



## PROJECT MANUAL

### **IFB #22-23**

## **RPS 205 HVAC Improvements**

**RPS #2233 - East High School Roof Replacement**

**RPS #2224 - Washington Elementary School HVAC Upgrades**

**RPS #2245 - Lincoln Middle School HVAC Upgrades**

**RPS #2246 - Flinn Middle School HVAC Upgrades**

**RPS #2247 - East High School HVAC Upgrades**

**(IMEG Project Nos.: 21002885.01, .02, .03, and .04)**

Rockford, Illinois

PREPARED FOR:

**Rockford School District No. 205**

January 28, 2022

Illinois Design Professional Registration #184-007637

**BID OFFER FORM**

**Bid # 22-23**

BID SUBMITTED BY: \_\_\_\_\_

Date \_\_\_\_\_

The undersigned, having become familiar with the local conditions affecting cost of work and with the Bidding Documents, including the advertisement of the Invitation for Bid, the Instructions and Supplementary Instructions to Bidders, this Bid Offer Form, the General and Supplementary Conditions, the Drawings and Specifications, and Addenda issued thereto, as prepared and issued by the Board of Education of Rockford School District No. 205, Winnebago and Boone Counties, Illinois hereby agrees to furnish all labor, material and equipment necessary to do the Work required for the project and IFB identified above, for the amount shown below:

**Note: Contractor to write "No Bid" in the dollar amount section for any line items not bid.**

**BASE BIDS**

**Base Bid A - Washington Elementary School HVAC Upgrades**

The undersigned agrees to perform all the General, Plumbing, HVAC, and Electrical work required, exclusive of work called for in Alternate Bids, for the sum of:

TOTAL: \_\_\_\_\_ DOLLARS (\$\_\_\_\_\_).

**Base Bid B-1 - Lincoln Middle School HVAC Upgrades**

The undersigned agrees to perform all the General, Plumbing, HVAC, and Electrical work required, exclusive of work called for in Alternate Bids, for the sum of:

TOTAL: \_\_\_\_\_ DOLLARS (\$\_\_\_\_\_).

**Base Bid B-2 - Lincoln Middle School Roofing Replacement and Parapet Repairs**

The undersigned agrees to perform all the roofing replacement and parapet repair work outlined in the document volume issued by Belles Firm of Architecture for the sum of:

TOTAL: \_\_\_\_\_ DOLLARS (\$\_\_\_\_\_).

**Base Bid C - Flinn Middle School HVAC Upgrades**

The undersigned agrees to perform all the General, Plumbing, HVAC, and Electrical work required, exclusive of work called for in Alternate Bids, for the sum of:

TOTAL: \_\_\_\_\_ DOLLARS (\$\_\_\_\_\_).

**Base Bid D-1 - East High School HVAC Upgrades**

The undersigned agrees to perform all the General, Plumbing, HVAC, and Electrical work required, exclusive of work called for in Alternate Bids, for the sum of:

TOTAL: \_\_\_\_\_ DOLLARS (\$\_\_\_\_\_).

**BID OFFER FORM**

**Base Bid D-2 - East High School Roof Replacement**

The undersigned agrees to perform all the roof replacement work as shown in the IMEG Lincoln document volume for the sum of:

TOTAL: \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_).

**COMBINATION BID – State the lump sum amount to perform all the work required, exclusive of Alternate Bids #1 and #2, for all four schools - Washington, Lincoln, Flinn, and East - Base Bids A, B-1, B-2, C, D-1, and D-2.**

TOTAL: \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_).

**BREAKDOWN OF COMBINATION BID:**

**HVAC SYSTEM UPGRADES Project at WASHINGTON ELEMENTARY SCHOOL:**

TOTAL: \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_)

**HVAC SYSTEM UPGRADES Project at LINCOLN MIDDLE SCHOOL:**

TOTAL: \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_)

**ROOF REPLACEMENT Project at LINCOLN MIDDLE SCHOOL:**

TOTAL: \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_)

**HVAC SYSTEM UPGRADES Project at FLINN MIDDLE SCHOOL:**

TOTAL: \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_)

**HVAC SYSTEM UPGRADES Project at EAST HIGH SCHOOL:**

TOTAL: \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_)

**ROOF REPLACEMENT Project at EAST HIGH SCHOOL:**

TOTAL: \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_)

**ALTERNATE BIDS**

**ALTERNATE BID NO. #1:** State the amount to be added to the base bid for all work associated with installing air conditioning within the existing air handling units that serve the East High School Fieldhouse as shown on the drawings.

(Add): \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_).

## BID OFFER FORM

**ALTERNATE BID NO. #2:** State the amount to be deducted from the base bid for all work associated with replacing the existing HVAC system within the 1980 Addition at East High School as shown on the drawings.

(Deduct): \_\_\_\_\_ DOLLARS (\$ \_\_\_\_\_).

**UNIT PRICES**

Should the net result of change for any of the following categories of work require more or less quantity of work than originally indicated in the Drawings and/or Specifications, the price for such added or deducted work will be as follows:

ALL IMEG ESSER HVAC Projects	UNIT	UNIT PRICE
Add for removing and relocating bell for new ceiling install	Per Unit	\$ _____
Add for removing and relocating existing camera for new ceiling install	Per Unit	\$ _____
Add for removing and relocating fire alarm devices for new ceiling install	Per Unit	\$ _____
Add for removing and relocating clocks for new ceiling install	Per Unit	\$ _____
Add for removing and relocating wireless access points for new ceiling install	Per Unit	\$ _____
Add for removing and relocating speakers/intercom for new ceiling install	Per Unit	\$ _____
Add for providing new receptacle where an existing receptacle is being covered by new wall furring	Per Unit	\$ _____

ITEMS - LINCOLN ROOF REPLACEMENT AND REPAIR	UNIT	UNIT PRICE
Add/Deduct for masonry cleaning	Sq.ft.	\$ _____
Add/Deduct for stone repointing	Lineal Ft.	\$ _____
Add/Deduct for unit masonry repointing	Sq.ft.	\$ _____
Add/Deduct for common brick masonry replacement	Per unit	\$ _____
Add/Deduct for masonry re-consolidation	Sq.ft.	\$ _____
Add/Deduct for sealant repair/replacement	Lineal Ft.	\$ _____
Add for masonry sealer	Sq.ft.	\$ _____

**ALLOWANCES: Not Applicable**

**ADDENDUM RECEIPT**

The undersigned acknowledges receipt of Addenda \_\_\_\_\_ to \_\_\_\_\_ inclusive.

**BID OFFER FORM**

**PRE-BID MEETING ATTENDANCE**

A Bidder representative attended the Pre-Bid Meeting? YES \_\_\_\_\_ OR No \_\_\_\_\_.

**SITE VISIT**

Existing premises and conditions were checked by an on-site inspection on \_\_\_\_\_.

**CONTRACTOR'S QUALIFICATION STATEMENT**

A fully completed AIA Document A305-1986 Contractor's Qualification Statement is **required** AND **MUST BE SUBMITTED WITH THE BID**. Include at least three references from projects completed in the past five (5) years with phone number, date of completion, description of work, and project architect (or engineer) contact name with phone number. Projects must be similar to the scope of this bid, and the bidder must have acted in the capacity of prime or general contractor.

Contractor has adequate equipment to perform the work properly and expeditiously: \_\_\_\_ Yes \_\_\_\_ No.

**COMMENCEMENT AND COMPLETION OF CONTRACT**

The undersigned agrees, if awarded the Contract, to commence the contract work within five (5) days of receipt of Order to Proceed or if required, upon execution of a formal written contract and to complete said Work within the specified completion time. The undersigned further agrees to execute the Contract, furnish satisfactory performance and payment bond as well as insurance coverage, as specified in strict accordance with the Contract Documents.

Date of Commencement of Construction: \_\_\_\_\_

Date of Substantial Completion: August 19, 2023

Date of Final Completion: September 30, 2023

**BID OFFER FORM**

BIDDER: \_\_\_\_\_  
(Corporation) (Partnership) (Individual) Circle One

Address \_\_\_\_\_  
Street

\_\_\_\_\_ City State Zip Code

\_\_\_\_\_ Phone No. Email address

BIDDER FEIN/SSN NO. \_\_\_\_\_

By: \_\_\_\_\_ Bidder or Authorized Agent Signature Print name

Title: \_\_\_\_\_

Subscribed and sworn to before be this \_\_\_\_ day of \_\_\_\_\_, \_\_\_\_\_.

\_\_\_\_\_  
Notary Public  
My commission expires: \_\_\_\_\_

**BID DEPOSIT CERTIFICATION**

A Bid Deposit is required in the amount of 5% of the total Bid including Alternate Bids. This Bid Deposit is to be a Bid Bond, Bank Draft or Certified Check made payable to the "Rockford School District No. 205", as a guarantee that if awarded all or part of the Bid, the firm will enter into a contract to perform with the Board of Education.

Amount of Total Bid \$ \_\_\_\_\_

Amount of Bank draft or Certified Check \$ \_\_\_\_\_

BIDDER: \_\_\_\_\_

\_\_\_\_\_  
Signature of Bidder or Authorized Agent

**BID OFFER FORM**

**SUBCONTRACTOR LISTING**

The Subcontractor list shall be filled out completely and submitted within 24 hours after the bid opening. Bidder's failure to submit the completed list may result in disqualification of bid.

SUBCONTRACTOR LIST

COMPANY NAME

Plumbing	_____
Piping	_____
HVAC	_____
Temperature Controls	_____
Electrical	_____
Earthwork/Excavation	_____
Paving	_____
Concrete Formwork	_____
Concrete	_____
Concrete Reinforcement	_____
Masonry	_____
Structural Steel	_____
Misc. Metals	_____
Steel Erection	_____
Carpentry & Millwork	_____
Roofing	_____
Sheet Metal	_____
Hollow Metal Work	_____
Glass/Glazing	_____
Acoustical Ceilings	_____
Tile	_____
Carpet	_____
Painting	_____

Bidder:  
\_\_\_\_\_

By: \_\_\_\_\_  
Bidder or Authorized Agent Signature

-END OF BID OFFER FORM-

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DIVISION 1 - GENERAL REQUIREMENTS  
Section 01 10 00 - Summary of Work

PART 1 - GENERAL

1.01 GENERAL

- A. The General Conditions, Supplementary Conditions and Division 1 - General Requirements are hereby made a part of each Division and Section of the Specifications.

1.02 DESCRIPTION

- A. Work covers complete construction and installation of work specified and/or required, including all trades for the Rockford PS ESSER HVAC Upgrades for Rockford Public School, Winnebago County, Illinois, hereinafter called the Owner and is to be constructed in accordance with the Contract Documents prepared by Saavedra Group Architects, 504 North Church St. Rockford, Illinois, the Architect.
- B. Products shall be installed in strict accordance with manufacturer recommendations. The Contractor shall review substrates prior to installing products. Installation of products shall represent that the Contractor has accepted the substrates as proper for the installation of products. Substrates which are not acceptable shall be corrected prior to the installation of products.

1.03 CONTRACT

- A. Work to be executed under one General Contract, including all trades.

1.04 COOPERATION BETWEEN CONTRACTORS

- A. The Contractor shall coordinate construction activities with the other Contractors performing projects as required to assure a complete, proper, and timely completion of all of the Work.

1.05 COOPERATION OF CONTRACTOR WITH THE OWNER

- A. Contractors are to conduct the Work and operations so that the usual 7 days per week activities which occur in and around the facility, can continue without interruption, and with as little inconvenience to the Owner as possible.
  - 1. Existing building systems must remain operational to facilitate safe, code compliant occupancy and use of the facility. Minor interruptions of short duration shall not occur without prior notification and approval by the Owner and are to be limited to off days or times when the facility is not occupied.
  - 2. Utilities, fire alarm, and security system shut-offs shall not occur without prior notification and approval by the Owner, and not without contact by the Contractor with the Authority Having Jurisdiction. Shut downs are to be limited to off days or times when the facility is not occupied.
- B. Maintain clear and proper exiting through areas of work. Coordinate requirements with Owner.

1.06 WORK SCHEDULE

- A. The schedule for this work shall be as follows:
  - 1. Start the Work immediately after the contract is fully executed.
  - 2. Begin Work in the Field not later than Date.

3. Substantially Complete all Work not later than Date.
- B. Utilities Shut-offs shall not occur without prior notification and approval by the Owner.
- C. The Contractor shall include expedited delivery schedules, additional labor shifts, overtime work, etc. necessary to complete the Work as scheduled.
- D. The only considerations for adjustment of the Substantial Completion Date will be for strikes that shut down the Project, unless such strike was instituted as a result of the conduct of the Contractor; or for delays due to damage caused by Acts of God consisting only of tornadoes or floods in which case the Substantial Completion Date will be extended by the number of days the Project is shut down. Change Orders will be considered part of the Work and will not be a consideration for adjustment of the Substantial Completion Date unless they are specifically requested by the Owner as a Scope of Work Change Order and exceed \$10,000 each, in which case the additional number of days shall be identified and agreed to as part of the Change Order. No other considerations will be allowed.

#### 1.07 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Product Delivery; Schedule deliveries in accordance with the project schedule, to minimize storage time at project site, and to prevent overcrowding of construction areas and Owner's facilities.
- B. Deliver products to project site in an undamaged condition in manufacturer's original sealed container or other packaging system, complete with labels and instructions for handling, storing, unpacking, protecting, and installing.
- C. Inspect products on delivery to ensure compliance with the Contract Documents and to ensure that products are undamaged and properly protected.

#### 1.08 PROJECT CONDITIONS

- A. Utilities Shut-offs shall not occur without prior approval of the Owner.
- B. Furniture and Equipment Relocation
  1. Owner will move unfixed and unattached furniture and equipment from the work areas prior to the Contractor starting operations. The Contractor shall relocate and reinstall all fixed and attached furniture and equipment, to location(s) as directed by the Owner. Reinstall to proper working condition. Items placed in storage shall be labeled, with all parts and components packaged together. Contractor to patch holes, etc. at original location to match adjacent surfaces and materials.
- C. Criminal background checks shall be performed for the project.
  1. The Contractor shall submit a criminal history background check for all persons who will be working in the school building or on school property including those employed directly by the Contractor and those employed by subcontractors and suppliers who will be utilized on the project.
  2. No one will be allowed on-site before the Owner receives and provides the Contractor with the results of the background checks.
  3. Only those employees who have been cleared through their background checks will be allowed on-site. The cost of the background check shall be the responsibility of the Contractor.
- D. Security Plan to Identify Construction Trade Workers

1. Buildings and Grounds Dept. will be consulted on construction project scheduling. Schedules for work within the existing building will be coordinated with the principal taking into consideration building activities.
  2. All workers are required to sign in at the Custodial Office each morning before proceeding to the work area within the existing building. Sign-in sheets will be turned into the Custodial Office each evening.
  3. Clothing that identifies a worker's employer and/or a badge, worn in plain sight, is required at all times while in and around a school building.
  4. It will be the responsibility of the Contractor to notify all construction trades under his contract of the security plan. The Contractor will be responsible for all workers wearing identifying clothing or badges and will be responsible for assessing and collecting fines from the trade contractors.
- E. Cleaning and Dustproofing
1. Rubbish and debris resulting from the Work shall be collected by the Contractor, removed at the end of each day, and legally disposed of away from the site.
  2. Furniture and equipment in the work area shall be covered to prevent dust accumulation and damage.
  3. Surfaces in the work area shall be vacuumed and wiped clean. Books and similar items exposed to dust shall be individually dusted.
- F. Cutting of Masonry Units
1. Cutting of new masonry units shall be done outside of the existing building in an area to prevent dust from entering the existing building. At no time will contractors be allowed to saw cut new masonry within the existing building.
- G. Protection of Existing Surfaces
1. The Contractor shall provide and maintain during the course of construction temporary protection to protect existing surfaces in the existing building from damage due to the construction activities. Such protection will include, but not be limited to temporary barricades to separate work areas from occupied areas to prevent dust and fume penetration, temporary floor covers to protect existing surfaces from damage, etc.
  2. Should damage to existing surfaces occur, the Contractor shall repair at his own expense.
- H. Installation of Materials with Color Variations
1. Materials are subject to color variation during the manufacturing or installation process. For this reason, there may be variations in shade, color or texture.
  2. Contractor shall mix and/or blend these materials to produce a uniform and consistent final appearance to meet the approval of the Architect.
  3. Should there be variation in shade, color or texture which are not acceptable, the Contractor shall repair or replace at his own expense.

