
- C. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

1.5 COORDINATION

- A. Fixtures, Mounting Hardware, and Trim: Coordinate layout and installation of lighting fixtures with ceiling system and other construction.

1.6 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty for Batteries: Written warranty, executed by manufacturer agreeing to replace rechargeable batteries that fail in materials or workmanship within specified warranty period.
 - 1. Special Warranty Period for Batteries: Manufacturer's standard, but not less than 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for last four years.
- C. Special Warranties for Fluorescent Ballasts: Written warranty, executed by manufacturer agreeing to replace fluorescent ballasts that fail in materials or workmanship within specified warranty period.
 - 1. Special Warranty Period for Electronic Ballasts: Five years from date of manufacture, but not less than four years from date of Substantial Completion.
 - 2. Special Warranty Period for Electronic Emergency Ballasts: Two years from date of Substantial Completion.
 - 3. Special Warranty Period for Electronic Dimming Ballasts: Three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products indicated for each designation in the Lighting Fixture Schedule.

2.2 FIXTURES AND FIXTURE COMPONENTS, GENERAL

- A. Metal Parts: Free from burrs, sharp corners, and edges.
- B. Sheet Metal Components: Steel, unless otherwise indicated. Form and support to prevent warping and sagging. All parts shall be painted after fabrication to facilitate installation, increase efficiency, and inhibit rusting.
- C. Doors, Frames, and Other Internal Access: Smooth operating, free from light leakage under operating conditions, and arranged to permit relamping without use of tools. Arrange doors,

frames, lenses, diffusers, and other pieces to prevent accidental falling during relamping and when secured in operating position.

- D. Reflecting Surfaces: Minimum reflectance as follows, unless otherwise indicated:
 - 1. White Surfaces: 90 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
 - 4. Laminated Silver Metallized Film: 90 percent.
- E. Lenses, Diffusers, Covers, and Globes: 100 percent virgin acrylic plastic or annealed crystal glass, unless otherwise indicated.
 - 1. Plastic: High resistance to yellowing and other changes due to aging, exposure to heat, and ultraviolet radiation.
 - 2. Lens Thickness: 0.125 inch (3 mm) minimum, unless greater thickness is indicated.

2.3 LIGHTING FIXTURES

- A. See the "Lighting Fixture Schedule" on plans.
 - 1. Upper case letter at fixture outlet symbol or in note on Drawings indicated the fixture type. Lower case letter at fixture symbol indicated switching circuit. Any outlets not specifically labeled shall be equipment with fixture similar to those in rooms used for like purposes.
 - 2. Fixtures requiring plaster frames or other special frames shall be furnished with these frames as required for type of construction. Fixtures requiring additional accessible outlet connection boxes and additional wiring from outlet box to fixture, shall be furnished with this wiring per the N.E.C. and Local Code requirements. Frames of all recessed fixtures shall be tight to the ceiling to eliminate light leaks. Gasketing shall be used to eliminate all light leaks.

2.4 FLUORESCENT LAMP BALLASTS

- A. Electronic type ballast as manufactured by Advance, Energy Savings Inc., GE Lighting, Howard Industries, Universal Lighting Technologies, or Sylvania.
- B. General Requirements: Unless otherwise indicated, features include the following:
 - 1. Designed for type and quantity of lamps indicated at full light output.
 - 2. Type: NEMA Premium, instant start, energy saving. Ballasts shall qualify for utility rebates. A list of qualified ballasts can be found at www.cee1.org.
 - 3. Total Harmonic Distortion Rating: Equal to or less than 10 percent.
 - 4. Power Factor: 95 percent, minimum.
 - 5. Ballast Factor: .88, unless noted otherwise.
 - 6. Sound Rating: A.
 - 7. Operating Voltage: Match connected circuits.
 - 8. Multi-lamp Ballasts: Utilize 1, 2, 3, or 4 lamp ballast as required to accommodate switching shown on the drawings.
 - 9. Fixtures Controlled By Occupancy Sensors: Ballasts which are controlled by occupancy sensors at locations where frequent switching will occur shall be programmed-start type

equal to Magnetek AccuStart series or Advance Optanium series, wired for parallel lamp operation.

- C. Electronic Ballasts for Linear Lamps: Unless otherwise indicated, features include the following, besides those in "General Requirements" Paragraph above:
 - 1. Certified Ballast Manufacturer Certification: Indicated by label.
 - 2. Encapsulation: Without voids in potting compound.
 - 3. Parallel Lamp Circuits: Multiple lamp ballasts connected to maintain full light output on surviving lamps if one or more lamps fail.
 - 4. Minimum Starting Temperature: 0°F.
- D. Ballasts for Dimmer-Controlled Fixtures: Comply with general and fixture-related requirements above for electronic ballasts.
 - 1. Compatibility: Certified by manufacturer for use with specific dimming system indicated for use with each dimming ballast. Dimming ballast shall provide continuous flicker-free dimming throughout the specified dimming range.
 - a. Ballast for linear lamps shall provide 10-100% dimming.
- E. Ballasts for Low-Temperature Environments: As follows:
 - 1. Temperatures 0 Deg F (Minus 17 Deg C) and Above: Electronic type rated for 0 deg F (minus 17 deg C) starting temperature.
 - 2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Above: Electromagnetic type designed for use with high-output lamps.
- F. Ballasts for Low Electromagnetic Interference Environments: Comply with 47 CFR, Chapter 1, Part 18, Subpart C for limitations on electromagnetic and radio-frequency interference for consumer equipment.

2.5 HIGH-INTENSITY-DISCHARGE LAMP BALLASTS

- A. General: Comply with ANSI C82.4. Unless otherwise indicated, features include the following:
 - 1. Type: Regulating high-power-factor type, unless otherwise indicated.
 - 2. Operating Voltage: Match connected circuits.
 - 3. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C) for single lamp ballasts.
 - 4. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
 - 5. Open-circuit operation that will not reduce average life.
 - 6. Auxiliary, Instant-on, Quartz System: Automatically switches quartz lamp on when fixture is initially energized and when momentary power outages occur. Automatically turns quartz lamp off when high-intensity-discharge lamp reaches approximately 60 percent light output.
- B. Encapsulation: Manufacturer's standard epoxy-encapsulated model designed to minimize audible fixture noise.

2.6 EXIT SIGNS

- A. General Requirements: Comply with UL 924 and the following:
 - 1. Sign Colors and Lettering Size: Comply with authorities having jurisdiction.
 - 2. Wire Guard: Where indicated, heavy-chrome-plated wire guard arranged to protect fixtures.
- B. Internally Lighted Signs: As follows:
 - 1. Lamps for AC Operation: Light-emitting diodes, 70,000 hours minimum rated lamp life.

2.7 LAMPS

- A. Lamps as manufactured by Osram Sylvania, Phillips Lighting, or General Electric.
- B. Fluorescent lamps shall qualify for utility rebates. A list of qualified lamps can be found at www.ceel.org.
- C. Reduced Wattage Linear Fluorescent T-8 lamps:
 - 1. Type: Rapid start.
 - 2. Minimum Rated Life (48"): 30,000 hrs rated average at 3 hours per start.
 - 3. Minimum Rated Life (36" and 24"): 24,000 hrs rated average at 3 hours per start.
 - 4. Color Temperature: 3500K.
 - 5. Color Rendering Index (CRI): 82 minimum.
 - 6. Minimum Initial Lumens: 2585 (48"), 2225 (36"), 1400 (24").
 - 7. Power Rating: 28 watts (48"), 25 watts (36"), 17 watts (24").
- D. Linear Fluorescent T-5 High Output High Performance lamps:
 - 1. Minimum Rated Life: 30,000 hrs rated average.
 - 2. Color Temperature: 3500K.
 - 3. Color Rendering Index (CRI): 82 minimum.
 - 4. Initial lumens: 4850 minimum.
 - 5. Nominal length: 48 inches.
 - 6. Power rating: 54 watts.
- E. LED:
 - 1. Color Temperature: 3500K.
 - 2. Color Rendering Index (CRI): 82 minimum.
- F. Metal-Halide Color Temperature and Minimum Color-Rendering Index:
 - 1. Ceramic Metal Halide T-6, PAR, ED-17 type 150 watts or less: 3000 K and 80 CRI, unless otherwise indicated.
 - 2. Other types: 3200K and 70 CRI, unless otherwise indicated.

2.8 FIXTURE SUPPORT COMPONENTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods," for channel- and angle-iron supports and nonmetallic channel and angle supports.