## 1.09 ENVIRONMENTAL TESTING

IMEG #21002885.00

Rockford PS ESSER HVAC Upgrades

01 10 00-3

- A. The Contractor shall be responsible for ensuring that there is no fungal growth on new building components and that there is acceptable indoor air quality (IAQ) within the new building and within the addition areas. Verification of the absence of fungal growth and of acceptable indoor air quality shall be accomplished through a visual inspection and indoor air quality testing of the building. The inspection and testing shall be performed by a Certified Industrial Hygienist (CIH) hired by the Contractor but who shall report directly to the Architect. A minimum of two IAQ tests shall be performed at
- and one outside the building to establish a baseline. The inspection and indoor air quality testing shall be performed after building finishes (flooring, painting, ceilings) have been installed and prior to Substantial Completion of the work. The indoor air quality testing shall be performed while the HVAC systems are operating.
- B. The Contractor shall provide the Architect with the CIH's written report detailing the inspection and testing. Air testing shall include monitoring for the following factors:
1. Airborne fungi
  2. Carbon monoxide
  3. Carbon dioxide
  4. Nitrogen dioxide
  5. Sulfur dioxide
  6. Formaldehyde
  7. Hydrocarbons
  8. Dust
  9. Ozone
  10. Hydrogen sulfide
  11. Temperature
  12. Humidity
- C. The above testing results shall be compared to the Occupational Safety and Health Administration (OSHA) permissible exposure limits (PELs), the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit values (TLVs), and recommended air quality and comfort standards developed by the American Society of Heating, Refrigeration, and Air Conditioning Engineers (ASHRAE). Since no current standards exist for fungal growth, airborne fungal sampling results will be subject to interpretation by the CIH.
- D. Report documentation of any of the following problems shall require action on the part of the Contractor to undertake remediation activities, followed by another series of CIH inspection and testing:
1. Visible fungal growth
  2. Air testing results exceeding the standards set forth above
  3. Total indoor airborne fungal concentrations which exceed outdoor concentrations
  4. Significant fungal species present indoors that were not present outdoors on the day of the survey, indicating an indoor source of fungal growth.

- E. The Work or designated portion thereof will not be considered Substantially Complete in accordance with the Contract Documents until the Contractor submits a report of the IAQ test results which demonstrates that the factors tested are within permissible exposure limits.
- F. The Contractor shall provide the Architect with a second set of IAQ test results which are to be taken approximately two months after occupancy of the building to test for carbon dioxide only. The second set of IAQ tests shall be taken while the building is occupied in its intended use. The second set of test results are not required to achieve Substantial Completion.

END 01 10 00

DIVISION 1 - GENERAL REQUIREMENTS  
Section 01 73 20 - Cutting and Patching

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall provide connections, repairs, watertight facilities, etc., as required in new construction. Each subcontractor shall furnish information to the Contractor as to size, location, etc., or accept the responsibility of doing the necessary cutting, patching at his own expense.
- B. The Contractor shall provide cutting, fitting or patching for work that may be required to make several parts come together properly, in accordance with the Contract Documents.
- C. Do not endanger the stability of the structure or any part thereof by cutting, digging or otherwise.
- D. The Contractor shall patch and match existing surfaces and materials, etc., affected by the work or patch and match existing surfaces with new materials, etc. as noted.

END 01 73 20

DIVISION 1 - GENERAL REQUIREMENTS  
Section 01 77 00 – Closeout Procedures

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PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures
  - 2. Final Completion procedures
  - 3. Extended Warranties
  - 4. Record Drawings
  - 5. Record Topographic Survey
  - 6. Operation and Maintenance Manuals
  - 7. Attic stock materials
  - 8. Allowances accounting
  - 9. Final cleaning
  - 10. Repair of the Work

1.02 SUBMITTALS

- A. Submittals Prior to Substantial Completion
  - 1. Letter from the Contractor to the Architect stating the project has achieved Substantial Completion
  - 2. Contractor's List of Items to be Completed or Corrected
  - 3. Specified certifications
- B. Submittals Prior to Final Completion
  - 1. Written notice that the Work is ready for final inspection and acceptance
  - 2. Letter stating that items included in the Architect's (Amended) List of Items to be Completed or Corrected have been completed or otherwise resolved for acceptance
  - 3. Evidence of final, continuing insurance coverage complying with insurance requirements
  - 4. Demonstration and training video recordings
  - 5. Extended Warranties
  - 6. Record Drawings
  - 7. Record Topographic Survey
  - 8. Operation and Maintenance Manuals
  - 9. Attic stock materials
  - 10. Allowances accounting

11. Waste Management Plan documenting a summary of recycling and salvage on-site logs, manifests, weight tickets, receipts, etc.

### 1.03 SUBSTANTIAL COMPLETION PROCEDURES

- A. Inspection Procedures: Submit a written request for inspection to determine Substantial Completion a minimum of ten (10) calendar days prior to date the work will be completed and ready for inspection. On receipt of request, Architect will either schedule an inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of critical items that must be completed or corrected before a certificate will be issued.
  1. Reinspection: Request reinspection when the critical items previously identified have been completed or corrected.
  2. On receipt of the reinspection request, Architect will either schedule an inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection has confirmed that the critical items have been completed or corrected.
  3. Substantial Completion is contingent upon the issuance of the Occupancy Permit by the Authority Having Jurisdiction (AHJ), therefore the date of Substantial Completion is subject to change to coincide with the date of Occupancy.
- B. List of Incomplete Items: When the Contractor considers the Work to be Substantially Complete, the Contractor shall prepare and submit a list of items to be completed and corrected (Contractor's punch list).
  1. When the Architect determines the Work is Substantially Complete, the Architect will issue the Amended List of Items to be Completed or Corrected (Architect's punch list) to the Contractor.
- C. Submittals Prior to Substantial Completion: Complete the following a minimum of ten (10) calendar days prior to requesting inspection for determining date of Substantial Completion.
  1. Submit specified certifications through the electronic submittal process. Non-reviewed, non-approved and incomplete documentation is not acceptable.
  2. After the electronic submittals have been accepted for contract compliance, submit three (3) clean, legible, approved copies of the specified certifications to the Architect at least ten (10) calendar days prior to the occupancy walk through by the AHJ. Each set of the approved documentation shall be bound in a three ring binder with tab divisions. Approved documentation binders will be transmitted by the Architect to the AHJ and subsequently delivered to Owner.
  3. Following is the list of specified certifications to be included in each binder.
    - a. Contractor Certification that no asbestos containing materials were used on the Project.

- b. Environmental Remediation Clearance Documents filed by the Contractor to the AHJ.
  - c. Environmental Testing Report including Indoor Air Quality (IAQ) test results which demonstrate that the factors tested are within permissible exposure limits.
  - d. Roofing System Manufacturer Inspection Report describing deficiencies with the roofing work and items that are to be completed or corrected.
  - e. Plumbing Systems Site: Chlorination test results for water main work indicating satisfactory compliance with Contract Documents transmitted under letterhead of the responsible Trade Contractor.
  - f. Mechanical Systems: Contractor Certification indicating the Heating, Ventilating, and Air Conditioning Systems have been inspected and start up procedures have been completed by the manufacturer and the systems are fully operational including functional temperature controls.
  - g. Boiler Systems: Certification that the boiler system has been inspected and tested by the manufacturer and is fully operational including functional temperature controls. The boiler system shall be inspected and approved by the Office of State Fire Marshal.
  - h. Mechanical Systems Testing and Balancing: Complete test and balance report including Contractor Certification indicating that at a minimum, code compliant fresh air changes are provided.
  - i. Mechanical System Ductwork Tightness Testing Report including test results which demonstrate the required results to pass.
4. Other items which are required to achieve Substantial Completion include but are not necessarily limited to the following: completed finishes and suspended ceiling systems; functional door hardware; corridors clear of debris and construction equipment; operational plumbing fixtures; electrical panels properly labeled; and interior signage indicating room numbers, directions, offices, and occupancy loads properly posted in assembly areas. Fire extinguishers, furnished by the Owner, must be installed in each cabinet and wall mounted at locations indicated.
- D. Procedures Prior to Substantial Completion: Complete the following a minimum of ten (10) calendar days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
- 1. Advise Owner of pending insurance changeover requirements.
  - 2. Complete startup and testing of systems and equipment.
  - 3. Advise Owner of changeover in heat and other utilities.
  - 4. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
  - 5. Complete final cleaning requirements, including touchup painting.

6. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- E. Procedures Following Substantial Completion: Complete the following items immediately after Substantial Completion.
1. Maintenance of seed, sod, plantings and landscaping areas.
  2. Removal of temporary facilities and protections. Restore modifications to existing facilities to the original design or configuration.
  3. Make final changeover of permanent locks and coordinate delivery of keys to Owner. Advise Owner's personnel of changeover in security provisions.
  4. Perform preventive maintenance on equipment used prior to Substantial Completion.
  5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings.
  6. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

#### 1.04 FINAL COMPLETION PROCEDURES

- A. Preliminary Procedures: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit letter stating that items included in the Architect's (Amended) List of Items to be Completed or Corrected have been completed or otherwise resolved for acceptance.
  2. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings.
  4. Submit Extended Warranties
  5. Submit Record Drawings
  6. Submit Operation and Maintenance Manuals
  7. Deliver attic stock materials
  8. Submit allowances accounting
- B. Inspection: Submit a written request for final inspection to determine acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will review the final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

#### 1.05 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
  - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
  - 2. Training recordings must include both high quality video and audio.
  - 3. Coordinate with Owner for required staff to be in attendance. Include a sign-in sheet to verify attendance.
- B. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
- C. Video Recording Format: Provide high-quality color video recordings with menu navigation.
- D. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.
- E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

#### 1.06 EXTENDED WARRANTIES

- A. Submit written extended warranties, as defined as warranties beyond the standard one year warranty period from the date of Substantial Completion, via the electronic submittal process.
  - 1. Warranty shall include the following information:
    - a. Name of the project.
    - b. Name of the warranty provider.
    - c. Description of the item being warranted.
    - d. Effective dates of the warranty, starting with the date of Substantial Completion.
    - e. Terms and conditions in conformance with the specified warranty.
- B. Upon acceptance of the warranties through the submittal process, the Contractor shall collect and assemble hard copy originals of the accepted warranties. Organize extended warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Bind warranties in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
  - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

- C. Where applicable, provide additional copies of each warranty to include in operation and maintenance manuals.

#### 1.07 RECORD DRAWINGS

- A. The Contractor and the Site Utilities, Mechanical, Electrical, Plumbing and Fire Protection Trade Contractors shall each maintain during construction a set of record drawings which shall be kept on site. Each set of these drawings shall be labeled in neat large printed letters "RECORD DRAWINGS". Contractors shall record information concurrently with construction progress and shall not conceal work until the required information is recorded. Concealed portions of the work which have not been documented shall be opened to fully document conditions at the Contractor's own cost.
- B. Record drawings shall be copies of the Contract Document drawings and shall be clearly and legibly marked to record actual construction, including the following.
  - 1. Changes made by Addenda, Change Directives, and/or Change Orders; clarifications not on Contract Documents drawings.
  - 2. Fully document horizontal and vertical locations of underground site utility and storm sewer lines and appurtenances referenced to permanent surface improvements with depths of various elements in relations to finish floor datum.
  - 3. Fully document horizontal and vertical locations of underground and under-slab service lines (plumbing, fire protection, mechanical, electric) and appurtenances referenced to permanent improvements with depths of various elements in relations to finish floor datum.
  - 4. Location of interior service lines (plumbing, fire protection, mechanical, electric) and devices concealed in above ground construction referenced to visible and accessible features of the structure.
  - 5. Location of concealed equipment, valves, ducts, dampers, access panels, outlets, etc. referenced to visible and accessible features of the structure.
  - 6. Field changes of dimensions and details.
  - 7. Other deviations made from the original Contract Document drawings.
- C. The Contractor shall make available record drawings for review for compliance. The frequency of review shall be at a minimum, 50% gross completion of the Contract and at Substantial Completion. The Contractor shall provide complete sets to facilitate review. If it is determined that the record drawings are not being maintained concurrently with construction progress, subsequent pay applications will not be reviewed until the record drawings are brought up to date.
- D. At the completion of the preparation of the record drawings, each contractor shall clearly indicate on the cover sheet of the drawings, "NAME OF CONTRACTOR" and "DATE" identifying the contractor who prepared the record drawings and the date of the record drawings.
- E. Prior to Final Completion, the Contractor shall deliver an electronically scanned copy of the record drawings in PDF format to the Architect for delivery to the Owner.

## 1.08 OPERATION AND MAINTENANCE MANUALS

- A. Submit operation and maintenance manuals via the electronic submittal process.
- B. Upon acceptance of the operation and maintenance manuals through the submittal process, the Contractor shall submit a final corrected version of the operation and maintenance manuals via the electronic submittal process and shall also collect and assemble hard copies of the accepted operation and maintenance manuals. Organize operation and maintenance manuals into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Bind operation and maintenance manuals in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
  - 2. Where documents do not allow for hole punching (such as under-sized documents or full size drawings), provide plastic sleeve for insertion into the three-ring binder.
  - 3. Provide heavy paper dividers with plastic-covered tabs for each separate section. Mark tab to identify the section. Provide a typed description of the sections, including the name of the product and the name, address, and telephone number of Installer.
  - 4. Identify each binder on the front and spine with the typed or printed title "OPERATION AND MAINTENANCE MANUAL", Project name, and name of Contractor.
  - 5. Provide additional documentation as specified elsewhere.
- C. Where applicable, provide additional copies of each warranty to include in operation and maintenance manuals.
- D. Submit three (3) copies of each operation and maintenance manual binder to the Architect for processing and distribution.

## 1.09 ATTIC STOCK

- A. Submit attic stock to the Owner as required. Coordinate time and location of delivery of attic stock with designated Owner's representative. Prepare a sign-off form for signature by the designated Owner's representative indicating acceptance and quantity of the attic stock items. Failure to obtain the designated Owner's representative sign-off shall represent that the attic stock delivery did not occur. A copy of the fully executed sign-off form shall be submitted to the Architect.

## 1.10 ALLOWANCE ACCOUNTING

- A. The Contractor shall submit a comprehensive accounting of each specified allowance with appropriate supporting documentation to justify the actual quantities used.
- B. Each allowance accounting item shall include the specified allowance amount and the actual amount of the allowance used and the net difference.
- C. A Change Order(s) will be prepared indicating the corresponding adjustments to the contract amount based upon adjusted allowance amounts.

## PART 2 - PRODUCTS

## 2.01 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.01 FINAL CLEANING

- A. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - h. Sweep concrete floors broom clean.
    - i. Remove protections used to prevent dust accumulation and damage to furniture and equipment in the work area.
    - j. Vacuum and wipe clean surface, furniture and equipment in the work area. Books within the work area shall be individually dusted.
    - k. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    - l. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and

other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

- m. Remove labels, wrapping and protective films that are not permanent.
- n. Wipe surfaces of mechanical and electrical equipment, elevator equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
- o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
- p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
- r. Leave Project clean and ready for occupancy.

### 3.02 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
  - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and other required labels including door and frame fire ratings.
    - b. Do not paint over identifications including mechanical and electrical nameplates.
    - c. Remove paint applied to required labels and identification.
  - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
  - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and HID fixtures to comply with requirements for new fixtures.

### 3.03 ELECTRONIC CLOSEOUT DOCUMENTATION

- A. General: Provide a complete project closeout documentation package in electronic format. This package shall include:
1. Project Record Drawings
  2. Project Manual
  3. Approved Submittals
  4. Operation and Maintenance Manuals
  5. Warranties
  6. Owner training DVD's
  7. Project Contact Directory including sub-contractors
- B. The Electronic Closeout Documentation shall be prepared by Digital Revolution Inc./BHFX LLC Contact TJ Hurckes at 847-899-3414 or [tj.hurckes@bhfx.net](mailto:tj.hurckes@bhfx.net).
- C. In order to facilitate the Electronic Closeout Documentation process, comply with the following procedures:
1. Contact Digital Revolution, Inc. a minimum of three months prior to the date of Substantial Completion to schedule a pre-closeout meeting. Review the following:
    - a. Format of documents: PDF electronic format for documents.
    - b. Folder structure for storage and transfer of files.
    - c. Schedule for collection and turn-over of closeout documentation.
    - d. Record Document format procedures: Provide clean and accurate paper copies of the marked-up Record Documents (Drawings and Specifications) for scanning.
    - e. Provide contact information for the individual responsible for the collection and transfer of the electronic closeout Documentation package contents.
    - f. Review a complete listing of closeout documentation package contents.
  2. Provide Documentation to Digital Revolution, Inc. for processing no later than 30 days after the date of Substantial Completion.
  3. Schedule a training conference with the Owner's Representative, Architect, Construction Manager and Digital Revolution, Inc. to present the completed Electronic Closeout Documentation Package.

END 01 77 00

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified in this section.

1.02 SCOPE OF WORK

- A. Work included under this section shall include but not necessarily be limited to the following:
  - 1. Perform demolition work as necessary to accomplish the work, including the removal and proper disposal of items which are exposed and not to remain in use, including but not necessarily limited to pavement, walks, plantings, foundations, slabs, structural items, walls, roofing, flashings, doors, frames, windows, curtain wall, glazing, finishes, ceilings, flooring, framing, trim, specialties, equipment, casework, plumbing, mechanical and electrical items, etc.
  - 2. Include items exposed such as sewer, water and electrical lines which may require capping per city or utility company requirements.
  - 3. Properly dispose of demolished material and such other obstacles required for a complete and proper installation of new work and the disposition of materials incidental to this work.
  - 4. Erection of barricades, etc., to protect existing building areas.
  - 5. Protection of existing utilities.
  - 6. Repair to building areas, utilities damaged during demolition.
  - 7. Demolition in specific building locations to the extent described on the drawings and/or required to construct the work shown.
  - 8. Remove protection when work is complete.
  - 9. Rubbish and debris shall be promptly removed from building as to minimize dust within the building.
  - 10. Coordinate with Owner Operations. Portions of the school building will be in operation during the construction phase.
- B. Existing surfaces and finishes which are marred or defaced as a result of demolition work shall be patched and matched as required.
- C. Demolition shall include the removal of debris materials associated with demolition procedures. Debris shall be properly deposited of into project dumpsters and subsequently taken to a legal dump site.

1.03 JOB CONDITIONS

- A. Visit the site and be informed as to the character and type of work to be removed. Owner assumes no responsibility for the condition of existing construction to be removed or demolished. Later claims for additional payment for conditions reasonably foreseeable shall not be allowed.

1.04 PROTECTION

- A. Provide and maintain, during demolition operations, barricades and temporary environmental protection to separate the working area from other areas.
- B. Remove protections and temporary enclosures when work is complete.
- C. Properly protect existing building, walks, paving, grass, trees, shrubs, etc. Properly restore/replace damaged items meeting Owner approval.
- D. Where demolition operations create conditions which may result in water and/or weather leaks, provide necessary temporary enclosures which create a weathertight barrier and protect existing structures and facilities from damage due to infiltration of water and/or weather.
- E. Verify routing of existing Fire Alarm, Electrical, Security, Phone, Mechanical, Plumbing, and other systems prior to cutting roof, walls, floor, etc. Maintain these systems in full operating condition during course of the work. Pay repair costs to systems and finishes damaged during the execution of the Work.

#### 1.05 DEMOLITION

- A. Exact extent of demolition as shown on drawings and to be completed shall be verified at the site. Determine the nature and extent of demolition that will be necessary by comparing the drawings with existing site conditions. Operations shall be done in a careful and orderly manner to avoid hazards to persons and property, and interference with the use of adjacent areas, and interruption of free passage to and from such areas.
- B. Where concrete or masonry is to be cut, a straight cut line shall be obtained by using a carborundum masonry saw.
- C. Work shall be demolished in small sections. Provide bracing and shoring necessary to maintain existing building integrity.
- D. Do not remove more of existing construction than is necessary. Do not mar, damage, or deface construction which is to remain.
- E. Verify routing of existing Fire Alarm, Electrical, Security, Phone, Mechanical, Plumbing, and other systems prior to cutting roof, walls, floor, etc. Maintain these systems in full operating condition during course of the work. Pay repair costs to systems and finishes damaged during the execution of the Work.
- F. Access routes to and from the site shall be kept clean of debris resulting from the Work.

#### 1.06 SALVAGEABLE ITEMS

- A. Verify with the Owner the items to be salvaged and turned over to the Owner.

END 02 41 19

DIVISION 3 – CONCRETE

Section 03 30 00 - Cast In Place Concrete

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 QUALITY ASSURANCE

A. Qualifications of Concrete Contractor

- 1. Installation shall be by a company continuously and regularly employed in the installation of Concrete Cast In Place work for a period of at least 5 consecutive years; and which can show evidence of these materials being satisfactorily installed on at least 6 projects of similar size, scope and type within such a period. At least 3 of the projects shall have been in successful use for 3 years or longer.

B. Interior Floor Slab Moisture Content Requirements, Testing, and Moisture Sealer

- 1. Schedule work as necessary to install slab with enough time prior to finish flooring, to allow for complete drying of concrete, minimum of 180 days, as per the recommendations of the concrete contractor and the finish floor manufacturer.
- 2. Provide appropriate scheduling, curing, & drying time, and other related conditions to insure moisture content as acceptable by the finish floor manufacturer. (The proper installation of the vapor retarder, the low water cement ratio specified, installation 180 days prior, protection from weather & rain, and moist curing can contribute significantly to accomplishing a timely drying date.) Repair and prepare concrete surfaces to meet the finish floor moisture content requirements. Moisture content shall not exceed 5 pounds, or 3 pounds if finish floor manufacturer recommends 3 pounds, per 1000 sq. ft. for a 24 hour period, as per calcium chloride test ASTM F1869-98, measured 45 days prior to scheduled Substantial Completion. Testing shall take place in the building envelope conditioned to the temperature and humidity levels as recommended by the finish floor manufacturer. Testing density is required to equal 3 tests in the first 1,000 square feet, with one additional test per each additional 1,000 square feet of concrete slab surface. Provide Architect with written test reports including pertinent data, locations as per a key plan, temperature, humidity, time & date, and moisture readings.

C. Pre-Installation-Concrete Meeting

- 1. Meeting with Architect and Contractor; Contractor shall submit procedures to provide quality installation of the work, and protection of work after placement, including: curing, testing, protection of fresh concrete from rain and water infiltration, flatness, minimize curling of slabs, minimize high spots at construction joints, provision (location, construction, and timing) of control joints, cold or hot weather placement & protection, special concrete finishes, meeting interior slab moisture

requirements, installation of Moisture Sealer, coordination with finish flooring substrate prerequisites, other coordination, and other requirements of this section.

### 1.03 REFERENCE STANDARDS

- A. Work shall conform to the following except as superseded by this Section, American Concrete Institute (ACI) and ASTM Publications:
  - 1. ACI 117 - Specifications for Tolerances for Concrete Construction.
  - 2. ACI 301 - Specifications of Structural Concrete for Buildings.
  - 3. ACI 302.1R-15 – Guide to Concrete Floor and Slab Construction.
  - 4. ACI 305 - Hot Weather Concreting.
  - 5. ACI 306 - Cold Weather Concreting.
  - 6. ACI 308 - Recommended Practice for Curing Concrete.
  - 7. ACI 309 - Standard Practice for Consolidation of Concrete.
  - 8. ACI 347 - Recommended Practice for Concrete Formwork. ( Includes tolerances.)
  - 9. ASTM C 494 - Standard Specification for Chemical Admixtures.
  - 10. ASTM C 260 - Standard Specification for Air-entraining Admixtures.
  - 11. ASTM C 94/C 94M - Ready-Mixed Concrete.

### 1.04 COORDINATION

- A. Coordinate Concrete Flatwork with Requirements of Finish Floors
  - 1. Coordinate the installation and components of concrete flatwork with the scheduled finish floor selections, such that concrete flatwork, including but not limited to mix design, admixtures, flatness, levelness, curing compounds, evaporative retarder, curing covers, surface treatments, moisture, moisture sealers, alkalinity, hardeners, sealers, fillers, underlayments, fiber reinforcing, joint design, joint location, joint fillers, elevation, recesses, inserts, and finishing are compatible with the final concrete finish and final finish flooring.

### 1.05 SUBMITTALS

- A. Concrete supplier's test reports indicating mix design specification compliance.
- B. Mix design components.
- C. Shop drawings indicating floor slab control joints.
- D. Proposed cold and hot weather placement & protection procedures.
- E. Product literature for Moisture Sealer.
- F. Product literature for products listed below.

### 1.06 FIELD-CONSTRUCTED MOCK-UP(S)

- A. Prior to installation of vapor barrier, assemble mock-up(s) to comply with the following requirements.

1. Assemble mock-up(s) of vapor barrier at typical edge, penetrations, thickened slabs, column piers, and standard lap joint conditions. Mock-ups may be part of the actual construction.
2. Protect the mock-up(s) from damage. The approved mock-up(s) conditions shall be used to review the quality of the installation of the vapor barrier throughout the project.
3. Approved mock-up(s) does not constitute approval to deviate from specifications.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store cementitious materials in a dry, weather tight location. Maintain accurate records of shipment and use.
- B. Store aggregates to permit free drainage and to avoid contamination with deleterious matter or other aggregates. When stockpiled on ground, discard bottom 6 inches of pile.
- C. Handle aggregates to avoid segregation.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Cementitious Materials: Portland cement meeting requirements of ASTM Specification C 150-81 Type I.
- B. Cementitious Materials: Fly Ash: ASTM C 618, Type C. Limit Fly Ash content to a maximum of 20% total cement content.
- C. Cementitious Materials: Ground Granulated Blast-Furnace Slag (GGBS): ASTM C 989, Grade 100 or Grade 120. Limit GGBS content to a maximum of 50% total cement content. Due to color variations between GGBS concrete and non-GGBS concrete, if GGBS concrete is used, it shall be used at all locations of exposed concrete.
- D. Fine aggregate: Sand, clean and sound grains, free of injurious amounts of dust and other deleterious matter and conform to ASTM C 33.
- E. Coarse aggregate: Clean, sound un-coated crushed stone or gravel (do not use gravel at vehicular pavements, walks, retaining wall, exterior stairs or curbs, unless material is approved by Illinois Department of Transportation, IDOT, for use in highway construction in portland cement concrete surfaces) free from injurious amounts of soft, thin or laminated pieces or other deleterious matter and conform to ASTM C 33. Aggregate shall pass a 3/4" ring except that used for footings which may be one inch (1").
- F. Water: Clean, fresh, potable, and free from injurious amounts of mineral or organic matter.
- G. Admixtures
  1. Contractor shall submit for review any proposed admixtures to improve workability of the mix without having detrimental effect on the strength, durability, permeability, curing, finishing, sealing, adhesion of final finish flooring, or other desirable attributes of the concrete.

2. The Contractor shall submit the name of the admixtures proposed and admixture manufacturer's certification that the selected admixtures meet the requirements herein. Admixture manufacturer's product literature shall specify when in the batching/mixing operation the admixture must be added, how the mixing shall be accomplished, and dosage rate range. Where multiple admixtures for a single design mix are proposed, Contractor shall submit a letter or notation from their concrete supplier certifying that such joint use of multiple admixtures are compatible with the design mix, such that the desirable effects of each admixture will be realized. Where the multiple admixtures which are proposed are not of the same brand, Contractor shall specifically address that issue within such letter or notation.
  3. Liquid admixtures shall be considered part of the total water. Admixtures which result in more than 0.1 percent of soluble chloride ions by weight of cement are prohibited.
  4. When admixtures are used with a mix containing cementitious materials other than Portland cement, such as fly ash or slag, Contractor shall verify with the admixture manufacturer whether the amount of the admixture shall be based on the amount of Portland cement only or the total amount of cementitious materials.
  5. Where concrete contains a Water Reducing, High Range Admixture or an Accelerating Admixture, the admixture manufacturer's representative shall attend the pre-installation-concrete meeting, observe project start-up of concrete placements, and offer recommendations.
  6. Admixtures:
    - a. Air-entraining Admixture: Comply with ASTM C 260. Air entraining is required as per Design of Concrete Mixes, listed above.
    - b. Accelerating Admixture: Accelerating admixture complying with ASTM C 494, Type C. Non-chloride admixture.
    - c. Water Reducing Admixture: Water reducing admixture complying with ASTM C 494, Type A.
    - d. Water Reducing and Retarding Admixture: Water reducing and retarding admixture complying with ASTM C 494, Type D.
    - e. Water Reducing, High Range Admixture: Water reducing, high range admixture (superplasticizer) complying with ASTM C 494, Type F or G, ASTM C 1017, Type 1 or 2.
    - f. Other: as complying with applicable ASTM requirements and approved by the Architect.
- H. Cure and Seal for interior slabs: Water based, non-yellowing, 20% solids, single coat or two coat application as specified herein. Confirm compatibility with finish flooring manufacturer for acceptable methods; if cure and seal is not acceptable provide 7 day moisture cured method in accordance with ACI-308 and as required by the finish flooring manufacturer:
1. BASF Master Builders, MasterKure CC 200WB

2. WR Meadows, VOCOMP 20
  3. Tamms-Euclid, Luster Seal WB 150
- I. Curing Cover for exterior slabs: Meet or exceed ASTM C171- 03, ASTM C171-97a, and AASHTO M171-00, single-use (not reusable), water retaining, waterproof, UV protective curing cover:
1. Sika Corporation, UltraCure NCF
  2. Mctech Group, UltraCure NCF
  3. PNA Construction Technologies, HydraCure S16.
- J. Interior Expansion Joint Filler, wood/cellulose fiber, thickness ½” unless as called out otherwise:
1. Knight-Celotex, "Flexcell"
  2. W.R. Meadows, Inc., "Fibre Expansion Joint"
  3. Right Pointe, "Right Joint Expansion Joint"
- K. Exterior Expansion Joint Fillers: Conform to applicable articles of the "Standard Specifications for Road and Bridge Construction, State of Illinois, Division of Transportation", current adopted edition.
- L. Vapor Barrier: Provide vapor retarder/barrier over prepared granular base material directly below slabs on grade. Vapor retarder/barrier membrane must have the following qualities:
1. Permeance: ASTM E 96; no greater than 0.01 Perms, as tested in accordance with mandatory conditioning test per ASTM E 1745 Section 7.1 (7.1.1-7.1.5)
  2. Strength: ASTM E 1745; exceeds Class A for tensile strength and puncture resistance.
  3. Thickness: ACI 302.1R-96; Not less than 15 mils
  4. Materials: polyethylene or polyolefin, manufactured for use as under slab vapor retarder/barrier; ordinary or generic polyethylene are not acceptable. No use of recycled or post consumer resins.
  5. Use only materials that are resistant to decay when tested in accordance with ASTM E 154 – Sections 8, 11, 12 and 13.
  6. Provided in continuous sheets of not less than 10 foot wide.
  7. Sealing Materials: Provided with vapor retarder/barrier manufacturer's recommended seam tape, mastics, and edge seal products.
  8. Provided with vapor retarder/barrier manufacturer's recommended prefabricated penetration boots, collars, etc.
  9. Provided with vapor retarder/barrier manufacturer's installation instructions.
  10. Products: Subject to compliance with requirements, provide from one of the following approved manufacturers:
    - a. Stego Industries, Inc., Stego-Wrap, 15 mil.

- b. WR Meadows, Perminator, 15 mil.
- M. Underlayment Compound: Free-flowing, self-leveling, cement-based compound, for interior applications as applicable, leveling from 1 inch thick to feathered edges. Must be compatible with finish flooring products and adhesives. Gypsum containing products are not permitted. Install with primer as per manufacturer's recommendations. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109M. Flexural Strength: Not less than 1000 psi at 28 days when tested according to ASTM C 78.
  - 1. Subject to compliance with requirements and recommendations of manufacturer for thickness required and substrate condition, provide one of the following:
    - a. Conspec Mfg. Co. Spec Topping ESL
    - b. Euclid-Tamms, Super Flo-Top
    - c. Ardex, K-15
    - d. Mapei, Ultraplan Easy
  - 2. If required for exterior applications manufacturer must provide their product as applicable for exterior and moist environments.
- N. Waterstops: Manufactured flexible waterstops shall be PVC, dumb-bell style, minimum 9" wide, with pre-fabricated corners.
  - 1. Manufacturer's
    - a. Greenstreak
    - b. Vinylex Corporation,
    - c. Tamms
- O. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, active sodium bentonite or other similar hydrophylic material for adhesive bonding to concrete with manufacturer's adhesives.
  - 1. Products: Subject to compliance with requirements, provide manufacturers proper shape for each condition:
    - a. CETCO, Waterstop RX
    - b. Concrete Sealants Inc., Conseal CS-231
    - c. Greenstreak, Hydrotite
    - d. Mirafi Moisture Protection, Mirastop
- P. Perimeter Insulation: 2 inches thick, extruded polystyrene board insulation (XPS), Type IV, 1.6 pcf minimum density, 25 psi minimum compressive strength, square edge rigid cellular polystyrene with closed-cells and integral high density skin, for below grade installation. Comply with ASTM C 578, ASTM E 84 maximum flame-spread of 10 and smoke-developed indexes of 175; 5 year aged R-values of 10.8 at 40 degrees F and 10.0 at 75 degrees F:
  - 1. Dow Chemical Company - "Styrofoam XPS"
  - 2. Owens Corning - "Foamular 250 XPS"

3. DiversiFoam Products Co. - "CertiFoam 25"

2.02 DESIGN OF CONCRETE MIXES

- A. The Contractor shall have prepared, the design mixes of the Portland cement (including other cementitious materials), aggregates, and water for each class of concrete to be used. Each mix shall be based upon a mix with the approved materials and admixtures, and the concrete supplier's testing laboratory results meeting the requirements herein. (Tested design mixes do not need to contain hot or cold weather conditioning admixtures such as accelerators.)
1. Design Mixes in accordance with ACI 211.1-81 to provide normal weight concrete with properties as indicated on drawings and schedule, but shall at a minimum meet the requirements set herein.
    - a. Provide two design mixes; one for flatwork, one for concrete other than flatwork. Design mix for interior and exterior flatwork shall produce 4,500 lb. per sq. in. compressive strength at the end of 28 days, and water/cement (water/cementitious materials) ratio is not to exceed 0.45. Design mix for other than flatwork shall produce 3,500 lb. per sq. in. compressive strength at the end of 28 days, and water-cement ratio shall not exceed 0.55.
    - b. Provide slump of 3 inches plus or minus 1 inch for flatwork and 4 inches plus or minus 1 inch for other concrete work.
    - c. Concrete exposed to the exterior, excluding building foundations; add an air entraining agent in accordance with air entraining manufacturer's recommendation; Air content; 6 percent plus or minus 1 percent.
    - d. Concrete exposed to the exterior, excluding building foundations; use GGBS cementitious materials in accordance with GGBS manufacturer's recommendation.