- B. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

2.9 FINISHES

- A. Fixtures: Manufacturer's standard, unless otherwise indicated.
 - 1. Paint Finish: Applied over corrosion-resistant treatment or primer, free of defects, after fabrication.
 - 2. Metallic Finish: Corrosion resistant.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fixtures: Set level, plumb, and square with ceiling and walls, and secure according to manufacturer's written instructions and approved submittal materials. Install lamps in each fixture.
 - 1. Where specific lamp designations are not indicated or specified, lamp fixtures according to manufacturer's recommendations.
 - 2. Square fluorescent light fixtures shall be orientated so all lamps run in the same direction in the same room, corridor, or definable space.
- B. Support for Fixtures in or on Grid-Type Suspended Ceilings: Use grid for support.
 - 1. For fixtures with a weight greater than 7 lbs per square foot of occupied ceiling space, install a minimum of four ceiling support system rods or wires for each fixture. Locate not more than 6 inches (150 mm) from fixture corners. These rods or wires shall be secured to individual support points directly vertical from attachment point to fixture to the extent possible.
 - 2. Support Clips: Fasten to fixtures and to ceiling grid members at or near each fixture corner.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Arrange as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.
- C. Fire Rated Ceilings:
 - 1. Lighting fixtures that are not fire rated for the ceiling they are to be installed in shall be provided with a fire rated enclosure. Enclosure shall be suitable for the application as approved by the local Authority Having Jurisdiction (AHJ). Contractor shall review architectural plans to determine which ceilings, if any, are to be constructed as fire rated assemblies and shall include the protection of any and all light fixtures installed in these ceilings in his/her bid.
- D. Exit Light Installation in Grid-Type Suspended or Gyp Board Ceilings:
 - 1. Support electrical boxes firmly to the deck structure utilizing unistrut or other acceptable means. Fixtures shall not be easily turned or rotated from below.

- E. Emergency Lighting Fixtures: Provide unswitched normal building power to all fixtures provided with generator transfer devices (GTD) or batteries for local power failure indication. The unswitched power connection shall be from a branch circuit serving the lighting in the space in which the emergency lighting is located.
- F. Fluorescent Lamps for Dimmer-Controlled Fixtures: Comply with lamp manufacturers recommendations for “seasoning” lamps.
 - 1. Operate new lamps at full intensity for 100 cumulative hours prior to dimming.

3.2 CONNECTIONS

- A. Ground equipment.
 - 1. 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.

3.3 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Tests: As follows:
 - 1. Verify normal operation of each fixture after installation.
 - 2. Emergency Lighting: Interrupt electrical supply to demonstrate proper operation.
 - 3. Verify normal transfer to battery source and retransfer to normal.
 - 4. Report results in writing.
- C. Malfunctioning Fixtures and Components: Replace or repair, then retest. Repeat procedure until units operate properly.
- D. Corrosive Fixtures: Replace during warranty period.

3.4 CLEANING AND ADJUSTING

- A. Clean fixtures internally and externally after installation. Use methods and materials recommended by manufacturer.
- B. Adjust aimable fixtures to provide required light intensities.

END OF SECTION 265110

SECTION 277290 - RF BROADBAND TV DISTRIBUTION SYSTEM

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 all labor, materials, equipment and related services to furnish and install the TV Distribution System as shown on the drawings and herein specified.
- B. The work to be provided under these specifications consists of furnishing and installing a complete RF Distribution System up to and including headend distribution amplifier and interface to the existing Owner provided Cable TV Signal source. This Contractor shall furnish all necessary equipment, labor, and installation materials necessary to provide a complete distribution system.

1.3 SUBMITTALS, SHOP DRAWINGS & MAINTENANCE MANUALS

- A. Submittals shall be provided in accordance with Division 1 and as further described herein.
- B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item. Manufacturer's product data sheets, describing each of the major components shall also be provided.
- C. Submittals shall be tab divided to aid in identifying the various sections of the submittal.
- D. Shop drawings shall include complete floor plan drawings showing device locations, conduit routing, wire and cable quantity and sizes. Functional block diagrams, complete termination diagrams, showing all headend, control and typical field devices, shall also accompany the submittal.
- E. Maintenance manuals shall be compiled in accordance with the Division 1, shall include all information provided as part of the original submittal and shall also be updated to include installation notes, manufacturer's manuals, etc. Manuals shall also include:
 - 1. Descriptions of all equipment and normal operations
 - 2. Final shop drawings, updated to reflect "as-built" accuracy. Include outlets with label ID's, and cable designations and routing information.
 - 3. Field test reports shall be provided, indicating and interpreting test results for compliance with performance requirements of the Project.
 - 4. Maintenance data shall be included for all major pieces of equipment, as per the requirements specified in Division 1.
 - 5. Copy of major equipment manufacturer's standard warranty statements, for future reference and use, should claims need to be submitted.

1.4 QUALITY ASSURANCE

A. Product Quality

1. Equipment described in this Section shall be provided by a company regularly engaged in the design, sale and installation of RF Broadband TV Distribution Systems. This company shall also have a service organization, trained by the equipment manufacturer and located a reasonable distance from the jobsite, which is capable of maintaining the system once installed. The services of this company shall be retained by the Electrical Contractor to supervise the system design, installation, make final system connections, and perform all tests and balance work required.
2. All basic electronic equipment shall be listed by Underwriter's Laboratories, Inc. for the application and shall be products of manufacturers of established reputation and experience.

B. Contractor Qualifications

1. The Installing Contractor shall be a firm specializing in the type of work called out in this specification section and shall, upon request, provide documentation that they have successfully completed at least three other installations of similar size and scope to this installation.
2. The Installing Contractor (and any Subcontractors working for the Installing Contractor) shall be licensed, in accordance with local, regional and state authorities having jurisdiction, to complete the work that they are contracted to perform.

1.5 CONFIGURATION

- A. The system shall provide for reception of both color and monochrome television signals at any outlet in the system equal to that obtainable by a single standard receiver connected directly to the CATV feed.
- B. The system shall meet or exceed the technical standards set forth in FCC Rules, Part 76.
- C. Equipment shall also be capable of providing two-way (bi-directional) communication over a single cable. Implementation of two-way communications shall not make present equipment obsolete, but shall require only the addition of future headend equipment.
- D. Bandwidth of all passive devices shall be from 50 MHz to 1000 MHz in the forward direction, and from 5 MHz to 50 MHz in the reverse path.
- E. The system shall be designed for minus 46 dB cross-modulation or better, and a carrier-to-noise ratio of at least 43 dB.
- F. Isolation between any two outlets in the system shall be a minimum of 20 dB on any TV frequency.
- G. All outlets in the system shall provide a minimum level of +0 dBmv and a maximum of +12 dBmv across the entire passband range, with a design level of +6dBmv, nominal. Provide additional amplifiers, as specified and required, to accomplish this requirement.
- H. Under the scope of this project, a complete system, including headend broadband amplifiers are to be provided. All necessary headend amplification equipment, modulators, convertors, etc., shall also be provided by this contractor.

- I. Under the scope of this contract, no TV sets are to be provided and no wall brackets for mounting of TV sets are to be installed. The Owner will contract for this work separately outside the scope of this contract.
- J. Coordination of TV Cable feed is to be by the Owner, outside the scope of this project.
- K. The TV Distribution System described herein and shown on plans shall be installed in a “home run” configuration with outlets in each area being connected together (daisy chain) and then served by a single separate home run cable originating at the central equipment TV headend. Provide one home run cable for each area, patient room, and similar application at locations shown on plans.

1.6 IN-HOUSE ORIGINATION PROGRAMMING CAPABILITIES

- A. Under the scope of this contract, there are to be no provisions for In-House Origination Programming.

1.7 MEDIA RETRIEVAL & MEDIA SCHEDULING

- A. Under the scope of this contract, there are to be no provisions for automatic time of day scheduling or remote control of any of the A/V Sources.

1.8 BULLETIN BOARD MESSAGING

- A. Under the scope of this contract, there is to be no bulletin board messaging capabilities (no character or graphics generator or associated processors or modulators).

1.9 PORTABLE A/V ORIGINATION EQUIPMENT & OPERATION

- A. Under the scope of this contract, there are to be no provisions to support Portable A/V Origination Equipment.

PART 2 - PRODUCTS

2.1 APPROVALS

- A. The Products that are to be provided to form the system described herein are defined both functionally and descriptively. It is to be understood that these explanations are provided to establish minimum acceptable standards of performance and appearance. Product make and model numbers have also been provided to further define and more closely describe specific operational characteristics and/ or to make the contractor aware of the owner’s preference for particular products.
- B. If, in the estimation of a qualified potential supplier or installer, equipment of other manufacture could be substituted without compromising the integrity of the installation or its’ overall design intent, then a request for consideration to substitute said product must be made in writing at least seven (7) days prior to bid date, fully describing the substitution.

- C. Any exceptions to specifications, in terms of product appearance, configuration, operation or capabilities, which alter a potential bidder's ability to meet these specifications shall be fully disclosed to the Architect/ Engineer at the time a request for approval to bid is received.
 - 1. Operational features and characteristics which exceed the requirements set forth in this specification as a minimum standard need not be disclosed at the time of product consideration for approval.
- D. Notice of all bidder and product approvals shall be by addendum issued prior to bid date.