2.03 FORM-FACING MATERIALS

- A. Formed Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Rust-free metal.
  2. Exterior-grade undamaged, unpatched plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - a. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.
    - b. Structural 1, B-B, or better, mill oiled and edge sealed.
    - c. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.
  3. Architecturally Exposed Concrete: Medium-density overlay, class 1 or better, mill-release agent treated and edge sealed
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of the exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes not larger than 1 inch (25 mm) in diameter in concrete surface.
  - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
  - 4. Furnish stainless steel ties where drawings indicate to be exposed.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Install products as per the manufacturer's written recommendations, except as superseded herein.

### 3.02 FORMS

- A. Construct forms true to lines, shapes and dimensions as shown. Erect plumb, straight and sufficiently tight to prevent leakage. Brace and shore to adequately and safely support construction loads and prevent displacement. The design and engineering of the formwork and shores as well as its construction and removal shall be the responsibility of the Contractor and shall conform to "Recommended Practice for Concrete Formwork", ACI 347 and Section 6.2 of ACI 318.
  - 1. Accurately form structural forms as per ACI 347-78. Brace, tie and shore as required to prevent movement in any direction during the placement of concrete.
  - 2. Side forms may be omitted at footings where soil conditions will permit excavation to accurate size without cave-in.
- B. Coat contact surfaces of forms with non-staining, rust preventative form-release agent, according to manufacturer's written instructions, before placing reinforcement. Rust stained steel formwork is not acceptable.
- C. Forms for exposed concrete:
  - 1. Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes.
  - 2. Do not use metal cover plates for patching holes or defects in forms.
  - 3. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersection.

4. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance of concrete. Do not use narrow strips of form material that will produce bow.
5. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.

### 3.03 PREPARATION FOR PLACING CONCRETE

- A. Clean earth surface upon which concrete footings are to be placed and interiors of forms free from frost, ice, mud, water and other foreign matter.
- B. Moisten wood forms, except in freezing weather, so joints will tighten to prevent cement grout seepage. The Contractor shall inspect reinforcement for secure fastening and accurate position.
- C. Level floor areas on grade to true planes with gravel as a bed for concrete, prior to applying mesh.
- D. Prior to the placing of concrete, the Contractor shall notify the Architect in due time to allow for the Architect's review of the work.

### 3.04 DELIVERING CONCRETE

- A. Batch, mix and deliver concrete in accordance with the requirements set forth in ASTM C 94; subject to provisions specified herein relative to materials, strength, proportioning, consistency and delivery timing.
- B. The rate of delivery of the mixed concrete shall be such that the interval between placing of successive batches shall not exceed 30 minutes. The elapsed time between the introduction of mixing water to the cement and aggregate and completion of discharge shall not exceed 90 minutes.
- C. Delivery tickets shall record the mix design and the batch time. Keep legible copies of these available for examination by the Architect.

### 3.05 ENTRANCE PLATFORM FOUNDATIONS

- A. Provide solid concrete foundation/frost protection wall around entire perimeter of entrance platforms, stoops, landings, etc. Depth of wall minimum of 4 feet below grade. Tie platform to foundation with minimum #5 bars 12" o.c.

### 3.06 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set anchorage devices, including but not limited to anchorage devices for precast concrete panel or slabs, curtainwall, elevator, masonry, mechanical/electrical equipment, and other items required for other work connected to or supported by cast-in-place concrete, using templates, setting drawings, and instructions from suppliers of items to be embedded.
  1. Install reglets to receive flashings and other membrane materials at locations indicated, in accordance with manufacturer's recommendations.
  2. Edge Forms and Screeds: Set edge forms and intermediate screeds as necessary to achieve final elevations indicated for finished slab surfaces.
  3. Install anchor rods and dowels, accurately located, to required elevations.
  4. Install dovetail masonry anchor slots per manufacturer's requirements to receive specified masonry ties.

- B. Waterstops: Install waterstops according to manufacturer's written instructions.
  - 1. PVC Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate, weld and seal joints in waterstops watertight according to manufacturer's written instructions.
  - 2. Self-Expanding Strip Waterstops: Install in construction joints and at other locations as indicated, according to manufacturer's written instructions, bonding with manufacturers adhesives, or mechanically fastening if conditions require, firmly pressing into place. Install in longest lengths practicable. Allow for expansion without damage or blow-out of concrete.

### 3.07 INSTALLATION OF VAPOR BARRIER

- A. Following leveling and tamping of granular base for slabs on grade, place vapor retarder/barrier sheeting with longest dimension parallel with direction of pour.
- B. Install as per ASTM E-1643, unless exceeded herein. Comply with manufacturer's recommendations, except as herein exceeded.
- C. Protect from damage, place vapor retarder/barrier just ahead of concrete placement, not to exceed extent of day's pour.
- D. Lap joints 6-12" and seal with vapor retarder/barrier manufacturer's appropriate tape. At foundation perimeter walls and vertical wall interruptions, provide manufacturer recommended double sided seal tape 1" below the installed slab elevation. Install vapor retarder/barrier up the perimeter walls and vertical wall interruptions so that the edges are showing 1" above the installed slab elevation. After installation of floor slab, trim flush with slab. Extend vapor retarder/barrier 6" out from construction joints for access for seam taping. Install manufacturer's recommended pipe boots fully sealed, or similar manufacturers approved sealing methods at pipe penetrations. Installation shall be water tight and vapor tight. Use extreme care to ensure that the integrity of the vapor retarder/barrier is not violated.
- E. Notify Architect by email and provide the opportunity for observation of the fully installed, taped and sealed vapor retarder/barrier by the Architect no less than 24 hours prior to installation of the concrete slab.

### 3.08 PERIMETER INSULATION:

- A. Install perimeter insulation around the entire perimeter of the foundation wall. Apply insulation complying with manufacturer's recommendations. Butt boards closely together. Apply board insulation to clean surfaces. On vertical surfaces, use appropriate spot adhesive to secure in place.
- B. Insulation shall extend vertically to top of footing, or 4'-0" where footing is lower than 4'-0", except where shown to exceed this. Where shown on horizontal surfaces, level fill below slab so that boards are well seated.

### 3.09 CONCRETE SLAB FINISH FLOORING SUBSTRATE REQUIREMENTS

- A. Concrete slab flatness, fiber exposure, final finish, recess or elevation, admixtures, curing methods/materials, sealers, sealants, alkalinity, and moisture

content shall meet the requirements of finish flooring in this project. Contractor shall verify the requirements with the finish floor suppliers prior to installation of this concrete work.

### 3.10 PLACING CONCRETE

- A. Place concrete immediately after mixing. Tamp, spade or vibrate to force out air pockets and work concrete into corners of forms and around reinforcement to ensure a dense homogeneous mass.
  - 1. Pouring shall be continuous from working joint to working joint.

### 3.11 JOBSITE ADDITION OF WATER TO CONCRETE

- A. Water shall not be permitted to be added at the jobsite unless all of the following are met:
  - 1. Design mix was batched to allow for added water, clearly states so on the batch ticket delivered to the site, and clearly states how many gallons per cubic yard may be added on site without exceeding the water/cement ratio.
  - 2. Batched water plus site added water shall not exceed the specified water/cement ratio.
  - 3. The slump, properly tested as per ASTM C143, is less than the specified requirement.
  - 4. The time from leaving the plant does not exceed 90 minutes.
  - 5. Water may be added only to a full batch (full truckload).
  - 6. Maximum amount of water permitted shall be 2 gallons of water per cubic yard of concrete.
  - 7. Truck drum shall make 35 revolutions after water added.
  - 8. The slump as originally tested and the amount of water added shall be recorded on copies of the batch ticket, and shall be signed by the Contractor.

### 3.12 COLD & HOT WEATHER PROCEDURES

- A. ACI cold & hot procedures are minimum requirements. Contractor must protect concrete from freezing, from frost below concrete slabs or footings, from excessive or fast evaporation or drying and provide for proper curing in all types of weather.
- B. Cold weather concreting: Do not mix or place concrete when the temperature is expected to fall below 40 deg. F. during the 24 hour period after placing concrete or below 30 deg. F. during the succeeding 6 days unless proper provision has been made for heating and protecting the concrete. In such cases provide heated concrete in accordance with ASTM C-94 and follow procedures outlined in ACI 306 or the "Manual of Concrete Practice".
- C. Hot weather concreting: During hot weather and periods of low humidity, take adequate precautions to reduce the detrimental effects of these conditions on concrete. When applicable, apply an evaporation retarder which is fully compatible with other materials, methods, and final finish flooring. The approved

practice for hot weather concreting are those approved by ACI 305. Conduct hot weather concreting in accordance with these practices as outlined.

### 3.13 FINISHING CONCRETE

- A. Exposed concrete wall areas, interior and exterior: Wet grind to a smooth finish, and to the approval of the Architect.
- B. Concrete paving, walks, stoops, ramps, and curbs shall receive a broom finish.
- C. Interior floor slabs: One course concrete, steel troweled to a smooth finish, without the use of drier. Screed concrete floor slabs with an approved vibrating screed or other approved methods to ensure a dense concrete.
- D. Interior floor slabs shall be level, and flat within a tolerance of 3/16" in 10 feet, or 1/8" in 10 feet where required by the finish floor manufacturer. Make corrections required to meet flatness levels before installation of flooring materials.
- E. Slope floors to pitch ¼ inch at a 1 foot radius from the edge of floor drains, except where shown with a larger slope or radius on the drawings.

### 3.14 CONCRETE JOINT CONSTRUCTION

- A. Construction Joints: Locate and install construction joints as indicated on drawings. If construction joints are not indicated, locate in manner which will not impair strength and will have least impact on appearance.
  - 1. Keyways: Provide keyways not less than 1-1/2 inches deep.
  - 2. Reinforcement: Continue reinforcement across and perpendicular to construction joints, unless details specifically indicate otherwise.
- B. Expansion Joints: Construct expansion joints where indicated. Install expansion joint filler to full depth of concrete.
- C. Control Joints: Construct control joints in slabs poured on grade to form panels of sizes indicated on drawings, but not more than 10 feet apart in either direction. Panels shall be nearly square and the length shall not exceed 1.5 times the width. L-shaped panels are not acceptable. Provide control joints at column centerlines. Provide additional control joints as necessary to comply with these guidelines. Provide control joints at elevated slabs. In addition, control joints at elevated slabs shall be centered on beam lines and as required to meet the above spacing requirements.
  - 1. Interior: Form control joints by means of saw cuts one-fourth the depth of the slab, performed as soon as possible after slab finishing without dislodging aggregate.
  - 2. Exterior: Form control joints by means of neatly tooling one-fourth the depth of the slab, performed as soon as possible after slab finishing without dislodging aggregate. Sawcut exterior control joints are not acceptable.

### 3.15 CURING CONCRETE

- A. Protect concrete from damage due to premature drying or exposure to rain.
  - 1. At interior concrete flatwork, apply one coat of cure and seal per manufacturer requirements.

- a. Locations which are to have exposed concrete floors without finish flooring, and areas indicated to have Sealed Concrete Floors, shall have two coats total. After initial coat, areas are to be thoroughly cleaned and prepared for the application of one additional coat of cure and seal. The additional coat of cure and seal should be applied after the end of the 28 day concrete cure time.
- b. Where floors are ground down, reapply cure and seal.
- 2. At exterior concrete flatwork, cure by placing curing cover over finish surface within two (2) hours after final troweling and leave in place for 7 days.
  - a. Follow curing cover manufacturer's requirements, if necessary keep concrete thoroughly wet for a period of seven (7) days when subjected to excessive heat, sun, wind or other elements producing a drying effect.
- B. Make provisions necessary to maintain temperature of concrete at a minimum of 50 deg. F. for at least five (5) days after placement.

### 3.16 QUALITY CONTROL DURING CONSTRUCTION

- A. Contractor shall fully prepare substrate, vapor retarder, reinforcing, formwork, etc, prior to concrete placement. Contractor shall notify Architect by email no less than 24 hours prior to installation of concrete, and provide the Architect the opportunity for observation of the full preparation (including reinforcing, vapor barrier, etc.) prior to the concrete placement. Should the Architect determine that the preparation is improper, incomplete, or otherwise fails to meet the requirements of the specifications, he shall notify Contractor, in writing or by email, stating observed shortcomings. Contractor shall take immediate steps to remedy the stated deficiencies and send a second 24 hour notice by email to Architect, certifying that preparation is now proper & complete & those deficiencies remedied, and again provide the Architect the opportunity for observation of the full preparation prior to the concrete placement.
- B. Should the Contractor fail to give the Architect proper notice prior to installation of any concrete work that concrete work shall be subject to additional testing, including core samples, and other testing methods. Contractor shall properly fill test holes and reimburse the Owner for the additional testing expenses, even if the concrete tests indicate general compliance with the specifications.
- C. Contractor shall take precautions as necessary to prevent curling of flatwork including but not limited to use of curing sheets, misting, and other ACI approved procedures.
- D. Contractor shall take precautions as necessary to provide a consistent appearance in the exposed concrete including but not limited to the use of consistent materials, installation, finishing, jointing, curing, patching, sealing, and other procedures, as well as avoiding "checker board" flatwork installation.

### 3.17 TESTING CONCRETE

- A. The Owner will engage one or more Materials & Geotech Testing agencies to conduct tests for concrete. Refer to Section 01 41 00 - Materials & Geotech

Testing for additional requirements.

### 3.18 ALLOWABLE TOLERANCES OF CONSTRUCTION:

- A. Provide at a minimum concrete tolerances to meet ACI 347 and ACI 117, except as superseded herein:
  - 1. Provide at a minimum the following formed concrete tolerances, except as superseded herein: Provide Class A tolerances for concrete surfaces exposed to view. Provide Class C tolerances for other concrete surfaces.
  - 2. Maximum Variation from Plumb: In lines and surfaces of columns, walls, piers, etc.:
    - a. 1/4 inch in 10 feet.
    - b. 3/8 inch in any story or 20 feet maximum.
    - c. 1/2 inch in 40 feet.
  - 3. Maximum variation from level or grades for exposed foundation wall tops, sills, horizontal grooves, and other conspicuous lines.
    - a. 1/4 inch in any bay or 20 feet maximum.
    - b. 1/2 inch in 40 feet.
  - 4. Maximum variation of linear building line from an established position in plans and related portions of columns, walls and partitions.
    - a. 1/2 inch in any bay or 20 feet maximum.
    - b. 3/4 inch in 40 feet.
    - c. Maximum variation in cross sectional dimensions of thickness of walls: Not less than 1/4 inch smaller or more than 1/2 inch larger.

### 3.19 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar after removing forms.
- B. Mix dry-pack mortar, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
  - 1. Cut out honeycombs, rock pockets, void over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
  - 2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surround color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface

deflects include but are not limited to honeycomb, cracks, spalls, color or texture irregularities, air bubbles, rock pockets, fins, other projections on the surface, stains, and discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycombs, rock pockets, and other objectionable conditions.
  2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days. Pay particular attention to slab construction joints, these high areas shall be ground down to minimize the thickness of any filling compound.
  3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing. Finish repaired areas to blend into adjacent concrete. Proprietary cementitious underlayment compounds may be used when installed as per manufacturer's written recommendations. Substrates shall be cleaned & primed as required and underlayment compound installed as per manufacturer's recommendations. No gypsum underlayment fillers may be used as underlayment compounds.
  4. Repair defective areas, except random cracks and single holes under 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- E. Repair isolated random cracks and single holes less than 1 inch in diameter with pressure injected repair epoxy in accordance with the repair epoxy manufacturer's recommendations.
- F. Perform structural repairs with prior approval of Architect for method and procedure.
- G. Repair methods not specified above may be used, subject to acceptance of Architect.