2.2 VHF/UHF BROADBAND AMPLIFIER

- A. Broadband amplifiers shall be provided to amplify all incoming CATV. No "cherry picking" or "channel blocking" is required beyond that already found on the existing combined feed.
- B. The amplifier shall be sized for the present project, with headroom to accommodate moderate future growth of the distribution system.
- C. Amplifiers shall operate with a minimum full gain of +43 dBmv across the entire CATV spectrum (50-860 MHz), with an output capability of at least 42 dB into a system configured with one hundred twenty-nine (129) active channels. Amplifiers shall be of push-pull design, offer power doubling where appropriate, and operate within the following parameters- cross modulation at -54dB or better, composite triple beat at -50dB or better.
- D. Gain, output level and tilt adjust controls shall all be provided on the face of the amplifier.
- E. A tunable FM trap with 10 dB notch filter shall also be provided. The unit shall be powered at 115 VAC.
- F. Broadband Amplifiers shall be equal to a Blonder-Tongue Model BIDA 86A-43.

2.3 DIRECTIONAL COUPLER TAPS

- A. Directional coupler type taps shall be provided as required for signal distribution. The taps shall be fully shielded and in compliance with FCC rules pertaining to radiation and have 120 dB minimum RF shielding. The taps shall be available in standard isolation values from 4 to 30 dB. Frequency response through any port shall be from 5 MHz to 1000 MHz.
- B. Directional coupler taps shall provide through loss of less than 1.2 dB and back match in excess of 18 dB. Any combination of taps shall provide a minimum isolation between tap ports of 18 dB. All cable connections shall be by "F" type fittings. Taps shall be solder-back type housed in a rugged cast aluminum case.
- C. Single port taps shall be Blonder-Tongue SRT series and four port taps shall be Blonder-Tongue SDC4 series.

2.4 TV ROOM OUTLETS

A. Standard TV Room Outlet Plates

1. Where noted on plans with the symbol "TV", standard TV Room outlets shall be provided. Plate appearance shall be that of a decora (GFCI) style receptacle, with ivory subplate. An "F" type feed through jacks shall pass through the face of the subplate. Provide a stainless steel 302 cover plate that matches other electrical outlets in the room.
2. TV Room Outlets shall be equal to Leviton 40681-IV.
3. Provide directional coupler (DC) type tap-offs in outlet backbox, where required to support daisy chain applications.

2.5 MIXING AND SPLITTING DEVICES

- A. Broadband mixing/splitting devices shall be used in the system as required. These units shall be solder-back type, housed in rugged, cast aluminum housings, equipped with flanges to permit mounting on any flat surface. Units shall meet FCC specifications on radiation and have 120 dB minimum RF shielding.
- B. All units shall have a frequency response from 5 MHz to 1000 MHz. Two-way splitters shall have a maximum splitting loss of 4.5 dB. Four-way splitters shall have a maximum splitting loss of 7.7 dB.
- C. Two Way Splitters shall be Blonder-Tongue SRT type and Four Way Splitters shall be Blonder-Tongue SDC4 type.

2.6 COAXIAL CABLES

- A. Two types of coaxial cables shall be used for the distribution system, in RG-6 and RG-11 sizes. The larger cable is to be used for all trunk lines, with the smaller dimension cable being reserved for shorter feed lines and room drops. Coaxial cable shall be of 75 ohm impedance with a return loss of 20 dB minimum from 5 MHz to 1000 MHz. Cable construction shall be solid bare copper conductor and cellular polyethylene dielectric. Cable jackets shall be black, non-contaminating, low temperature, polyvinyl chloride or chlorinated polyethylene.
 1. RG-6 size cable shall have a nominal loss per 100 feet of 0.50 dB at 5 MHz, 1.5 dB at 50 MHz, and 5.0 dB at 450 MHz. The center conductor shall be #18 AWG copper clad steel with a dielectric O.D. of 0.17 inches. Overall cable O.D. shall be no greater than 0.254 inches. Shield shall be bifoil type with 100% aluminum clad mylar and a separate 80% aluminum braid.
- B. Individual drain wires in lieu of braid are not acceptable.
- C. Coaxial cables shall be equal to Coleman 921015, in RG6 size. Use minimum conduit size of 3/4".
- D. All coax cables shall be plenum type.

2.7 CABLE CONNECTORS

- A. Coaxial cable connectors shall be used to connect to equipment as required. Connectors shall be solder-less, 75-ohm impedance and be designed for the specific type of cable used. *“Screw-on” type connectors are NOT acceptable.* Splices in any coaxial cable line are not acceptable, unless splice connectors specifically designed for the purpose are available and used.
- B. “F” Type Mating Connectors, required at each outlet and tap, shall be of a type designed specifically to minimize RF leakage. “F” Connectors shall have attached rings with sleeve length of at least 5/8" and be designed for 360^o crimping, using a compression type (radial) crimp tool to form a concentric seal. Crimp connectors that have a separate crimp ring and/or are to be crimped using a hex crimp tool are NOT acceptable. Connectors used outdoors shall also have an “O” ring, or other type of seal, to maintain electrical integrity in such an environment.
- C. In RG6 size, cable connectors shall be equal to ICM/F-CONN RG6WR, RG6NR or DB6 series. LRC SNS (snap-n-seal) and Gilbert GF-UE (ultra-ease) series connectors shall be considered equal. Use plenum or non-plenum versions of these connectors, as appropriate.

2.8 EQUIPMENT HOUSINGS, RACKS & TERMINATION BOARDS

- A. Broadband amplifiers, signal processors and miscellaneous splitters shall be mounted on a data termination board, where noted on plans. Terminal board shall be of 3/4" plywood, sized for the application and painted with two coats of gray fire retardant paint. Reserve at least 24"x48" of space at each termination board location for cable TV makeup. Electrical Contractor shall also provide a surface mounted duplex power receptacle at each termination board, to accommodate any present or future amplification equipment that may be needed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction
- B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.
- C. Cable shall be adequately supported, and connectors specifically designed for the type cable in use shall be installed.
- D. All equipment shall be suitably mounted in cabinets, junction boxes, or otherwise solidly supported. Equipment suspended by its coaxial connection is not acceptable.
- E. Electronic equipment, antennas, antenna supports, etc., shall be bonded to earth ground using #6 solid copper wire extended to the building electrical ground point.
- F. Amplifier input cables shall not be bundled with output cables.

- G. All outdoor connections shall be weatherproofed through use of weather boots or other approved methods.
- H. Wiring Method: Install wiring in raceway and cable tray (where provided) except within consoles, cabinets, desks, counters, accessible ceiling spaces, and in gypsum board partitions where “free air” cable wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and wiring except in unfinished spaces. All cabling routed at exposed ceiling structure in finished spaces shall be installed in raceway. All wiring installed underground or underslab shall be wet location listed.
1. Whether system cabling is installed in cable tray or “free air”, the system cabling shall be neatly run and shall be bundled separately from all other systems cabling.
 2. Where cable is run “free air”, the cable shall be rated for the intended use and shall be neatly run and supported, using acceptable means to ensure reliable installation and performance.
 - a. Install cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
 - b. Install sleeves for cable penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls. Provide insulated bushings for protection of conductors.
 - c. Secure and support cable at intervals not exceeding 8 feet and not more than 12 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - d. Utilize cable distribution rings and hangers, standoffs, spools and other suitable devices as an aid in managing all cable runs. Where cable tray is not provided and where 10 or more cables are routed together, cable distribution rings or hangers shall be wall or ceiling mounted above accessible ceilings at varying 4 to 6 foot intervals.
 - e. Cables shall not be laid on or draped across any ceiling tiles, grids, electrical or mechanical fixtures. Maintain at least a 12 inch separation between the communications cables and fluorescent or HID lighting.
 - f. Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support.

3.2 SYSTEM TESTS

- A. Upon completion of the system installation, it shall be the responsibility of this Contractor to perform all necessary adjustments and balancing of all signal levels to ensure proper system operation.
- B. The system shall be physically inspected by an authorized Representative of the customer to assure that all equipment is installed in a neat and workmanlike manner as called for by the plans and specifications.

- C. Before the contract shall be considered complete, the Contractor shall conduct an operating test for approval. The system shall be demonstrated to operate in accordance with the requirements of these specifications. The test shall be performed in the presence of the Engineer. The Contractor shall furnish all equipment and personnel required for the tests.
 - 1. Each cable feeder line shall be inspected for proper termination.
 - 2. Using a field strength meter, measure the signal level at the last outlet on each feeder line and other randomly selected outlets totaling not less than 25 percent of the total number of outlets. At any outlet, signal levels shall be more than 0dBmv and less than 12dBmv, as measured on any active channel.
 - 3. Using a standard TV receiver connected to randomly selected outlets, not less than one per feeder, observe picture quality. No visible components of cross-modulation (windshield wiper effect) ghosting or beat interference shall appear on the screen of a receiver tuned to any normal channel.