END 03 30 00

DIVISION 4 – MASONRY

Section 04 10 00 – Mortar and Grout

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

A. Mortar and Grout

1. Product data.
2. Mortar mix designs. Must clearly state Portland cement, lime, proportional mix, of proper type.
3. Grout mix design.
4. Mortar test reports, ASTM C270 (Lab mixed) & ASTM C780 (Field mixed).
5. Integral Water Repellant (IWR) Admixture, which is the same as the water repellent admixture products used in provided masonry products.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Mortar Mix: Prepackaged or silo mix, must clearly state Portland cement lime mortar mix. Masonry cement or mortar cement mortars are not acceptable.
- B. Masonry: Type N Portland cement lime mortar, complying with ASTM C270, Table 1 (Proportional design), with average compressive strength of 750 psi (800 psi max.).
- C. Grout Mix (for masonry & hollow metal frames): Comply with ASTM C476. Aggregate ASTM C404. Grout shall comply with proportion requirements of ASTM C476. 1 part Portland cement 1/10 part hydrated lime 3 parts sand 2 parts coarse aggregate (for coarse grout only, omit for fine grout). Fine or coarse grout mix as per ACI 530.1. Slump for masonry shall be 8-11 inches. Slump for hollow metal frames shall be 4 inches. Gypsum grout components are not allowed. Mortar is not an acceptable substitution for grout.
- D. Components for field mixed mortar and grout:
1. Cement: Portland cement meeting the requirements of ASTM Specification C 150-81 Type I.
  2. Lime: Hydrated lime meeting standard specifications ASTM C 207 for hydrated lime, Type S.
  3. Sand: Well graded, clean, sharp mason sand meeting ASTM C 144-527.
  4. Water: Clean, fresh and free from salt, dirt and sewage and potable.
  5. Aggregate for Mortar: ASTM C 144.

- 6. Aggregate for Grout: ASTM C 404.
- E. Water Repellent Admixture: Provide water repellent admixture in mortar, which is the same as the water repellent admixture products used in provided masonry products to assure bonding of mortar to masonry products. Use at masonry which has integral water repellent.
- F. Provide mortar, products and accessories compatible with specified masonry products for a complete and proper installation and to assure bonding of mortar to masonry products.
- G. Other Admixtures: The use of calcium chloride or other agents for lowering freezing temperature, or for accelerating, or any other admixtures not listed herein, are not allowed.

### PART 3 - EXECUTION

#### 3.01 MIXING

- A. Mix mortar in such quantities that it will be used within a reasonable time. Re-tempering of mortar is not allowed.

#### 3.02 TESTING MORTAR

- A. The Owner will engage one or more Materials & Geotech Testing agencies to conduct tests for mortar. Refer to Section 01 41 00 - Materials & Geotech Testing for additional requirements.

END 04 10 00

DIVISION 4 – MASONRY  
Section 04 20 00 - Unit Masonry

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

- A. Product data for each of the following.
1. CMU
  2. Split Faced CMU
  3. Burnished Block
  4. Smooth Face masonry
  5. Texture Face masonry
  6. Rough Face masonry
  7. Diffuser CMU (including Burnished if applicable)
  8. Slotted Acoustical CMU
  9. Face Brick including IRA
  10. Water Repellent Admixture
  11. Masonry Cleaning Products
  12. Built-in members, flashings, reinforcing, and accessories
- B. Samples for each of the following.
1. Split Faced CMU
  2. Burnished Block
  3. Smooth Face masonry
  4. Texture Face masonry
  5. Rough Face masonry
  6. Diffuser CMU (including Burnished if applicable)
  7. Slotted Acoustical CMU
  8. Face Brick with cost per thousand as described in the allowance below, for each masonry type and size. Final selection of face brick shall not be approved without written allowance costs.
- C. Control joint layout plans and details.
- D. Final Itemized Cost Accounting for adjustment of masonry allowance

1.03 QUALITY ASSURANCE

- A. Pre-Installation Masonry Meeting: Meeting with Architect and Contractor; Contractor shall review procedures to provide quality installation of the work,

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including: mockup sketch and installation, material selections, accessories, detailing, protection of masonry materials and walls from weather, control joints, cold weather construction and protection, special masonry materials or units or finishes, special or unusual details or conditions, and other requirements of this section.

B. Materials:

1. Do not change source or brands of masonry materials during the Work.
2. Obtain masonry units from one manufacturer, cured (if applicable) by one process and of uniform texture and color, for each type required for each continuous area and visually related areas.
3. Fire-Resistive ratings: Provide materials and construction identical to those of assemblies with fire-resistive ratings determined per ASTM E 119 by a testing and inspection agency, by equivalent concrete masonry thickness, or other means, as acceptable to authorities having jurisdiction.
4. Regulatory Requirements: Comply with the applicable requirements of governing authorities and codes.
5. Unit Masonry Standard: Comply with TMS602/ACI530.1/ASCE6 current edition "Specifications for Masonry Structures," except as otherwise specified.
6. Coordination: Review installation procedures and coordinate with other Work that must be integrated with masonry.

1.04 FIELD-CONSTRUCTED MOCK-UP

A. Prior to installation of masonry, erect mock-up to comply with the following requirements, using preliminary masonry unit selections:

1. Submit a shop drawing sketch of the proposed mock-up panel, prior to mock-up panel construction, showing front and rear elevations.
2. Build Mock-Up approximately 8 feet long by 6 feet high, with a 1 foot 4 inch corner return, full wall thickness, including face and backup wythes as well as masonry accessories. Mockup shall be constructed upon a stable concrete foundation.
3. Include each and every masonry type used on the building, both interior and exterior.
4. Install full range of color, texture, etc. of masonry units in the mock up.
5. Wall construction shall include typical wall vocabulary including flashing and drip edge, drainage mesh, insulation, weep holes, reinforcing, brick and CMU control joints, etc. Leave base of wall flashing partially exposed for viewing flashing installation.
6. Include masonry details such as: special banding, bonding, mortar joint profiles, etc. Foreshorten typical wall construction as required to fully include top of wall cornice, wall banding, etc.
7. Window opening: 16" x 16" opening including jamb, sill, head with lintel, jamb closure wood blocking, weep holes, flashing, and drip edge. Leave flashed lintel partially exposed for viewing flashing and end dam installation. Leave window sill flashing partially exposed for viewing

flashing, flashing support, and end dam installation.

8. Protect the mock-up wall cavity from the elements, with a typical top of masonry wall with wood blocking, flashing, and cap installation at the top of the mock-up wall. Leave one end of the top of wall partially exposed for viewing flashing, flashing support, and blocking installation.
9. Construct the mock-up 21 days prior to the date selections are to be finalized. Approved mockup does not constitute approval to deviate from specifications.
10. Retain and maintain mock-up during construction in undisturbed condition until directed to remove the mock-up. When directed, demolish and remove mock-up from project site.

#### 1.05 MASONRY WARRANTY

- A. The Contractor accepts the responsibility of providing proper workmanship, including completely filling head and bed joints with mortar, proper installing of flashings, and the assumption that leaks through the walls, cracks in the mortar, and improper bonding to masonry units will be due to the Contractor's improper workmanship. Contractor further warrants that the walls will not leak, cracks will not occur in the mortar, and the mortar will be properly bonded to masonry units, and flashing will be properly installed. Contractor agrees to cut out mortar joints to 3/4" depth in areas with either leaks, cracks, or poorly bonding, to point them with mortar, and to replace improperly installed flashings, until such conditions have been stopped. This warranty covers a period of 2 years from the date of Substantial Completion.

#### 1.06 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602, and as indicated herein.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- C. Masonry Protections:
  1. During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
    - a. Where one wythe of multi wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
  2. Do not apply uniform floor or roof loads or concentrated loads for at least 7 days after constructing masonry walls or columns which support these loads.
  3. Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar, and soil that comes in contact with such masonry.

4. Protect base of walls from rain-splashed mud and mortar splatter.
5. Protect sills, ledges, and projections from grout and mortar droppings.
6. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes from grout and mortar droppings.

## PART 2 - PRODUCTS

### 2.01 MASONRY UNITS

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work; if units are installed exposed they will be subject to rejection and replacement.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction, and as specified within.

### 2.02 CONCRETE MASONRY

- A. Concrete block: Standard medium weight concrete block, ASTM C-90, Grade N, Type I, for concrete masonry units.
  1. Interior partitions and exterior back-up medium weight except as otherwise called for on drawings of Haydite, Arcalite, or Solite Plus Limestone. Metallic admixtures not allowed.
  2. Maximum weight of thoroughly cured 8" x 16" medium weight block: 34 lbs. Density, 105-125 lbs. per cu. ft. Blocks shall be of true height so courses and joints line up and be uniform. Interior exposed block shall have a fine to dense uniform surface texture free from superficial defects, to be supplied from one manufacturer.
  3. Minimum net area compressive strength of concrete masonry units shall be 3,000 psi or net area compressive strength of masonry, f'm shall be 1775 by the prism strength test method.
  4. The block, other than those which are autoclave cured, shall be a minimum of 90 days old. Furnish a certification that blocks furnished for this project are a minimum of 90 days when delivered.
  5. Fire Rating:
    - a. 4" and 6" concrete block: Certified classification C-1 (1-hour rating).
    - b. 8" and 12" concrete block: Certified classification C-2 (2-hour rating).
  6. Earlier delivery may be approved when the manufacturer utilizes special curing, or drying processes, or both, which insure the delivery of cured units with a moisture content of less than 30% of total absorption.
  7. Special shapes: At interior block, exposed outside vertical corners shall be bull nosed except door and window jambs, unless shown otherwise. Provide bull nosed units for window sills, unless shown otherwise. Bull nose units shall be manufactured, not field fabricated. Lintel & bond

beam block with "U" shape for use at block lintels and bond beams as called for by the Drawings. Special "control joint" slotted sash units to be provided at masonry control joints. Use solid concrete brick of load bearing grade, where required to adjust steel bearing elevation.

- B. Burnished Block: Burnished block to be factory ground face at exposed surfaces, cast-in integral color, with factory applied clear sealer. Block shall have integral waterproofing, equal to W.R. Grace Dry-Block, with a compatible mortar waterproofing product available from the same waterproofing manufacturer. Approved manufacturers, subject to the requirements herein:
1. Northfield Block Co./Trendstone; Ground Faced Masonry; Provide manufacturer's full color options for selection.
  2. Provide 4", 8", 12" and bond beam units as indicated and required to complete the Work.
  3. Special shapes: At interior block, exposed outside vertical corners shall be factory manufactured bull nose units, except at door and window jambs. Provide special 135° corner units at angled outside corners. Provide special units with multiple ground surfaces as required or indicated to maintain uniform, consistent finish throughout area.
  4. Special finishes: At exterior and interior block, seal walls with one coat of Trencat low VOC 20% solids acrylic sealer (or comparable product, products must be approved by masonry unit manufacturer) clear acrylic sealer. Apply sealer per manufacturer's recommendations. Seal units after properly removing mortar drippings, smears, etc., and proper approved cleaning methods have been accomplished. Protect adjacent dissimilar surfaces, including but not limited to wood, glass, aluminum, prefinished metal, etc.
- C. Split Faced CMU: Standard medium weight split faced concrete block, ASTM C-90, Grade N, Type I, for concrete masonry units. Cast-in integral color, with integral waterproofing, equal to W.R. Grace Dry-Block, with a compatible mortar waterproofing product available from the same waterproofing manufacturer. Approved manufacturer, subject to the requirements herein:
1. Trenwyth Industries, Split Face Concrete Masonry Units; Provide manufacturer's full color options for selection.
  2. Sizes: 8" x 16" x 8"w. Provide factory finished special shapes for corner units (edge returns to have factory texture matching face), door jambs (smooth returns), and as shown or otherwise necessary to accomplish the work.
  3. Maximum weight of thoroughly cured 8" x 16" medium weight block: 34 lbs. Density, 105-125 lbs. per cu. ft. Blocks shall be of true height so courses and joints line up and be uniform.
  4. Minimum net area compressive strength of concrete masonry units shall be 3,000 psi or net area compressive strength of masonry, f'm shall be 1775 by the prism strength test method.
  5. The block, other than those which are autoclave cured, shall be a minimum of 90 days old. Furnish a certification that blocks furnished for this project are a minimum of 90 days when delivered.

6. Earlier delivery may be approved when the manufacturer utilizes special curing, or drying processes, or both, which insure the delivery of cured units with a moisture content of less than 30% of total absorption.
- D. Smooth Face Masonry, Texture Face Masonry, and Rough Face Masonry: Units shall have a fine grain textured appearance similar to natural Indiana Limestone, with no surface crazing or pin holes. Units shall meet the requirements of the Cast Stone Institute, except where listed here otherwise. Units shall have a minimum compressive strength of 5000 PSI and a maximum moisture absorption ASTM C1195 of 6%. Units shall have cast-in integral color or natural aggregate color as selected. Block shall have integral waterproofing, equal to W.R. Grace Dry-Block, with a compatible mortar waterproofing product available from the same waterproofing manufacturer. Units shall be delivered to the job site packaged in a manner to minimize damage to the faces in shipment. The face of masonry units shall be of uniform color, exposure and texture. Surfaces are to be factory coated with a clear, unpigmented sealer.
1. Trenwyth Industries, Cordova Stone
    - a. Smooth; Ground face.
    - b. Texture; Texture face
    - c. Rough; Chisel face.
  2. Sizes: 4" x 24" x 4"w, 8" x 24" x 4"w, and as indicated or required. Provide factory finished special shapes for corner units (edge returns to have factory texture matching face), jambs (smooth returns as indicated), sills, and copings as shown or otherwise necessary to accomplish the work.
- E. Diffuser CMU and Burnished diffuser CMU to be 8" and 12" "Diffuser Blox" without acoustical slots and filler by RPG Diffuser Systems, Inc. Provide necessary components to provide a complete and proper installation. Diffuser CMU to be laid in stack bond and reinforced with vertical and horizontal reinforcing bars grouted in solid as indicated and per manufacturer's requirements. Units at Auditorium and Stage areas to have cast-in integral color matching adjacent burnished CMU units. After installation, seal burnished units after properly removing mortar drippings, smears, etc., and proper approved cleaning methods have been performed. Seal interior walls with one coat of TK Sealer, "Bright Seal" (or comparable product, products must be approved by masonry unit manufacturer) clear acrylic sealer. Apply sealers per manufacturer's recommendations. Protect adjacent dissimilar surfaces, including but not limited to glass, aluminum, prefinished metal, etc.
- F. Slotted Acoustical buCMU: Slotted Acoustical CMU in walls as indicated to be 8" "Soundblox", Type RSC, by Proudfoot Company, Inc. Provide incombustible fibrous filler in each cavity. Provide right and left hand half slot face units at ends to allow running bond to be maintained with straight vertical end slot patterns. Provide RSC-RF units at vertical reinforced locations.

## 2.03 FACE BRICK

- A. General: Provide shapes indicated and as follows:
1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.

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2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
  3. Provide special shapes as detailed or required, including corner brick (other than 90 degree corners) angle units, solid units, etc. Use solid brick at recessed or projected courses, and at corbelling.
  4. Initial Rate of Absorption (IRA): Provide test data of Initial Rate of Absorption to verify less than 30g / 30sq. in. per minute when tested per ASTM C 67.
  5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
- B. Face brick to be the same color, manufactured by the same manufacturer, and produced on the same run to assure color match. Face brick to be in sizes and textures as selected.

Specifier Note: Must be edited and allowances updated for each project

1. Face brick Type 'A' shall be furnished where indicated or required. Face brick shall meet A.S.T.M. C-216, Grade SW, Type FBX, velour finish.
  - a. Utility size (3-5/8" x 3-5/8" x 11-5/8")
    1. Typical U.O.N.
    2. Material cost allowance of \$1,500 per thousand F.O.B. jobsite.
  - b. Closure size (3-5/8" x 3-5/8" x 7-5/8")
    1. Material cost allowance of \$1,200 per thousand F.O.B. jobsite.
  - c. Modular size (2-1/4" x 3-5/8" x 7-5/8")
    1. Material cost allowance of \$900 per thousand F.O.B. jobsite.
2. Face Brick Type 'B' shall be furnished where indicated or required. Face brick shall meet A.S.T.M. C-216, Grade SW, Type FBX, vertically struck wire cut finish.
  - a. Utility size (3-5/8" x 3-5/8" x 11-5/8")
    1. Typical U.O.N.
    2. Material cost allowance of \$1,600 per thousand F.O.B. jobsite.
  - b. Closure size (3-5/8" x 3-5/8" x 7-5/8")
    1. Material cost allowance of \$1,300 per thousand F.O.B. jobsite.
  - c. Modular size (2-1/4" x 3-5/8" x 7-5/8")
    1. Material cost allowance of \$950 per thousand F.O.B. jobsite.
3. Face Brick Type 'C' shall be furnished where indicated or required. Face brick shall meet A.S.T.M. C-216, Grade SW, Type FBX, smooth finish.

- a. Utility size (3-5/8" x 3-5/8" x 11-5/8")
    - 1. Typical U.O.N.
    - 2. Material cost allowance of \$1,600 per thousand F.O.B. jobsite.
  - b. Closure size (3-5/8" x 3-5/8" x 7-5/8")
    - 1. Material cost allowance of \$1,300 per thousand F.O.B. jobsite.
  - c. Modular size (2-1/4" x 3-5/8" x 7-5/8")
    - 1. Material cost allowance of \$950 per thousand F.O.B. jobsite.
- C. Allowance: Provide material cost allowance noted above for each masonry type, F.O.B. jobsite, unloaded in a location as directed by Contractor.
- 1. Submit substantiating paperwork for review prior to final approval of the brick selections.
  - 2. Final Itemized Cost Accounting will be reviewed for adjustment of masonry allowance.

#### 2.04 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: Billet steel deformed bars complying with ASTM A 615/A 615M, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
  - 1. Interior Walls: Class 1 Mill galvanized, carbon steel (ASTM A641).
  - 2. Exterior Walls: Class B-2 Hot-dip galvanized, carbon steel (ASTM A153).
  - 3. Wire Size for Side Rods: 9 gauge.
  - 4. Wire Size for Veneer Ties: 9 gauge.
  - 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
  - 6. Masonry Veneer Horizontal Joint Reinforcement at Wood or Metal Stud Walls: 9 gauge wire.
  - 7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- C. Horizontal Joint Reinforcement: Welded-wire units prefabricated with prefabricated corner and tee units. Width of reinforcing shall be not less than two inches (2") less than total width of wall. Provide prefabricated corners and/or tees at intersecting masonry walls.
  - 1. For multi-wythe masonry, provide type as follows: Ladder Design with cross rods spaced not more than 16 inches o.c. and number of side rods as follows: Number of side rods for multi-wythe concrete masonry: One side rod for each face shell of hollow masonry units more than 4 inches in nominal width plus one side rod for each wythe of masonry 4 inches or less in nominal width. Provide drip at cross rod between wythes.
  - 2. For single-wythe masonry, provide type as follows with single pair of side

rods: Truss Design with continuous diagonal cross rods spaced not more than 16" o.c.

3. For multi-wythe masonry, where construction of the concrete block precedes the installation of the exterior veneer, or alignment or horizontal masonry joints do not align between wythes, provide: Ladder Design with cross rods spaced not more than 16 inches o.c., with side rods & accessories as follows: Two side rods at the interior concrete block masonry. One rod at 4" thick exterior masonry wythe, or two ladder type rods at exterior 6" or thicker masonry veneer. 3/16" diameter wire U anchor fabricated to secure a similar wire bent tie. Provide an interlock system (Holmann & Barnard, Inc. "Seismicclip" or comparable), such that the exterior masonry wire reinforcing is tied back to the interior reinforcing.
4. Manufacturers:
  - a. Holmann & Barnard, Inc.
  - b. Heckmann Building Products, Inc.

## 2.05 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
  1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
  2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
  3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8" cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Masonry anchors at poured in place concrete wall back up with 3/4" minimum joint depth shall be hot dipped galvanized 3/16" dia. triangular wire tie of the proper length for embed depth required with dovetail clip (corresponding cast in 12 ga. galv. metal dovetail slot by installing contractor from same manufacturer, verify and coordinate exact requirements), and premolded horizontal wire reinforcing seismic clip. Items to be hot dipped galvanized. Provides for continuous horizontal wall reinforcement to be secured to ties.
  1. Hohmann & Barnard, Inc.; #315-BT S.I.S.
  2. Heckman Building Products, Inc.; comparable to (1)
- D. Interior masonry wall anchors at poured in place concrete wall back up with 3/4" minimum joint depth shall be mill galvanized 3/16" dia. triangular wire tie of the proper length for embed depth required with channel clip, premolded horizontal wire reinforcing seismic clip, and surface mounted mill galvanized 12 ga. metal channel slot receiver strips. Provides for continuous horizontal wall reinforcement to be secured to ties.
  1. Hohmann & Barnard, Inc.; #363-BT S.I.S. and #362-C channel
  2. Heckman Building Products Inc.; comparable to (1)

- E. Intersecting Masonry Wall Anchors: Wire Mesh Wall Tie: 1/2" sq. x 16 gauge hot dipped galvanized wire, 16" long panel x 2" width less than wall. Use as tie between intersecting masonry walls.
  - 1. Hohmann & Barnard; MWT
  - 2. Heckman Building Products; No. 269
- F. Masonry wall anchors at embedded steel columns and beams shall be mill galvanized, hot dipped galvanized at exterior walls, 3/16" dia. triangular wire ties of the proper length for embed depth required with proper end clip or strap (corresponding surface anchored 12 ga. channel slot or wire tie receiver strips from same manufacturer as ties, provided by structural steel manufacturer, verify and coordinate exact requirements). Provides for continuous horizontal wall reinforcement to be secured to ties.
  - 1. Hohmann & Barnard, Inc.; #315-BT S.I.S.
  - 2. Heckman Building Products, Inc.; comparable to (1)
- G. Masonry veneer wall anchors at concrete or masonry back up, and embedded steel columns, with 3/8" joint depth, shall be 3/16" dia. wire tie of the proper length for embed depth required with surface mounted 12 ga. metal anchorage strap. Items to be hot dipped galvanized. Provides for continuous horizontal wall reinforcement to be secured to ties.
  - 1. Hohmann & Barnard, Inc.; #345-BL S.I.S.
  - 2. Heckman Building Products Inc.; comparable to (1)
- H. Masonry veneer wall anchors at wood or metal frame wall construction shall be 3/16" dia. triangular wire tie of the proper length for embed depth required with channel clip, pre-molded horizontal wire reinforcing seismic clip, and surface mounted 12 ga. metal channel slot receiver strips of required type for the specified rigid cavity wall insulation thickness. Items to be hot dipped galvanized. Provides for continuous horizontal 9 gauge wire wall reinforcement to be secured to ties.
  - 1. Hohmann & Barnard, Inc.; #363-BT S.I.S. and #362-CX channel
  - 2. Heckman Building Products Inc.; comparable to (1)
- I. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM A 325M, Property Class 4.6); with comparable hex nuts and, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

## 2.06 EMBEDDED FLASHING MATERIALS

- A. Flexible Flashing: Use the following unless otherwise indicated, for damp course and through wall flashing:
  - 1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040" (40 mil.).
    - a. Products: Subject to compliance with requirements, provide one of the following available products:
      - 1. Grace Construction Products, W. R. Grace & Co. - Conn.;

Perm-A-Barrier Wall Flashing.

2. IPCO; Self Adhesive Rubberized Asphalt Flashing.
3. W.R. Meadows, Inc., Air-Shield Thru-Wall Flashing

b. Associated Flashing Accessories:

1. Mastic: Mastic compatible with flashing materials, supplied by flashing manufacturer.
2. Termination bar: Stainless steel, type 304, Size: 1/8" thick x 1" wide with holes pre-drilled 6" or 8" o.c.
3. Primer: Primer compatible with flashing materials, supplied by flashing manufacturer.
4. Drip Edge Flashing: Shall be stainless steel, type 304, 26 gauge, 1 5/8" min. depth with 2B finish, shall be installed in accordance with manufacturer's recommendation. Provide preformed corners where available from manufacturer. Approved manufacturers subject to requirements as listed:
  - a. Hohmann & Barnard, Inc.
  - b. Sandell Manufacturing.
  - c. IPCO.
5. Flashing Support within wall cavity: IPCO stainless steel (type 304 minimum 28ga) cavity bridge, type F, L, Z, as applicable.
6. Preformed Door Jamb End Dam: IPCO stainless steel (type 304 minimum 28ga) with diagonal end dam. Use at unsupported end dam conditions.

## 2.07 MISCELLANEOUS MASONRY ACCESSORIES

- A. Control joint shear key to be premolded joint filler for use with CMU sash block.
  1. Hohmann & Barnard; RS Series
  2. Heckman Building Products, Inc.; comparable to (1)
  3. Dur-O-Wall; DA 2000 Series
- B. Expansion Joint Filler, Non-metallic (for use at exterior wythe of exterior masonry walls at Expansion Joint): Pre-molded filler strips complying with ASTM D 1056, Type 2, (closed cell), Class A (cellular rubber and rubber-like materials with resistance to petroleum base oils), Grade 1 (compression-deflection range of 2 to 5 psi), compressible up to 35 percent, of width indicated, formulated from the following material:
  1. Neoprene.
  2. Urethane.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep Hole Rope: Sash cord, cotton, 3/8" diameter, 12" minimum length.
- E. Cavity Drainage Mesh: Free-draining mesh, made from polymer strands that will

not degrade within the wall cavity; 1" thick by approximately 10 inches high, polyethylene, polyester, or nylon mesh, 90% open weave, with a top surface in a trapezoidal (dovetail) configuration designed to allow moisture to flow downward in the cavity to masonry flashing and weeps. Drainage system shall be continuous at base of wall and above flashed installations where the cavity extends at least 24" above. Match clear cavity width to drainage mesh thickness. Clear cavity width should be no more than 1/4" wider than the drainage mesh thickness. Make adjustments to the clear cavity width, by installing an additional 12" high piece of rigid cavity wall insulation, thickness as required, in back of the drainage mesh, such that there remains no more than 1/4" of clear cavity space. Approved manufacturers, subject to compliance with these requirements:

1. Mortar Net USA, Ltd.; Mortar Net.
2. Hohmann & Barnard, Inc.; Mortar Trap.
3. CavClear; Mortar Drop Stop.

## 2.08 MASONRY CLEANERS

- A. Proprietary Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Diedrich Technologies, Inc.
    - b. ProSoCo, Inc.

## PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- D. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond with vertical joint in each course centered on units in courses above and below.
  1. Match existing bond unless noted otherwise

### 3.02 TOLERANCES

- A. Dimensions and Locations of Elements:
  1. For dimensions in cross section or elevation do not vary by more than

plus 1/2" or minus 1/4".

2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2".
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4" in a story height or 1/2" total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4" in 10 feet, or 1/2" maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8" in 10 feet, 1/4" in 20 feet, or 1/2" maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4" in 10 feet, 3/8" in 20 feet, or 1/2" maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8" in 10 feet, 1/4" in 20 feet, or 1/2" maximum.
5. For lines and surfaces do not vary from straight by more than 1/4" in 10 feet, 3/8" in 20 feet, or 1/2" maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2".
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8" or minus 1/4".
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8".

### 3.03 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond pattern for exposed masonry as indicated in paragraph 3.01. Do not use units with less than nominal 4" horizontal face dimensions at corners or jambs.
  1. Lay concealed masonry with all units in a wythe bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners.
- C. Discard units with cracked faces, chipped edges, or corners or other defects that affect appearance or performance.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
  1. Install steel lintels, bearing plates, etc. plumb and level.
- E. Fill cores in hollow CMU's with grout 24 inches each way under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

- F. Chases. Ascertain from each trade subcontractor where chases or openings for pipes, wires, ducts, etc., are to go and do not wait for such information to be given. Construct such chases as shown or required.
- G. Build in anchors, bolts, flashings, wall plugs, nailing strips, frames, etc., as may be required. Place these materials according to directions of those manufacturers who furnish them, except as exceeded herein.
- H. Provide openings as shown or required for windows, doors, as well as mechanical, electrical, plumbing, and other items."
- I. Grout hollow metal frames in masonry or concrete partitions, filling with concrete grout vertical frame members, except for the bottom 8". Do not grout hollow metal frames at gypsum walls. Grout shall comply with ASTM C 476, mixed to provide a 4" maximum slump, and hand troweled into place. Do not use grout mixed to a thin/pumpable consistency, or with an accelerant, or with antifreeze, or with a chloride, or a gypsum grout, any of which may cause premature rusting of frames.
- J. Rake and caulk exposed sill and coping head joints; rake joints 1/2" deep, install backer rod and sealant.

### 3.04 CONTROL JOINTS

- A. Exterior wall control joints shall be provided where indicated on the drawings.
- B. Interior wall control joints shall be provided at the following applications:
  - 1. At non-vertically reinforced wall runs where the length (L) to height (H) ratio (L/H) exceeds 2. Where practicable, place required joint near corners, near intersecting walls and at edges of large openings.
  - 2. At changes in wall height or thickness including at pilasters.
  - 3. At locations where structural columns are fully encased within masonry.

### 3.05 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and CMU's as follows:
  - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  - 2. With webs fully bedded in mortar in courses of piers, columns, and pilasters.
  - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated. Joints 16" above ceilings, and that will not be exposed shall be struck flush.

### 3.06 CAVITY WALLS

- A. Bond wythes of cavity walls together using the following methods:
  - 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 24 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 16 inches o.c. vertically.
  - 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
    - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes or adjustable two-piece tab-type reinforcement if veneer is installed later.
    - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
    - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown. Tape joints and around penetrations with manufacturer's approved tape.

### 3.07 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8" on exterior side of walls, 1/2" elsewhere. Lap reinforcement a minimum of 6 inches.
  - 1. Space reinforcement not more than 16 inches o.c.
  - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

### 3.08 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

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- A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
  - 1. Provide an open space not less than 1/2" wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
  - 3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally.

### 3.09 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to concrete, and masonry backup with seismic masonry-veneer anchors to comply with the following requirements:
  - 1. Fasten screw-attached and seismic anchors to concrete and masonry backup with metal fasteners of type recommended by manufacturer. Use two fasteners unless anchor design only uses one fastener.
  - 2. Embed tie sections connector sections and continuous wire in masonry joints. Provide not less than indicated air space between back of masonry veneer and face of concrete, or masonry backup.
  - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
  - 4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

### 3.10 ANCHORING MASONRY VENEERS TO STUD FRAMING

- A. Anchor masonry veneers to wood or metal stud framing backup with seismic masonry-veneer anchors to comply with the following requirements:
  - 1. Place seismic anchor channels on face of rigid cavity wall insulation, fasten by screw-attached method with metal spacer clips through rigid insulation and wall sheathing to wall framing with metal fasteners of type recommended by manufacturer.
  - 2. Insert wire tie section into channel, embed tie section connector sections and continuous horizontal reinforcement wire (set in tie section seismic clip) in masonry joints. Provide not less than indicated air space between back of masonry veneer and face of sheathing backup. Allow for rigid wall insulation clearance and installation requirements.
  - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
  - 4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

### 3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles,  
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lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

- B. Install flashing as follows unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  2. At lintels and shelf angles, extend flashing a minimum of 6 inches above drainage mat. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
  3. Install stainless steel metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2" back from outside face of wall and adhere flexible flashing to top of stainless steel metal drip edge.
  4. Install stainless steel metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2" back from outside face of wall and adhere flexible flashing to top of stainless steel metal flashing termination.
- C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep rope products to form weep holes.
  2. Provide rope and weeps in head joints in first course at base of wall as well as every location immediately above flashing. Provide at the bottom of head joints, spaced as follows: minimum of 16" o.c. at masonry units which are equal to or less than 8" long; 24" o.c. at masonry units which are 12" long; 16" o.c. at masonry units which are 16" long; 24" o.c. at masonry units which are 24" long.
  3. Lay rope on flashing and properly extend rope into cavity and run horizontally behind veneer masonry, below cavity drainage mat.
- D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

### 3.12 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has

attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

### 3.13 PROTECTION OF WORK AND MATERIAL

- A. Refer to Project Conditions paragraph 1.06 for further requirements.
- B. Keep wall surfaces and projections free of droppings and mortar smears.
- C. Corners of entrances and jambs and external corners that could be damaged shall be protected by wood and boxing.
- D. Cover masonry units stored on the site, and keep dry until after placed in the wall. Cover tops of walls, projections, openings, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress. Extend cover a minimum of 24 inches down both sides and secure cover in place against high winds, rain, snow, and ice. Concrete masonry shall be thoroughly cured and dry before placement. Keep stored masonry away from contact with the ground.
- E. Do not perform work when the temperature might drop below freezing before initial set without proper protection and procedures as herein described.

### 3.14 COLD WEATHER CONSTRUCTION/PROTECTION

- A. Cold Weather Construction: Perform the following construction procedures while masonry work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation. In heating mortar and grout materials, maintain mixing temperature selected within 10° F. Do not heat water for mortar and grout to above 160° F.
  1. 40° F to 32° F.:

Mortar: Heat sand or mixing water to produce mortar temperature between 40° F. and 120° F.

Grout: Follow normal masonry procedures.
  2. 32° F. to 25° F.:

Mortar: Heat mixing water and sand to produce mortar temperatures between 40° F. and 120° F.; maintain temperature of mortar until used above freezing.