3.3 DOCUMENTATION

- A. Upon completion of work, three (3) complete sets of Operator/Maintenance (O&M) Manuals shall be compiled and released to the Owner.
- B. Manuals shall include, but not be limited to, complete sets of “as built” floor plans and termination drawings, material lists, product data sheets, as well as the manufacturer’s published (O&M) literature.
- C. Manuals shall be prepared, divided, and identified by system type to ensure ease of use in the future.

3.4 WARRANTY

- A. The entire installation shall be guaranteed against all defects in materials and workmanship for a period of one (1) year from date of system acceptance. First response to a problem, during the first year, shall be provided by factory trained personnel representing the various equipment suppliers. This response is to include maintenance, repair, or replacement of any equipment found to be defective, provided the defect is not caused by misuse, abuse, neglect, or unauthorized tampering or modification. All labor, shipping, transportation and related expenses are to be at no additional cost to the Owner for any warranty service provided.

END OF SECTION 277290

SECTION 277400 - COMMUNICATION AND DATA-PROCESSING 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 wire, cable, connecting devices, installation, and testing for wiring systems to be used as signal pathways for voice and high-speed data transmission.
- B. The data transmission system shall be a Manufacturer Certified Category 5e system as specified and indicated on the drawings. Warranty shall be a minimum of fifteen years.
 - 1. The cable shall have guaranteed performance measurements out to 350MHz for all categories except ARC which needs to be measured up to 200MHz. These guaranteed measurements need to be equal to or better than Mohawk Megalan Category 5E+.
 - 2. The system shall incorporate commercial grade products as specified. Lead frame and residential grade products are not acceptable.
- C. This contractor shall be responsible for the removal and legal disposal of all abandoned communications cabling and devices.

1.3 SUBMITTALS

- A. Submittals shall be provided in accordance with Division 1 and as further described herein.
- B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item. Manufacturer's product data sheets, describing each of the major components shall also be provided.
- C. Submittals shall be tab divided by system to aid in identifying the products associated with each system.
- D. Shop Drawings: Include dimensioned plan and elevation views of components. Show access and workspace requirements.
 - 1. System labeling schedules, including electronic copy of labeling schedules, as specified in Part 3, in software and format selected by Owner.
- E. Product Certificates: Signed by manufacturers of cables, connectors, and equipment certifying that products furnished comply with requirements.
- F. Qualification Data: Submit evidence that the firms and persons scheduled by this contractor to execute the installation, termination and testing of the communication and data processing

equipment are qualified to properly complete all work required and that they are properly registered or certified as specified in the "Quality Assurance" Article.

- G. Maintenance Data: For products to include in maintenance manuals specified in Division 1.
1. Descriptions of all equipment and normal operating procedures.
 2. Provide as-built floor plan drawings showing all installed outlets with label ID's and cabling designation and routing information.
 3. Provide riser diagrams showing all cabling as installed.
 4. Provide warranty information required by manufacturers for submission of warranty claims for all materials installed.
 5. Include a complete proof of performance report outlining the operating parameters tested, complete test results and a review of industry standards for each parameter. One copy of test results in electronic format accompanied with the software from the test equipment manufacturer to view and update test results must also be included.
 6. Include proof of calibration for all copper and fiber test equipment.

1.4 QUALITY ASSURANCE

- A. This contractor shall be a firm that specializes in this type of work and shall, upon request, provide documentation of a minimum of three other successfully completed projects of similar size and magnitude that they are responsible for completing.
- B. On the date of document issue, this contractor shall be a certified installer by:
1. Panduit Corporation, Network Systems Division.
- C. This contractor and all employees working on the jobsite shall currently meet all manufacturer requirements for the provision of all equipment specified herein. This contractor shall provide certification that all assigned staff has attended training courses corresponding to the types of cabling and installations specified herein.
- D. This contractor shall be familiar with and utilize the following reference documents and codes throughout the course of equipment installation.
1. ANSI/TIA/EIA-568-B.1 Commercial Building Telecommunications Cabling Standard and all addendums.
 2. ANSI/TIA/EIA-568-B.2 Commercial Building Telecommunications Cabling Standard Part 2: Balanced Twisted-Pair Cabling Components and all addendums.
 3. ANSI/TIA/EIA-568-B.3 Commercial Building Telecommunications Cabling Standard Part 3: Optical Fiber Cabling Components Standard and all addendums.
 4. ANSI/TIA/EIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces.
 5. ANSI/TIA/EIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings.
 6. BICSI Telecommunications Distribution Methods Manual, most recent edition.
 7. BICSI Telecommunications Cabling Installation Manual, most recent edition.
 8. NFPA-70 National Electrical Code, most recent adopted edition.
 9. NECA/BICSI-568-A Standard for Installing Commercial Building Telecommunications Cabling.
 10. Federal Communications Commission Part 15 and Part 68.
 11. UL 444 – Standard for Safety of Communications Cable.

12. UL 1666 – Standard for Safety of Flame Propagation Height.
 13. NFPA 262 – Flame Travel and Smoke of Wires and Cables.
 14. Any additional requirements of the Local Authority Having Jurisdiction.
- E. This contractor shall utilize and have operators trained in the utilization of the following test equipment:
1. Copper Cable Test Equipment
 - a. Fluke DTX 1800 or approved equal.
 - b. JDSU NGC-4500, or approved equal.
 2. Fiber Optic Cable Test Equipment
 - a. Tektronix OTDR-OF-150, HP-E6000A OTDR, Siecor 2001HR, or approved equal.
 - b. Fotec M210A, Siecor OM-100F, or equal.
 - c. Fotec S370, Siecor OS-100D, or equal.
- F. All products provided as part of this project shall be manufactured by firms experienced in manufacturing components listed under ANSI/TIA/EIA 568-B.2 and whose products conform to the standards of this specification.
- G. 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.

1.5 COORDINATION

- A. Coordinate Work of this Section with Owner's telephone switch, telephone instrument, workstation, and LAN equipment suppliers. Coordinate service entrance arrangement with local exchange carrier.
1. Meet jointly with representatives of above organizations and Owner's representatives to exchange information and agree on details of equipment arrangements and installation interfaces.
 2. Record agreements reached in meetings and distribute record to other participants.
 3. Adjust arrangements and locations of distribution frames, patch panels, and cross connects in equipment rooms and wiring closets to accommodate and optimize arrangement and space requirements of the telephone switch and LAN equipment.

1.6 MAINTENANCE/WARRANTY

- A. Provide service and maintenance of cabling system for one year from date of substantial completion.
- B. Provide a warranty for the system (including complete horizontal channels) against malfunction due to component failure or improper installation for a period of fifteen years from date of substantial completion. When notified of a malfunction, proceed to immediately correct the situation by replacement of repair, without cost to the Owner. Clearly indicate provisions of the warranty in the shop drawing submittals and maintenance manuals.

- C. Within the warranty period, the contractor shall repair or replace any defective system components within 48 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Cable products:
 - a. Belden.
 - b. Berk-Tek, Inc.
 - c. CommScope, Inc.
 - d. General Cable.
 - e. Hitachi Cable Manchester.
 - f. Mohawk/CDT.
 - g. Optical Cable Corporation.
 - h. Corning.
 - i. Superior Essex.
 - 2. Connectors, distribution racks, modular jacks, wall plates, patch panels, cable management products, etc. shall be to the greatest extent possible, of one of the following manufacturers:
 - a. Panduit Corporation, Network Systems Division.
 - 3. Innerduct:
 - a. Carlon
 - b. Endot Industries
 - c. Pyramid

2.2 SYSTEM REQUIREMENTS

- A. General: Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance.
- B. Expansion Capability: Unless otherwise indicated, all patch panels, cross connects, terminal strips, trays, wireways, equipment racks, etc. shall be sized to accommodate 20 percent future increase in active workstations.

2.3 MOUNTING ELEMENTS

- A. Cable Trays: Comply with Division 26 Section "Cable Trays."
- B. Raceways and Boxes: Comply with Division 26 Section "Raceways and Boxes."
- C. Backboards: 3/4-inch (19-mm) interior-grade, fire-resistive-treated plywood.

- D. Distribution Racks: Freestanding and/or wall-mounting, as appropriate for the application, and be modular-steel units designed specifically for attachment of telecommunications terminal support equipment.
 - 1. Racks shall be designed to accommodate TIA/EIA standard rack mount equipment.
 - 2. Free standing racks shall be approximately 78 inches high by 19 inches wide. Finish in black powder coat baked finish
 - 3. Provide vertical (front and rear on each side of rack extending from floor to top of rack) and horizontal (2 rack space unit between each patch panel) cable management channels.

2.4 WIRE MANAGEMENT

- A. Jumper Troughs:
 - 1. Furnish and install 110 jumper troughs for management of terminal block patch cords and jumper wires, two per terminal block.
- B. Patch Cord Organizer:
 - 1. Furnish and install 110 patch cord organizers for management of terminal block patch cords and jumper wires, two per patch panel.
- C. Wire Distribution Spools:
 - 1. Furnish and install wire distribution spools for management of terminal block jumper wires, quantities as required.
- D. Wire Hanger Assembly:
 - 1. Furnish and install wire hanger assemblies for management of patch cables, four per backboard.
- E. Cable Hangers:
 - 1. Furnish and install “j-hook” cable hangers that are a minimum of one inch wide and be spaced no more than four feet on center.

2.5 COPPER CONNECTS AND TERMINAL EQUIPMENT

- A. Patch panels (data and voice terminations) shall be modular and designed to accommodate the mounting of multiple numbered jack units. Connectors of the category 5e IDC type, at each jack, are to be used to terminate all wires of each arriving cable. Provide a jack for every arriving cable, plus spares as elsewhere required.
- B. Jacks and jack assemblies for UTP cables shall be category 5e jack modules, modular, color coded, RJ45 type receptacles, with integral IDC type terminals (clips).
 - 1. Jacks shall conform to the performance standard set for in EIA standards and shall have been tested in accordance with TIA/EIA 568-B.2 standard. Jacks shall be durable enough to withstand 2,500 (minimum) insertions and withdrawals of a mating plug, without jack failure or degradation of the connection, as defined in IEC 603-7.

- C. Patch panel patch cords shall be category 5e, 4 pair cables in required lengths, not to exceed 5 meters in length, and shall be of the same manufacturer as other connectivity components in the system. Furnish as UTP and STP, as required. Plug connectors must be designed to properly mate with the jacks being installed. Provide one patch cord for every patch panel data jack in the facility.
- D. Communications outlets (as designated by a half filled/half open triangle on the drawings) shall consist of multi jack/connector assemblies mounted in single gang faceplates. Outlets shall be Panduit products equal to Siemons CT4 series plastic faceplates in light almond finish with designation labels and covers, provide space for two couplers. Couplers shall be Panduit products equal to Siemons CT series angled coupler assemblies in light almond finish (flat couplers shall be used for communications outlets located in ceilings and floor boxes). Unless noted otherwise on the plans, all communications outlets shall be equipped with a category 5e double jack coupler, Panduit products equal to Siemons CT-5e series, with two cables (2D) routed to the nearest MDF or IDF location.
- E. Where wall mount telephone outlets are to be installed, the associated wall jack assemblies shall be of stainless steel design and utilizing binder screws to capture the wires and metal stud posts to hold the wall mount phone in place. Wall mount telephone outlets shall be provided with one voice jack matching other jacks in the facility and one associated voice cable to the nearest IDF location unless noted otherwise.

2.6 UTP/STP COPPER CABLES

- A. All voice and data communications cables shall be listed in compliance with enhanced category 5e TIA/EIA-568-B.1 standards. All voice and data cables shall be category 5e extended frequency (350 MHz) type. Manufacturer's test results shall certify compliance with this standard.
 - 1. Data cables shall be blue, voice cables shall be white.
- B. Conductors shall all be of solid copper.
- C. Unshielded Twisted Pair (UTP) Cable shall be multipair, 24 ga., color coded, thermoplastic-insulated conductors in a PVC jacket.
- D. Where required to comply with building and life safety codes, cables shall be rated for use in a Plenum environment. Features to remain as previously described, except that jacket materials are to be modified to attain the proper listing for the cable.
- E. Provide 4 pair category 5e cables for all data and voice runs to communications outlets and wall mount telephone outlets.
- F. Provide 25 pair minimum cat 5e cables between MDF and IDF's. Backbone cable shall be terminated on patch panels with one pair terminated per port on the blue pair designation of the patch panel. The violet/slate pair of each 25 pair will be coiled for use as a spare.
- G. Whenever cabling is routed under grade with each end of the raceway rising to finish floor elevation, cabling must be wet location listed.

2.7 FIBER-OPTIC CABLES, CONNECTORS, AND TERMINAL EQUIPMENT

- A. Cables: Factory fabricated, jacketed, low loss, glass type, fiber optic, multi-mode, graded index, operating at 850 and 1300 nm, and be laser optimized with aqua jacket.
 - 1. Backbone, Strands per Cable: 6, unless otherwise indicated.
 - 2. Dimensions: 50-micrometer core diameter, 125-micrometer cladding diameter.
 - 3. Maximum Attenuation: 3.5 dB/km at 850 nm; minus 1.5 dB/km at 1300 nm.
 - 4. Minimum Modal Bandwidth: 2000 MHz/km at 850 nm; 500 MHz/km at 1300 nm.
 - 5. Rated for 10 GBPS Ethernet at 300 meters for both 850 nm and 1300 nm.
 - 6. Operating Temperature Range: Minus 20 to plus 70 deg C.
 - 7. Whenever cabling is routed under grade with each end of the raceway rising to finish floor elevation, cabling must be wet location listed.
- B. Plenum Cable: Listed for use in plenums.
- C. Cable Connectors: Quick-connect, simplex- and duplex-type LC couplers with self-centering, axial adaptor mechanisms. Insertion shall not exceed more than 0.75 dB per mated pair.
- D. Patch Panel: Modular panels housing multiple-numbered duplex cable connectors.
 - 1. Permanent Connection: Permanently connect one end of each connector module to installed cable fiber.
 - 2. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to satisfy specified expansion criteria.

2.8 INNERDUCT

- A. Furnish and install plenum rated innerduct, sized for the application, for protection of all fiber optic backbone data cabling, quantities as required. Armored MIC fiber cables may be used in place of innerduct type installation.

2.9 LIGHTNING PROTECTION

- 1. All conductive communications cables that exits one building and arrives at a separate building shall be protected on all leads and on both ends against lightning and over current, utilizing ground protection and sneak circuit protection devices, as appropriate for the application.
- 2. Protection of devices connected to incoming and outgoing cables shall be provided in the form of gas tube protectors at each end of every wire in the cables.
- 3. Typical protection modules shall be housed in a telecommunications block with 66 or 110 type punch down IDC terminals on the input and output of the block. The protectors shall be configured to be able to isolate the circuit from protection by pulling the gas tube out halfway from the normally fully inserted position.
- 4. The protection block shall have a grounding lug that is connected to the ground buss specified in the section via #10AWG stranded copper wire.

2.10 IDENTIFICATION PRODUCTS

- A. Comply with Division 26 Section "Basic Electrical Materials and Methods" the following:
 - 1. Cable Labels: Self-adhesive vinyl or vinyl-cloth wraparound tape markers, machine printed with alphanumeric cable designations.
 - 2. Machine generated labels shall likewise be applied to all faceplates, patch panels, and other locations, as appropriate.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cable. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CABLE APPLICATION

- A. Backbone Fiber Cable: 6 strand (minimum) multi-mode for runs between equipment rooms and wiring closets.
- B. Backbone UTP Cable: Category 5e, 25 pair minimum, to run between equipment rooms and wiring closets.
- C. UTP Cable for Horizontal Runs: Category 5e, 4 pair minimum, to be used in runs from communications outlets to wiring closets.
- D. Cabling for Outdoor Locations: Shall be direct burial rated with applied flooding compound.

3.3 INSTALLATION

- A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction along with meeting BICSI standards.
- B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.
- C. Communications outlet raceway shall consist of 4" square backbox, single gang ring, and ¾" (minimum) conduit with insulated bushing to accessible ceiling space unless noted otherwise.