Grout: Heat grout materials to 90° F. to produce in-place grout temperature of 70° F.
  3. 25° F. to 20° F.:

Mortar: Heat mixing water and sand to produce mortar temperatures between 40° F. and 120° F.; maintain temperature of mortar until used above freezing.

Grout: Heat grout materials between 70° F. and 120° F to produce in-place grout temperature of 70° F.
  4. Provide enclosure and auxiliary heat to maintain an air temperature of at

least 40° F.

5. 20° F. and below:

Mortar: Heat mixing water and sand to produce mortar temperatures between 40° F. and 120° F.

Grout: Heat grout materials to 90° F. to produce in-place grout temperature of 70° F.

Masonry Units: Heat masonry units so that they are above 40° F. at time of laying.

Provide enclosure and auxiliary heat to maintain an air temperature of at least 40° F. for 24 hours after laying units.

- B. Cold Weather Protection: These requirements apply after masonry is placed and are based on anticipated minimum daily temperature for grouted masonry and anticipated mean daily temperature for ungrouted masonry. Protect completed masonry in the following manner.

1. 40° F. to 25° F.:

Completely cover masonry with weather-resistive membrane for at least 24 hours.

2. 25° F. to 20° F.:

Completely cover masonry with weather-resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.

3. 20° F. and below:

Except as otherwise indicated, maintain masonry temperature above 32° F. for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry maintain heated enclosure to 40° F. for 48 hours.

### 3.15 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

- B. Inspections: Level 1 special inspections according to the "International Building Code" where the height (H) of masonry or length of masonry (L) to thickness (T) of masonry ratio (H/T or L/T) exceeds 18.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

- C. Testing Prior to Construction: One set of tests.

- D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion

thereof.

- E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
- F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- G. During progress of work, mortar tests shall be made by an approved testing laboratory in accordance with "Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry", A.S.T.M. C 780. Include the cost of tests in contract price.
  - 1. Perform one series of mortar tests for each 10,000 square feet of gross building area.
- H. If the test results indicate that the mortar does not meet specified requirements, Architect shall have the right to request additional tests to be made on portions of the building affected at the Contractor's expense. Should the results of the additional testing fail to meet specified requirements, it is the Contractor's responsibility to remove and replace such faulty masonry work as determined by the Architect.

### 3.16 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
  - 2. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  - 3. Clean masonry with a proprietary commercial cleaner applied according to manufacturer's written instructions only if above methods do not achieve approved results.
  - 4. Protect surfaces from contact with cleaner.
  - 5. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

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DIVISION 6 - WOOD & PLASTICS  
Section 06 10 00 – Rough Carpentry

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified in this section.

1.02 REFERENCE

- A. Framing Standard: American Forest & Paper Association's WCD 1, "Details for Conventional Wood Frame Construction".

1.03 SUBMITTALS

- A. Product Data
- B. Wood Treatment Data:
  - 1. Rot-Resistant Treatment: Submit Certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained and conformance with applicable standards.
  - 2. Fire-Retardant Treatment: Submit Certification by treating plant that treatment material complies with specified standard and other requirements.
    - a. Include certified classification from manufacturer's testing agency, either Underwriters Laboratories, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction, including meeting or exceeding the requirements of the specified rated assembly testing agency.
- C. Certification: Modification of Engineered Wood Product (LVL) components.

1.04 PRODUCT HANDLING

- A. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar material.

1.05 PROJECT CONDITIONS

- A. Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of nailers and similar supports to allow attachment of other work.

PART 2 - PRODUCTS

2.01 LUMBER

- A. Rough lumber for plates, blocking, nailers, etc., without large knots or splits shall be a minimum of No. 2 & better Doug-Fir Larch, Southern Yellow Pine, or SPF's (Spruce-Pine-Fir South) with fiber stress (fb) = 1,100 psi minimum. Provide continuous and intermediate lengths as required.
  - 1. Utility, standard, stud and No. 3 grade of any lumber species are not permitted.

2. Rough lumber in contact with concrete or earth, to be pressure treated for rot resistance as specified herein.

## 2.02 PLYWOOD

- A. Plywood floor decking to be 3/4" nominal thickness, T & G edge, Group 1 species.
  1. 23/32 PERF CAT APA Rated STURD-I-FLOOR 16" oc Exposure 1.
- B. Plywood wall sheathing to be 5/8" nominal thickness, square edge, Group 1 species.
  1. 19/32 PERF CAT APA Rated Sheathing 24/16 Exposure 1.
- C. Plywood roof sheathing to be 5/8" nominal thickness, square edge, Group 1 species.
  1. 19/32 PERF CAT APA Rated Sheathing 40/20 Exposure 1.
- D. Plywood as indicated for roofing nailer assemblies, blocking, etc. to be 3/4" thickness, square edge, Group 1 species.
  1. 3/4 PERF CAT APA C-C Exposure 1.
- E. Plywood as indicated for use at stainless steel countertops and sills to be 3/4" nominal thickness, square edge, Group 1 species.
  1. 23/32 PERF CAT APA C-C Plugged Exterior.
- F. Miscellaneous plywood indicated within walls and/or roof areas to match the specified plywood wall or roof sheathing for the application condition.
- G. Interior wall sheathing, to receive surface applied FRP panels, to be 1/2" nominal thickness sanded plywood panels, square edge, Group 1 species.
  1. 15/32 PERF CAT APA A-D Exposure 1.
- H. Plywood as indicated for use as an interior exposed mounting board for low voltage equipment such as FACP, TTB, etc. to be at a minimum 5/8" nominal thickness, square edge, Group 1 species.
  1. 19/32 PERF CAT APA A-D Exposure 1
- I. Miscellaneous plywood for temporary use such as enclosures and protection boards to be at a minimum 5/8" thickness, square edge, Group 1 species.
  1. 19/32 PERF CAT APA C-C Exposure 1.
  2. 19/32 PERF CAT APA C-C Plugged Exterior; provide if subject to prolonged exposure to weather affecting the weather tightness of the installation.

## 2.03 TREATED WOOD PRODUCTS

- A. Meet requirements specified in 2.01 for Lumber and 2.02 Plywood.
- B. Rot Resistant Treated: Rough lumber indicated to be treated, in contact with concrete, gravel, earth, and where indicated, exposed to all weather cycles, to be pressure treated for rot resistance, AWPA Category UC4a for exterior items with ground contact, Kiln dried after treatment to a maximum moisture content of 19 percent. Products containing arsenic, chromium, or inorganic boron are not acceptable. Warped material is not acceptable.
  1. Exterior construction, exposed to elements

- C. Rot Resistant Treated: Rough lumber indicated to be treated, above grade, protected from weather, to be pressure treated for rot resistance, AWPA Category UC2 for interior items without ground contact, Kiln dried after treatment to a maximum moisture content of 19 percent. Products containing arsenic, chromium, or inorganic boron are not acceptable. Warped material is not acceptable.
  - 1. Interior construction, concealed
- D. Fire Retardant Treated (FRT): Rough lumber indicated to be fire-retardant-treated (FRT), to be pressure impregnated with fire-retardant chemicals, AWPA Category UCFA for interior items without ground contact and protected from exterior exposure; identify lumber with appropriate classification marking of Underwriters Laboratories, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction. Maximum moisture content of 19 percent. Warped material is not acceptable.
  - 1. Interior construction, concealed
- E. Fire Retardant Treated (FRT) Plywood Roof Sheathing: Plywood roof sheathing indicated to be fire-retardant-treated, to be 5/8" nominal thickness, square edge, Group 1 species, fire-retardant-treated (FRT) plywood pressure impregnated with fire-retardant chemicals in accordance with AWPA C27, Category UCFA for interior items without ground contact and protected from exterior exposure.
  - 1. FRT plywood sheathing must meet the performance category requirements and load capacities of the specified plywood roof sheathing.
  - 2. Flame spread rating of 25 or less in accordance with ASTM E 84, Class I.
  - 3. Identify with appropriate classification marking of Underwriters Laboratories, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

#### 2.04 FLEXIBLE WALL FLASHING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Grace Construction Products, Perm-A-Barrier Wall Flashing
  - 2. W.R. Meadows, Inc., Air-Shield Thru-Wall Flashing
- B. Flexible wall flashing to be 40 mil. self-adhesive membrane, rubberized asphalt, self-healing, integrally bonded to cross-laminated, high-density polyethylene film. Membrane shall be interleaved with disposable coated release paper until installed.
- C. Primer for Flexible Membrane Wall Flashing:
  - 1. Grace Construction Products, Perm-A-Barrier WB Primer
  - 2. W.R. Meadows, Inc., MEL-Prime W/B

#### 2.05 ENGINEERED WOOD PRODUCTS - LAMINATED VENEER LUMBER (LVL)

- A. Laminated Veneer Lumber of series called for on the drawings, shall be structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559.

- B. Subject to compliance with requirements, provide products by one of the following.
  - 1. Trusjoist MacMillan
  - 2. Alpine Engineered Products, Inc.
  - 3. Gang-Nail Systems, Inc.
- C. Include extended ends and accessories for the complete and proper installation.
- D. Minimum modulus of elasticity shall be 2,000,000 psi.

## 2.06 MISCELLANEOUS METAL FRAMING ANCHORS

- A. Manufacturers: Subject to compliance with requirements, provide products by:
  - 1. Simpson Strong-Tie Co., Inc.
- B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
  - 1. Provide proper number and size fasteners to comply with required loads.
- C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A653M; Structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
  - 1. Provide stainless steel framing anchors where use with fire retardant treated (FRT) lumber.

## 2.07 MISCELLANEOUS MATERIALS

- A. Rough hardware. Bolts, screws, nails, expansion anchors, hangers, clips, etc., necessary for connection of carpentry, framing, and lumber members shall be of proper size, configuration and strength and shall be hot dipped heavy galvanized.
  - 1. Rough hardware for use with treated members shall be stainless steel.
  - 2. Rough hardware for use with fire retardant treated (FRT) plywood shall be stainless steel unless FRT panel manufacturer allows hot dipped galvanized for the intended application.
  - 3. Rough hardware for exterior gypsum wall sheathing to be hot dipped galvanized drilled fasteners of the proper type for each condition meeting sheathing manufacturers requirements.
- B. Anchor Bolts: L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM A 325M, Property Class 4.6); with comparable hex nuts and, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.
  - 1. Anchor bolts for use with treated members shall be stainless steel.
- C. Plywood roof sheathing metal H-clips shall be prefabricated units of the proper size, configuration and strength, and shall be 20 gauge minimum hot dipped galvanized steel. Clips must be the proper type for the thickness of the panels being supported, and allow for APA recommended 1/8" gap between panels.

1. Clips for use with fire retardant treated (FRT) plywood shall be stainless steel unless FRT panel manufacturer allows hot dipped galvanized for the intended application.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Sill-Sealer Gaskets: ASTM D 1056-91, high density closed-cell neoprene foam strip sill sealer with pressure sensitive adhesive on one side, 1/4 inch thick, match width of sill plate members.
  1. Hohmann & Barnard, Inc., Neoprene Sill Sealer

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Do not use lumber of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate the Work with a minimum of joints or the optimum jointing arrangement.
- B. Treated lumber and wood products, apply minimum 1/16" coating of bituminous paint to the contact surface of steel, galvanized steel, and aluminum to ensure separation from contact with the treated products.
- C. Frame and bolt framing as detailed or as required in straight lines, securely anchored.
- D. Plates and sills resting on masonry or steel shall be secured with bolts of required size and length with suitable washers and nuts spaced not more than 4'-0" o.c. or as detailed.
- E. Install grounds for application of wood trim, etc., where required and of proper thickness and securely fastened.
- F. Frame soffits, install furring, blocking, etc., as shown or required.
- G. Fit carpentry work to other Work. Scribe and cope as required for accurate fit.
- H. Set carpentry work accurately to required levels and lines with members plumb and true.
- I. Securely attach carpentry work to substrates by anchoring and fastening as shown and as required by recognized standards.
- J. Provide washers under bolt heads and nuts in contact with wood.
- K. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.
- L. Do not drive threaded friction-type fasteners; turn into place. Tighten bolts and lag screws at installation and retighten as required for tight connections prior to closing in or at completion of Work.
- M. Set wood framing accurately to required lines and levels. Provide framing members of sizes and on spacings shown, and frame openings as shown or, if not shown, comply with the recommendations of the NFPA (National Forest Products Association). Cut, join and tightly fit framing around other Work. Do not splice structural members between supports unless otherwise detailed.
- N. Anchor and nail as shown or, if not shown, to comply with the Recommended Nailing Schedule and other recommendations of NFPA.

- O. Grounds, Nailers and Blocking:
  - 1. Provide wherever shown and where required for screeding or attachment of other Work. Form to shapes and cut as required for true line and level of Work to be attached or screeded.
  - 2. Provide solid wood blocking built into gypsum board partitions and walls where shelving, cabinets, toilet partitions, accessories and similar are secured.
  - 3. Coordinate location with other Work. Refer to Shop Drawings of such Work, if any.
  - 4. Attach to substrates securely with anchor bolts or other attachment devices as shown and as required to support applied loading.
  - 5. Countersink bolts and nuts flush with surfaces, unless otherwise indicated.
  - 6. Build into masonry as Work progresses, cutting to fit masonry unit size involved.
  - 7. Anchor to formwork before concrete placement.
- P. Temporary closers shall be of substantial construction with appropriate security measures provided as required.

### 3.02 TREATED LUMBER

- A. Install rot resistant treated lumber where indicated and required including necessary incidentals, components, etc.
  - 1. Rough hardware for use with treated members shall be stainless steel.
- B. Install fire retardant treated (FRT) lumber where indicated and required including necessary incidentals, components, etc. meeting the requirements of the specified assembly testing agency, and the authority having jurisdiction to provide at a minimum the required fire rated assembly.
  - 1. Rough hardware for use with treated members shall be stainless steel.

### 3.03 STRUCTURAL FRAMING

- A. Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Sill plates to be continuous, in longest lengths possible. At exterior walls set on concrete foundations with continuous sill-sealer neoprene gaskets of width matching sill plate, and securely anchor to foundation wall with cast-in anchor bolts as indicated. At existing concrete foundation walls and at interior wall locations securely anchor to concrete with drilled epoxy expansion anchors. Sill-sealer gaskets are not required at interior walls.
- C. Stud System Erection. Attach sill plates at floor with suitable fasteners located 2" from each end and spaced 16" o.c. engaging floor joists. Position studs vertically, engaging floor and ceiling plates and spaced 16" o.c. Studs shall run full height from sill plates at floor to height as indicated. Place studs in direct contact with door frame jambs, abutting partitions and partition corners.
- D. Anchor studs for shelf-walls, counter, vanity, and those adjacent to door frames, partition intersections, and corners to ceiling and floor sill plates with mechanical

fasteners. Securely anchor studs to jamb and head anchor clips of door frames by screw attachment.

- E. Framing components shall be cut squarely for attachment to perpendicular members, or as required for an angular fit against abutting members. Members shall be held positively in place until properly fastened.
- F. Construct corners using minimum 3 studs, double stud at wall opening, door and windows jambs.
- G. Erect studs 1 piece full length; splicing of studs not permitted.
- H. Provide necessary stud bracing, etc. as detailed and/or required to support design and anticipated loads.
- I. Install intermediate studs above and below openings to match wall stud spacing.
- J. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- K. Provide substantial intermediate wood blocking properly anchored to studs for secure attachment of wall mounted items including but not limited to door stops, toilet accessories, wall mounted equipment, casework, etc.
- L. Install Engineered Wood Products per manufacturers requirements. Modifications to these products require review and approval by the manufacturer.

#### 3.04 GENERAL DECKING AND SHEATHING INSTALLATION

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate and supports by fastening as indicated, complying with the more stringent of the following:
  - 1. NES NER-272 for power-driven fasteners
  - 2. IBC 2015 Table 2304.10 Fastening Schedule

#### 3.05 FLOOR DECKING

- A. Plywood floor decking to be installed continuous over two or more spans, strength axis perpendicular to supports. Ends shall be centered over supports. Secure to supports with continuous bead of adhesive, and with mechanical fasteners spaced at a minimum of 6" o.c. at panel edges and 12" o.c. at intermediate supports. Top layer of decking to be adhered over base layer decking with joints staggered from base layer and secured in the same manner.
  - 1. Wood framing, secure with non-corrosive ring or screw shank 8d nails.
  - 2. Metal framing, secure with non-corrosive hardened screw shank or self-tapping fasteners of the proper size and type. Pneumatically-driven steel pins are not acceptable.

#### 3.06 WALL SHEATHING

- A. Plywood wall sheathing to be installed continuous over two or more spans, strength axis perpendicular to supports, with ends staggered between panels and

centered over supports. Secure to supports with continuous bead of adhesive, and with mechanical fasteners spaced at a minimum of 6" o.c. at panel edges and 12" o.c. at intermediate supports.