- D. Wiring Method: Install wiring in raceway and cable tray (where provided) except within consoles, cabinets, desks, counters, accessible ceiling spaces, and in gypsum board partitions where “free air” cable wiring method may be used. Use UL-listed plenum cable in environmental air spaces, including plenum ceilings. Conceal raceway and wiring except in unfinished spaces. All cabling routed at exposed ceiling structure in finished spaces shall be installed in raceway.
1. Whether system cabling is installed in cable tray or “free air”, the system cabling shall be neatly run and shall be bundled separately from all other systems cabling.
 2. Where cable is run “free air”, the cable shall be rated for the intended use and shall be neatly run and supported, using acceptable means to ensure reliable installation and performance.
 - a. Install cable parallel and perpendicular to surfaces or exposed structural members, and follow surface contours where possible.
 - b. Install sleeves for cable penetrations of concrete slabs and walls unless core-drilled holes are used. Install sleeves for cable penetrations of masonry and fire-rated gypsum walls and of all other fire-rated floor and wall assemblies. Install sleeves during erection of concrete and masonry walls. Provide insulated bushings for protection of conductors.
 - c. Secure and support cable at intervals not exceeding 4 feet and not more than 12 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - d. Utilize cable distribution rings and hangers, standoffs, spools and other suitable devices as an aid in managing all cable runs. Where cable tray is not provided, cable distribution hangers shall be wall or ceiling mounted above accessible ceilings at varying 4 to 6 foot intervals. All cable hangers shall be self supporting and be attached to building structure.
 - e. Cables shall not be laid on or draped across any ceiling tiles, grids, electrical or mechanical fixtures, raceways, piping, or ductwork. Maintain at least a 6 inch separation between the communications cables and fluorescent or HID lighting.
 - f. Cables shall not be strapped, taped, or attached by any means to the exterior of any conduit or raceway as a means of support.
 - g. Tie-wraps are not approved, where extra supports are needed for cable support, utilize Velcro strapping.
- E. Install cable using techniques, practices, and methods that are consistent with Category 5e rating of components and that ensure category 5e performance of completed and linked signal paths, end to end.
- F. All fiber-optic back-bone cabling shall be installed in innerduct unless armored MIC type fiber is used.
- G. Install cable without damaging conductors, shield, or jacket.
- H. Do not bend cable in handling or in installing to smaller radii than minimums recommended by manufacturer.

- I. Pull cables without exceeding cable manufacturer's recommended pulling tensions.
 - 1. Pull cables simultaneously if more than one is being installed in the same raceway.
 - 2. Use pulling compound or lubricant if necessary. Use compounds that will not damage conductor or insulation.
 - 3. Use pulling means; including fish tape, cable, rope, and basket-weave wire/cable grips that will not damage media or raceway.
- J. Cable Slack: Provide additional slack at both ends of cables to accommodate future cabling system changes. Include the slack length in all length calculations to ensure that horizontal cable does not exceed 295'.
 - 1. Do not store slack cables in bundled loops. Store cable slack in an extended loop or in a figure 8 configuration to alleviate stress.
 - a. The minimum amount of slack at the MDF and IDF locations shall be 10'.
 - b. The minimum amount of slack at communications outlet locations shall be 1'.
- K. Wiring within Wiring Closets: Provide adequate length of conductors. Train conductors to terminal points with no excess. Use lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
- L. Make splices, taps, and terminations only at indicated outlets, terminals, and cross-connect and patch panels.
- M. Use splice and tap connectors compatible with media types.

3.4 GROUNDING

- A. Comply with Division 26 Section "Grounding."
- B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. To ensure proper grounding, a separate, green #6 copper stranded wire shall be provided & extend from the main distribution frame (MDF) to all intermediate distribution frames (IDF) and all other wiring closets back to the main electrical service entrance central ground reference location. Grounding and bonding shall conform to requirements and TIA/EIA-607 standard.
- D. A ground buss bar shall be installed in each MDF and IDF. It shall have insulated standoffs and be pre-drilled with an array of ¼" holes. The MDF's buss bar size shall be ¼" x 4" x 14" and the IDF bus bars shall be ¼" x 2" x 7". All connections to the buss bars shall be made via non-reversible crimp style one or two hole connectors.

3.5 INSTALLATION IN EQUIPMENT ROOMS AND WIRING CLOSETS

- A. Line walls with ¾" plywood backboards. Paint backboards with two coats of grey fire retardant paint.
- B. Mount patch panels, terminal strips, connecting hardware, and cable management equipment on backboards, unless otherwise indicated.
- C. Group connecting hardware for cables into separate logical fields.
- D. Use patch panels to terminate data and voice cables entering the space, unless otherwise indicated.

3.6 IDENTIFICATION

- A. Identify system components complying with applicable requirements in Division 26 Section "Basic Electrical Materials and Methods", TIA/EIA-606 standard, and the following specifications.
- B. System: Use a unique, three-syllable alphanumeric designation for each cable, and label cable and jacks, connectors, and terminals to which it connects with the same designation. Use logical and systematic designations for facility's architectural arrangement.
 - 1. First character identifies and locates wiring closet or equipment room where cable originates.
 - 2. Second character identifies and locates cross-connect or patch-panel field in which cable terminates.
 - 3. Third character designates the position occupied by the cable (and its pairs) in the field.
 - 4. Subsequent characters to further describe the cable routing and destination, as deemed necessary.
- C. Communications Outlet: Label jacks within outlets and cables within outlet boxes.
- D. Distribution Racks and Frames: Label each unit and field within that unit.
- E. Within Connector Fields, in Wiring Closets and Equipment Rooms: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both communication and data-processing equipment, use a different color for jacks and plugs of each service.
- F. Cables, General: Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
- G. Cable Schedule: Post in prominent location in each wiring closet and equipment room. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Provide electronic copy of final comprehensive schedules for Project, in software and format selected by Owner.

3.7 FIELD QUALITY CONTROL

- A. Testing: On installation of cable and connectors, demonstrate product capability and compliance with requirements. Test each signal path for end-to-end performance from each end of all pairs installed.
- B. Test Reports shall be generated utilizing the compilation software provided as part of the test equipment package routinely included with current data communications test equipment.
- C. Correct malfunctioning units at the Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.
- D. Test Equipment Criteria:
 - 1. All category 5e field testing shall be performed with an approved level IV UTP/ScTP field test device.
 - 2. All UTP/ScTP field testers shall be factory calibrated each calendar year by the field test equipment manufacturer as stipulated by the manuals provided with the field test unit. The calibration certificate shall be provided for review prior to the start of testing.
 - 3. Autotest settings provided in the field tester for testing the installed cabling shall be set to the default parameters.
 - 4. Test settings selected from options provided in the field testers shall be compatible with the installed cable under test.
- E. Copper Cable Testing:
 - 1. Category 5e Data and Voice Cable:
 - a. Category 5e UTP/ScTP horizontal and backbone cables, whose length does not exceed 90 m (295 ft) for the permanent link, and 100 m (328 ft) for the channel shall be 100% tested according to ANSI/TIA/EIA-568-B.1.
 - b. Test parameters include wire map plus ScTP shield (when present) continuity, length, NEXT loss (pair to pair), NEXT loss (power sum), ELFEXT loss (pair to pair), ELFEXT loss (power sum), return loss, insertion loss, propagation delay, and delay skew.
 - c. All UTP/ScTP backbone cables exceeding 90 meters shall be 100% tested for continuity.
 - d. All installed channels shall perform equal to or better than the minimum requirements as specified below at the highest frequency:
 - 1) Frequency Range: 1-100MHz
 - 2) Insertion Loss: 24 dB
 - 3) NEXT Loss: 30.1 dB
 - 4) Power Sum NEXT Loss: 27.1 dB
 - 5) ELFEXT: 17.4 dB
 - 6) Power Sum ELFEXT: 14.4 dB
 - 7) Return Loss: 10.0 dB
 - 8) Propagation Delay: 548 ns
 - 9) Delay Skew: 50 ns
 - 10) ACR: 6.1 dB
 - 11) Power Sum ACR: 3.1 dB

F. Fiber Optic Cable Testing:

1. Fiber optic cables shall be 100% tested for insertion loss and length.
2. Length shall be tested using an OTDR, optical length test measurement device, or sequential cable measurement markings.
3. Insertion loss shall be tested in at least one direction using the 1-jumper method.
4. Acceptable insertion loss test results shall be determined using the following calculation:
 - a. Link Insertion Loss = cable attenuation + connector insertion loss + splice insertion loss
 - 1) Cable attenuation (dB) = attenuation coefficient (dB/km) x length (km).
 - 2) Connector Insertion Loss = .75dB.
 - 3) Splice Insertion Loss = .3 dB per splice.
5. Horizontal Fiber Testing: All installed channels shall perform equal to or better than the minimum requirements as specified below:
 - a. Maximum Insertion Loss: 1.85 dB at 850 nm, 1.7 dB at 1300 nm.
 - b. Minimum Return Loss: -45dB.
6. Backbone Fiber Testing: All installed channels shall perform equal to or better than the minimum requirements as determined from the above equation for the cable length installed.
 - a. Multimode Cable:
 - 1) Maximum Insertion Loss at 2 km length: 8.5 dB (+ .3 dB per splice) at 850 nm, 4.5 dB (+ .3 dB per splice) at 1300 nm.
 - 2) Minimum Return Loss: -45dB.
 - b. Singlemode Cable, Inside Plant:
 - 1) Maximum Insertion Loss at 3 km length: 4.5 dB (+ .3 dB per splice) at 1310 and 1550 nm.
 - 2) Minimum Return Loss: -45dB.
 - c. Singlemode Cable, Outside Plant:
 - 1) Maximum Insertion Loss at 3 km length: 3.0 dB (+ .3 dB per splice) at 1310 and 1550 nm.
 - 2) Minimum Return Loss: -45dB.

3.8 ACCEPTANCE REQUIREMENTS

- A. The contractor must warrant in writing that 100% of the installation meets the requirements specified.
- B. The owner reserves the right to conduct, using contractor equipment and labor, a random re-test of up to 5% of the cable plant to confirm documented results. Any failing cabling shall be re-tested and restored to a passing condition. In the event more than 2% of the cable plant fails during re-test, the entire cable plant shall be re-tested and restored to a passing condition at no additional cost to the owner.
- C. Acceptance shall be subject to completion of all work, successful post-installation testing which yields 100% PASS rating, and receipt of full documentation as described in this specification.

3.9 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

3.10 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain systems.
 - 1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
 - 2. Train designated personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and extending wiring to establish new workstation outlets. Provide a minimum of four hours training.
 - 3. Review data in maintenance manuals. Include copies of all field tests and results. Test results shall show every termination point by identification number and list results of all tests performed. Identify every jack and outlet by name, cable ID, patch panel and crosspoint ID, as well as a description of the building location where the jack is located.
 - 4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

END OF SECTION 277400

SECTION 287210 - FIRE ALARM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes fire alarm systems with manual stations, detectors, signal equipment, controls, and devices.
- B. Related Sections include the following:
 - 1. Division 8 Section "Hardware" for door closers/holders/smoke detectors, electric door locks, and release devices that interface with fire alarm systems.
 - 2. Division 21 for water flow devices and sprinkler valve-tamper devices.

1.3 SYSTEM DESCRIPTION

- A. General: All new fire alarm devices shall be connected to the existing Siemens fire alarm system. All new field devices shall be UL listed with the existing system and shall operate in a compatible, seamless manner. Where required by applicable codes, existing and new notification devices shall be synchronized. Expand and upgrade the existing system as required for a complete operating system.
- B. Wiring Class and Style: Initiating device circuits and signaling line circuits shall be Class B.

1.4 SUBMITTALS, SHOP DRAWINGS & MAINTENANCE MANUALS

- A. Submittals shall be provided in accordance with Division 1 and as further described herein.
- B. Submittals shall include major equipment material lists, summarizing every item to be provided, by manufacturer, part number, quantity, and include a brief summary of each item. Manufacturer's product data sheets, describing each of the major components shall also be provided.
- C. Submittals shall be tab divided to aid in identifying the various sections of the submittal.
- D. Shop drawings shall include complete floor plan drawings showing device locations, conduit routing, wire and cable quantity and sizes. Functional block diagrams, complete termination diagrams, showing all headend, control and typical field devices, shall also accompany the submittal.
 - 1. Battery: Provide battery sizing calculations for the control panel and each power expander for actual connected loads.

2. Voltage Drop Calculations: Provide voltage drop calculations for all notification circuits.
 3. System Operation Description: Detailed description for this Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.
- E. Maintenance manuals shall be compiled in accordance with the Division 1, shall include all information provided as part of the original submittal and shall also be updated to include installation notes, manufacturer's manuals, etc. Manuals shall also include:
1. Descriptions of all equipment and normal operating procedures.
 2. Final shop drawings, updated to reflect "as-built" accuracy. Include outlets with label ID's, and cable designations and routing information.
 3. Field test reports shall be provided, indicating and interpreting test results for compliance with performance requirements of the Project. Provide certificate of completion in compliance with NFPA 72.
 4. Maintenance data shall be included for all major pieces of equipment, as per the requirements specified in Division 1.
 5. Copy of major equipment manufacturer's standard warranty statements, for future reference and use, should claims need to be submitted.
- F. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals specified in Division 1 Section "Submittals", make an identical submission (quantity as required by the AHJ) to authorities having jurisdiction. Include copies of annotated Contract Drawings as needed to depict component locations to facilitate review. Resubmit if required to make clarifications or revisions to obtain approval. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

1.5 QUALITY ASSURANCE

- A. Product Quality
1. Equipment described in this Section shall be provided by a company regularly engaged in the design, sale and installation of Fire Alarm Systems. This company shall also have a service organization, trained by the equipment manufacturer and located a reasonable distance from the jobsite, which is capable of maintaining the system once installed. The services of this company shall be retained by the Electrical Contractor to supervise the system design, installation, make final system connections, and perform all tests and balance work required.
 2. All basic electronic equipment shall be listed by Underwriter's Laboratories, Inc. for the application and shall be products of manufacturers of established reputation and experience.
 3. Obtain fire alarm system components through one source from a single manufacturer.
- B. Contractor Qualifications
1. The Installing Contractor shall be a firm specializing in the type of work called out in this specification section and shall, upon request, provide documentation that they have successfully completed at least three other installations of similar size and scope to this installation.
 2. Compliance with Local Requirements: Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.
 3. Comply with NFPA 72.

4. The Installing Contractor (and any Subcontractors working for the Installing Contractor) shall be licensed, in accordance with local, regional and state authorities having jurisdiction, to complete the work that they are contracted to perform.

1.6 SEQUENCING AND SCHEDULING

- A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.
- B. Equipment Removal: After acceptance of the new fire alarm system, remove existing disconnected fire alarm equipment and restore damaged surfaces.
 1. Package operational fire alarm and detection equipment that has been removed and deliver to Owner.
 2. Remove from site and legally dispose of existing material not designated for other disposition.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by Siemens.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

- A. Control of System: By the existing FACP.
- B. System Supervision: Automatically detect and report open circuits, shorts, and grounds of wiring for initiating device, signaling line, and notification-appliance circuits.
- C. Priority of Signals: Automatic alarm response functions resulting from an alarm signal from one zone or device are not altered by subsequent alarm, supervisory, or trouble signals. An alarm signal is the highest priority. Supervisory and trouble signals have second- and third-level priority. Higher-priority signals take precedence over signals of lower priority, even when the lower-priority condition occurs first. Annunciate and display all alarm, supervisory, and trouble signals regardless of priority or order received.
- D. Noninterference: A signal on one zone shall not prevent the receipt of signals from other zones.
- E. System Reset: All zones are manually resettable from the FACP after initiating devices are restored to normal.
- F. Transmission to Remote Alarm Receiving Station: Automatically route alarm, supervisory, and trouble signals to a remote alarm station by means of a digital alarm communicator transmitter and telephone lines.

- G. Loss of primary power at the FACP initiates a trouble signal at the FACP and the annunciator. An emergency power light is illuminated at both locations when the system is operating on the secondary power supply.
- H. Basic Alarm Performance Requirements: Unless otherwise indicated, operation of a manual station, automatic alarm operation of a smoke (duct type smoke detector shall result in either an alarm or a supervisory condition as required by the AHJ) or flame or heat detector, or operation of a sprinkler flow device initiates the following:
 - 1. Notification-appliance operation.
 - 2. Identification at the FACP and the remote annunciator of the device originating the alarm.
 - 3. Transmission of an alarm signal to the remote alarm receiving station.
 - 4. Unlocking of electric door locks in designated egress paths.
 - 5. Release of fire and smoke doors held open by magnetic door holders.
 - 6. Recall of elevators.
 - 7. Shutdown of fans and other air-handling equipment serving zone where alarm was initiated.
 - 8. Closing of smoke dampers in air ducts of system serving zone where alarm was initiated.
 - 9. Recording of the event in the system memory.
 - 10. Recording of the event by the system printer.
- I. Alarm Silencing, System Reset and Indication: Controlled by switches in the FACP and the remote annunciator.
 - 1. Silencing-switch operation halts alarm operation of notification appliances and activates an "alarm silence" light. Display of identity of the alarm zone or device is retained.
 - 2. Subsequent alarm signals from other devices or zones reactivate notification appliances until silencing switch is operated again.
 - 3. When alarm-initiating devices return to normal and system reset switch is operated, notification appliances operate again until alarm silence switch is reset.
- J. Water-flow alarm switch operation initiates the following:
 - 1. Notification-appliance operation.
 - 2. Flashing of the device location-indicating light for the device that has operated.
- K. Smoke detection for zones or detectors with alarm verification initiates the following:
 - 1. Audible and visible indication of an "alarm verification" signal at the FACP.
 - 2. Activation of a listed and approved "alarm verification" sequence at the FACP and the detector.
 - 3. Recording of the event by the system printer.
 - 4. General alarm if the alarm is verified.
 - 5. Cancellation of the FACP indication and system reset if the alarm is not verified.
- L. Sprinkler valve-tamper switch operation initiates the following:
 - 1. A supervisory, audible, and visible "valve-tamper" signal indication at the FACP and the annunciator.
 - 2. Flashing of the device location-indicating light for the device that has operated.
 - 3. Recording of the event by the system printer.
 - 4. Recording of the event in the system memory.

5. Transmission of supervisory signal to remote alarm receiving station.

M. Removal of an alarm-initiating device or a notification appliance initiates the following:

1. A "trouble" signal indication at the FACP and the annunciator for the device or zone involved.
2. Recording of the event in the system memory.
3. Transmission of trouble signal to remote alarm receiving station.

2.3 MANUAL PULL STATIONS

A. Description: Fabricated of metal or lexan, and finished in red with molded, raised-letter operating instructions of contrasting color.

1. Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm. Break glass stations are not acceptable.
2. Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
3. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

2.4 SMOKE DETECTORS

A. General: Include the following features:

1. Operating Voltage: 24-V dc, nominal.
2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
4. Integral Visual-Indicating Light: LED type. Indicates detector has operated.
5. Sensitivity: Can be tested and adjusted in-place after installation.
6. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

B. Photoelectric Smoke Detectors: Include the following features:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot (0.008 and 0.011 percent/mm) smoke obscuration when tested according to UL 268A.

C. Duct Smoke Detector: Photoelectric type.

1. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
2. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.5 OTHER DETECTORS

- A. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or rate of rise of temperature that exceeds 15 deg F (8.3 deg C) per minute, unless otherwise indicated.
1. Mounting: Plug-in base, interchangeable with smoke detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.6 NOTIFICATION APPLIANCES

- A. Description: Equip for mounting as indicated and have screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.
 2. Weatherproof where indicated.
 3. Where shown to be ceiling mounted, units shall be listed for ceiling mount application.
 4. Devices shall match existing finish.
- B. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Horns produce a sound-pressure level of 90 dB, measured 10 feet (3 m) from the horn.
1. Horn audibility level shall be field selectable to suit conditions.
- C. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.
1. Rated Light Output: 15/75 candela, unless noted otherwise on plans.
 2. Rated Light Output in Sleeping Areas: 110 candela.
 3. Devices shall be synchronized as required by applicable codes.
 4. Strobe Leads: Factory connected to screw terminals.

2.7 REMOTE DEVICE LOCATION-REMOTE TEST/INDICATING LIGHTS AND IDENTIFICATION PLATES

- A. Description: Remote test station with LED indicating light and remote test key switch near each smoke detector that may not be readily visible. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp and test switch are flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector is located.

2.8 MAGNETIC DOOR HOLDERS

- A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.
 - 1. Electromagnet: Requires no more than 3 W to develop 25-lbf (111-N) holding force.
 - 2. Wall-Mounted Units: Flush mounted, unless otherwise indicated. Provide catch plate extensions as required for holding door.
 - 3. Rating: 24-V ac or dc.
- B. Material and Finish: Match door hardware.

2.9 NOTIFICATION APPLIANCE CIRCUIT POWER EXTENDER PANEL

- A. Provide additional panels as required for operation of notification appliances.
 - 1. Panel shall provide synchronization of strobes at a rate of 1Hz and operate horns with a temporal code pattern.
 - 2. Panel shall provide the capability to silence the audible signals, while the strobes continue to flash.
 - 3. Panel shall provide the capability to synchronize multiple notification appliance circuits.

2.10 EMERGENCY POWER SUPPLY

- A. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.
 - 1. Battery Nominal Life Expectancy: 4 years, minimum.
- B. Battery Capacity: Comply with NFPA 72.
 - 1. Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails.
- C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.
- D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

2.11 ADDRESSABLE INTERFACE DEVICE

- A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts.

2.12 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Listed and labeled under UL 864 and NFPA 72.
- B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.
- C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.
- D. Self Test: Conducted automatically every 24 hours with report transmitted to central station.

2.13 WIRE

- A. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation. Sized per manufacturer requirements.
- B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

- A. The installation shall be in accordance with the latest requirements of the NEC, State, and Local Codes, ordinances and regulations of any other governing body having jurisdiction
- B. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Project Engineer.
- C. Provide a smoke detector at each notification appliance circuit signal power extender panel.
- D. Manual Pull Stations: Mount semi-flush in recessed back boxes.
- E. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.
- F. Fire Department Connection: Provide a weatherproof audible/visual notification device at the fire department connection, coordinate location with the fire protection contractor.

- G. Ceiling-Mounted Smoke Detectors: Not less than 4 inches (100 mm) from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 feet (9 m) apart in any direction.
- H. Wall-Mounted Smoke Detectors: At least 4 inches (100 mm), but not more than 12 inches (300 mm), below the ceiling.
- I. Smoke Detectors near Air Registers: Install no closer than 36 inches.
- J. Duct Smoke Detectors: Comply with manufacturer's written instructions.
 - 1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 - 2. Install sampling tubes so they extend the full width of the duct.
- K. Interface with Mechanical HVAC Equipment:
 - 1. Coordinate with the mechanical contractor the zoning of smoke detectors for control of smoke dampers. Provide control outputs and relays for zoned control of smoke dampers as required.
 - 2. Provide alarm output signals and wiring to the building automation system and all HVAC equipment motor starters and/or AFD controllers for fan shutdown upon alarm as required by the International Mechanical Code. Coordinate requirements with mechanical contractor.
- L. Wall Mounted Audible Alarm-Indicating Devices: Install with top of device not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Combine audible and visible alarms at the same location into a single unit.
- M. Wall Mounted Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and with top of device at least 6 inches (150 mm) below the ceiling.
- N. Visible Alarm-Indicating Devices in Sleeping Rooms: Install with top of device at least 24 inches below the ceiling.
- O. Notification Appliance Circuits: Connected appliance load shall not exceed 80% of the allowable circuit load.
- P. Remote Device Location-Remote Test/Indicating Lights and Identification Plates: Provide for each smoke detector which is not readily visible and locate in public space near the device they monitor.

3.2 WIRING INSTALLATION

- A. Wiring Method: Install wiring in raceway except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces. All wiring installed underground or underslab shall be wet location listed.
 - 1. Raceway and boxes shall be installed in accordance with Division 26 Section "Raceway and Boxes".
 - 2. "Free-Air" Cabling techniques are NOT acceptable for this project. All cables shall be in raceway.

- B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.
- D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction box covers red in non-public, un-finished spaces, and above accessible ceilings.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Basic Electrical Materials and Methods."

3.4 GROUNDING

- A. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.
- B. Install grounding electrodes of type, size, location, and quantity as indicated. Comply with installation requirements in Division 26 Section "Grounding."
- C. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and connections and to supervise pretesting, testing, and adjustment of the system. Report results in writing.
- B. Pretesting: After installation, align, adjust, and balance the system and perform complete pretesting. Determine, through pretesting, the compliance of the system with requirements of Drawings and Specifications. Correct deficiencies observed in pretesting. Replace malfunctioning or damaged items with new ones, and retest until satisfactory performance and conditions are achieved. Prepare forms for systematic recording of acceptance test results.
- C. Report of Pretesting: After pretesting is complete, provide a letter certifying the installation is complete and fully operable, including the names and titles of witnesses to preliminary tests.

- D. Final Test Notice: Provide a minimum of 10 days' notice in writing when the system is ready for final acceptance testing.
- E. Minimum System Tests: Test the system according to procedures outlined in NFPA 72. Minimum required tests are as follows:
 - 1. Verify the absence of unwanted voltages between circuit conductors and ground.
 - 2. Test all conductors for short circuits using an insulation-testing device.
 - 3. With each circuit pair, short circuit at the far end of the circuit and measure the circuit resistance with an ohmmeter. Record the circuit resistance of each circuit on record drawings.
 - 4. Verify that the control unit is in the normal condition as detailed in the manufacturer's operation and maintenance manual.
 - 5. Test initiating and indicating circuits for proper signal transmission under open circuit conditions. One connection each should be opened at not less than 10 percent of initiating and indicating devices. Observe proper signal transmission according to class of wiring used.
 - 6. Test each initiating and indicating device for alarm operation and proper response at the control unit. Test smoke detectors with actual products of combustion.
 - 7. Test the system for all specified functions according to the approved operation and maintenance manual. Systematically initiate specified functional performance items at each station, including making all possible alarm and monitoring initiations and using all communications options. For each item, observe related performance at all devices required to be affected by the item under all system sequences. Observe indicating lights, displays, signal tones, and annunciator indications.
 - 8. Test Both Primary and Secondary Power: Verify by test that the secondary power system is capable of operating the system for the period and in the manner specified.
- F. Retesting: Correct deficiencies indicated by tests and completely retest work affected by such deficiencies. Verify by the system test that the total system meets Specifications and complies with applicable standards.
- G. Report of Tests and Inspections: Provide a written record of inspections, tests, and detailed test results in the form of a test log. Submit log on the satisfactory completion of tests.
- H. Tag all equipment, stations, and other components at which tests have been satisfactorily completed.

3.6 CLEANING AND ADJUSTING

- A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.7 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 4 hours' training.
2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
3. Schedule training with Owner, through Architect/Engineer, with at least seven days advance notice.

3.8 ON-SITE ASSISTANCE

- A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to two requested visits to Project site for this purpose.

END OF SECTION 287210