1. Wood framing, secure with non-corrosive deformed shank 8d nails.
2. Metal framing, secure with non-corrosive hardened screw shank or self-tapping fasteners of the proper size and type. Pneumatically-driven steel pins are not acceptable.

### 3.07 FLEXIBLE WALL FLASHING

- A. Install membrane flashing, and auxiliary materials according to manufacturer's written instructions to form a seal with adjacent construction and maintain a weathertight barrier.
- B. Apply primer to substrates to receive membrane flashing at required rate and allow to dry. Limit priming to areas that will be covered in same day. Re-prime areas exposed for more than 24 hours.
  1. Prime glass-fiber-surfaced gypsum sheathing and/or roof underlayment board not covered with an air membrane material with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Fill gaps in perimeter framed wall opening surfaces and miscellaneous sheathing penetrations with foam insulation sealant prior to flashing installation.
- D. Connect and seal membrane flashing continuously to roofing membrane air barrier.
- E. Repair punctures, voids, and deficient lapped seams in membrane per manufacturers requirements. Slit and flatten fish-mouths and blisters. Patch with membrane extending 6 inches beyond repaired areas.

### 3.08 ROOF SHEATHING

- A. Plywood roof sheathing to be installed continuous over two or more spans, strength axis perpendicular to supports, with ends centered over supports. Space nails no less than 6" o.c. at panel edges and 12" o.c. at intermediate supports using non-corrosive deformed shank 8d nails.
  1. Provide proper metal H-clips between adjacent panels and at any unavoidable unsupported edges. Clip spacing at a minimum to be one per span of supporting framing member and as required by the loads.
  2. Roof sheathing to be covered and protected from moisture with the specified roofing felts as appropriate sized areas are completed and in a manner to avoid interference between tradesmen.
- B. Fire retardant treated (FRT) plywood roof sheathing panels to be kept dry and protected from moisture, wetting, and condensation during shipping, storage, and installation. Install sheathing continuous over two or more spans, strength axis perpendicular to supports, with ends centered over supports. Space nails no less than 6" o.c. at panel edges and 12" o.c. at intermediate supports using stainless steel deformed shank 8d nails.
  1. Install FRT panels meeting the requirements of the specified assembly testing agency, and the authority having jurisdiction to provide at a minimum the required fire rated assembly.

2. Provide proper metal H-clips between adjacent panels and at any unavoidable unsupported edges. Clip spacing at a minimum to be one per span of supporting framing member and as required by the loads.
3. FRT roof sheathing to be covered and protected from moisture with the specified roofing felts as appropriate sized areas are completed and in a manner to avoid interference between tradesmen.

### 3.09 ROOF NAILERS AND EDGE ASSEMBLIES

- A. Roofing nailers and blocking, to be installed as indicated and called for in specified roofing sections.
  1. Install grounds for application of wood roofing nailers and blocking, etc., where required and of proper thickness and securely fastened.
  2. Fabricate roof edge assemblies with nailers, plywood, blocking, etc. as indicated to provide a secure, stable substrate properly anchored to wall construction to meet applicable codes and standards, and meet roofing system requirements.
    - a. At curved wall locations provide additional layers of specified plywood cut to indicated radius in lieu of multiple 2x nailers. Bottom exterior and interior edges of assembly to be 2x3 nailers cut to meet indicated radius from 2x10 specified material in longest lengths possible to minimize joints.

END 06 10 00

DIVISION 6 - WOOD & PLASTICS  
Section 06 20 00 - Finish Carpentry

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

- A. Shop Drawings
  - 1. Countertops
  - 2. Wood Trim indicating component profiles, locations, and fastening methods.
- B. Product Data
- C. Samples
  - 1. Plastic Laminate and PVC edge banding for color selection
  - 2. Solid Surface for color selection
  - 3. Wood Trim
    - a. Solid wood for transparent finish, set of 3 samples, minimum one foot long, for each required configuration, showing extremes in color and grain.
    - b. Solid wood for opaque finish, 1 sample, minimum one foot long, for each required configuration.
- D. Solid Surface Warranty

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer producing products in an ISO 9001, ISO 14001, and OHSAS 18001 certified facility.
- B. Fabricator/Installer: A firm which has successfully produced work similar to the quality specified and in the quantity shown for a period of not less than 5 years.
- C. Reference Standards: Comply with the applicable provisions for grading and workmanship of the "Architectural Woodwork Quality Standards", Current Version, published by the Architectural Woodwork Institute (AWI) (herein referred to as Standards), except as otherwise specified.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Protect woodwork during transit, delivery, storage and handling to prevent damage, soiling and deterioration.
- B. Store plastic laminate and solid surface materials protected from exposure to harmful weather conditions, at temperature and humidity conditions recommended by manufacturer. Store sheet materials flat on pallets or similar rack-type storage to preclude damage.

- C. Store woodwork materials and completed woodwork only in a dry, ventilated place, protected from the weather.
- D. Protect woodwork from soiling and damage during handling and installation. Keep covered with polyethylene film or other protective covering.
- E. Do not deliver woodwork until painting, wet work, grinding and similar operations which could damage, soil or deteriorate woodwork have been completed in installation areas. If, due to unforeseen circumstances, woodwork must be stored in other than installation areas, store only in areas which meet the requirements specified for installation areas.

#### 1.05 JOB CONDITIONS

- A. Environmental Requirements: Do not start Work until room or space is at normal use temperature and humidity and wood has tempered to the room or space.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before on Shop Drawings.

#### 1.06 COORDINATION

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

#### 1.07 SOLID SURFACE MATERIAL WARRANTY

- A. Manufacturer's 10 year commercial limited warranty against defects in solid surface sheet materials.

### PART 2 - PRODUCTS

#### 2.01 PLASTIC LAMINATE TOPS

- A. Continuous, 3/4" min. thickness with 1 1/4" edge thickness, 3/4" x 4" backsplash where indicated. Exposed end corners to have 2" radius corners.
- B. Description:
  - 1. Self edge plastic laminate edge for countertop and top of backsplash.
- C. Material:
  - 1. Horizontal surfaces; .048" high pressure plastic laminate (HPL) horizontal grade, unless otherwise noted.
  - 2. Countertops, associated backsplash/top edge, transaction counter work surfaces; .048" high pressure high wear (HW) grade plastic laminate. Exceed NEMA LD-3 2005 for wear resistance.
  - 3. Edges of countertops, and transaction counter work surfaces; As described in B. above.

4. Vertical surfaces; .030" high pressure plastic laminate (HPL) vertical grade.
  5. Substrate for plastic laminate tops, panels, shelves, etc., to be 3/4" min. thickness water resistant M-2 industrial grade 45# density particle board substrate. All boards to be balanced.
- D. Plastic laminate (HPL): Colors to be as selected by Architect from manufacturer's full line of non-metallic, non-solid depth colors regardless of quantity. Matte or similar finish.
1. Formica Corp.
  2. Wilsonart, LLC
  3. Panolam Surface Systems, Nevamar/Pionite
- E. PVC edge banding: Colors to be as selected by Architect from manufacturer's full line of non-metallic colors regardless of quantity, matching HPL finish.
1. Richelieu
  2. Dollken
  3. HPL Manufacturer

## 2.02 SOLID SURFACE COUNTERTOPS

- A. Solid surface material countertop and backsplash shall be 1/2" thick with eased profile edges:
1. Dupont, Corian
  2. Formica Corp, Solid Surfacing
  3. Wilsonart LLC, Solid Surfacing
  4. LG, Hi-Macs
  5. Meganite, Solid Surfacing
- B. Color as selected by Architect from Corian color Group 4 and 5 or manufacturer's equivalent color group.

## 2.03 INTERIOR WOOD

- A. Finished wood trim, base, mouldings, handrails, frames, etc., to be premium grade, solid, clear select, smooth sanded for transparent finish. Consecutive members shall match one to the other in color and grain.
1. AWI Premium Grade 1, Red Oak, plain sawn.
- B. Finished wood trim, base, mouldings, handrails, frames, etc., to be premium grade, solid, clear select, smooth sanded for painted finish.
1. AWI Premium Grade 1, Yellow Poplar, plain sawn

## 2.04 EXTERIOR WOOD TRIM

- A. Exterior wood trim, fascias, soffits, etc., shall be smooth sanded Western Red Cedar, clear select, sizes indicated, maximum moisture content of 15% (MC15).

## PART 3 - EXECUTION

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Rockford PS ESSER HVAC Upgrades

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### 3.01 FINISH CARPENTRY

- A. Finish carpentry work shall be neatly and substantially constructed in a workmanlike manner according to details. Joints shall be neatly made, coping interior angle joints wherever possible and mitering exterior corners.
- B. Woodwork, trim, etc. to be as detailed. Trim to be backed out to permit tight fit against wall. Items shall be applied in a neat and workmanlike manner by experienced mechanics and left free from hammer marks or other defects.
  - 1. Install in single, unjointed lengths for openings and for runs less than maximum length of lumber available. For longer runs, use only one piece less than maximum length available in any straight run. Stagger joints in adjacent members.
  - 2. Distribute defects allowed in the quality grade specified to the best overall advantage, when installing job assembled woodwork items.
  - 3. Cope moldings at returns and miter at corners.
  - 4. Attach woodwork securely in place with uniform joints providing for thermal and building movements.
  - 5. Blind nail where possible. Use fine finishing nails where exposed. Set exposed nail heads.
  - 6. Screw to wall studs behind finish at each crossing. Countersink and plug with matching wood plugs glued and set flush
  - 7. Hand dressed, cleaned free of tool marks with nails set and holes filled and sand papered smooth. Fastening to be concealed.
- C. Solid surface materials to be installed in strict accord with manufacturer's requirements. Solid surfacing material to be fused together to provide a uniform, watertight, monolithic appearance.

END 06 20 00

DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 10 00 - Building Waterproofing

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified in this section.
- B. Section Includes: Restoration System used in combination with waterproofing system including surface preparation and cement based coating application.
  - 1. Substrate applications of system include:
    - a. Concrete Foundation - vertical surfaces (positive side/ exterior).
    - b. Concrete Foundation - horizontal surfaces (positive side/ exterior).

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM D 4258-83- Practice for Surface Cleaning Concrete for Coating.
  - 2. ASTM D 4262-83- Test Method for pH of Chemically Cleaned Concrete.
  - 3. ASTM D 4259-83- Practice for Abrading Concrete.
  - 4. ASTM C 666-92 - Resistance of Concrete to Rapid Freezing and Thawing.
  - 5. American Concrete Institute: ACI 546R-90 - Guide to Concrete Repairs.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide a concrete coating system utilizing a long term waterproofing restoration system in conjunction with a drainage system, which will comply with performance requirements and environmental regulations when tested by methods indicated.

1.04 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Installer Qualifications: Minimum of Five (5) Years experience in the successful application of waterproofing restoration products and cement/acrylic coating systems. Installer trained and certified System Manufacturer for the products specified.
  - 2. Manufacturer Qualifications: Provide installer training and certification. Manufacturer with a minimum of Five (5) Years experience in the production of specified waterproofing materials and systems.
  - 3. Field Service: Manufacturer shall provide field service representation before, during and after installation. Field Service must be technical representative authorized to make decisions on behalf of the system manufacturer.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's current technical product data indicating product test results and compliance as indicated. Submit project specific details. Details shall bear manufacturer's approval prior to submissions to Owner's Representative.
- B. Quality Control Submittals:
  - 1. Pre-Installation Conference: Submit report verifying project site conditions, approval of Mock-Up panels, manufacturer's instructions and requirements.
  - 2. Provide listed Installer's certification and acceptance by system Manufacturer. Include protection plan of surrounding areas and non-masonry surfaces.
  - 3. V.O.C. Certification: Submit certification of compliance that materials furnished comply with regulations controlling the use of Volatile Organic Compounds (VOC).
- C. Contract Closeout Submittals:
  - 1. Warranty: Manufacturer's executed system warranty form with authorized signatures and endorsements.
  - 2. Warranty in final form must be submitted prior to receiving final payment.
  - 3. Warranty proposed for this project: 10 year Below Grade Waterproofing for Concrete Warranty for materials and workmanship.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, handle and protect products in accordance with the manufacturer recommendations.
- B. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- D. Storage and Protection: Store and protect materials from harmful weather conditions and at temperatures conditions recommended by manufacturer. Do not allow freezing to occur in storage or shipping. Protect from damage during construction and while stored onsite.

#### 1.07 PROJECT CONDITIONS

- A. Environmental Requirements: In accordance with manufacturer's recommendations, substrates and ambient air temperature shall be 40 degrees F (4 degrees C) or greater and rising at installation time and remain above 40 degrees F for at least 12 hours after installation.
  - 1. Weather Conditions: In accordance with manufacturer's instructions, do not apply material(s) in snow, rain, fog, or mist, or when such conditions are expected. Do not apply when relative humidity exceeds 85%, or at temperatures less than 5 degrees F (3 degrees C) above the dew point.

Allow surfaces to attain temperature ranges and conditions recommended by manufacturer before proceeding with installation.

2. Compliance: Follow manufacturer's instructions with regard to safety, health, and other related environmental precautions. Comply with applicable Federal, State, and Local Environmental Regulations.

#### 1.08 WARRANTY

- A. Contractor shall warrant the product and the application from the time of Substantial Completion of the project for two years.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS/MATERIALS

- A. Factory-made composite product with a minimum thickness of 60 mils consisting of rubberized asphalt and cross-laminated, high density polyethylene film and with release paper which is to be removed during installation.
  1. W.R. Grace & Co.; Bituthene 3000 Waterproofing Membrane.
  2. Carlisle; Mirafi Waterproofing Membrane comparable to 1 above.
- B. Manufacturer recommended Mutli-Composite Drainage and Protection Board.

### PART 3 - EXECUTION

#### 3.01 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's most recently published product technical bulletins including, installation instructions, substrate testing, surface preparation and cleaning, and post installation testing.

#### 3.02 EXAMINATION

- A. Verify substrate conditions are acceptable for Restoration & Waterproofing Coating material system. Installation shall be in accordance with manufacturer's instructions.
- B. Following excavation of existing soil material from existing foundation walls, determine acceptable removal techniques for contaminants harmful to coating system performance, such as dust, dirt, grease, oils, curing compounds, form release agents, laitance, efflorescence, existing paint films and other existing coatings. Remove, collect, sort, and legally dispose of chemical contaminants.
- C. Thoroughly inspect existing concrete substrate. Identify contaminants and remove and dispose of contaminated materials. Remove fins, edges and sharp protrusions. Fill voids and honeycombed areas.
- D. Slope of Horizontal Foundation Footing: Ensure that the footing at the base of the vertical foundation wall has a grade (slopes) away from the building and angles down towards the drain tile. Install additional bonded cementitious materials as to provide a minimum 1:12 slope for proper pitch/drainage away from foundation and to new drain tile collector.

#### 3.03 PREPARATION - CONCRETE RESTORATION - SUBSTRATES:

- A. Following excavation of existing soil material from existing foundation walls, remove loose or unsound concrete.
- B. Where existing concrete is sound and therefore removal of loose or concrete is not required:
  - 1. Remove laitance, contamination, plaster, oil, paint, grease, corrosion deposits, algae, and other materials detrimental to adhesion of mortar using mechanical means.
  - 2. Where breaking out is not required, roughen substrate by mechanical means or abrasive blasting.
  - 3. Substrate shall be clean and free from dust, plaster, oil, paint, grease, corrosion deposits, algae and unsound or contaminated material that may interfere with bonding
  - 4. Ensure previous product systems including damproofing, and bentonite are fully removed from the substrate prior to applying the waterproofing system.
  - 5. Perform sandblasting without free compressed air to remove dust and dirt.
- C. Protect adjacent work areas and finish surfaces from damage during cement coating system installation. Prior to installation, clean substrates of substances that could impair adhesion and/or bonding. Coordinate cleaning and application to avoid contamination of newly treated surfaces.
- D. Test and clean substrates in accordance with manufacturer's printed recommendations and the following National standards;
  - 1. ASTM D 4261, Practice for Cleaning Unit Masonry for Coating.
  - 2. ASTM D 4258, Practice for Surface Cleaning Concrete for Coating.
  - 3. ASTM D 4262, Test Method for pH of Chemically Cleaned Concrete.
  - 4. ASTM D 4259, Practice for Abrading Concrete.
- E. For Application of waterproofing membrane, continue keeping surfaces clean and free from contaminants as mentioned above. Consult technical bulletins for additional information. Continue to protect adjacent work areas and finish surfaces from damage during coating system installation. Prior to installation, clean substrates of substances that could impair adhesion, and or bonding. Coordinate cleaning and application to avoid contamination of newly treated surfaces. Surfaces must be dry before applying membrane. Test for moisture must be performed.
- F. For application of drainage/protection board, apply drainage/protection board materials on both horizontal and vertical surfaces where waterproofing membrane has been applied. Ensure proper mounting as per technical data sheet.

### 3.04 APPLICATION

- A. Waterproofing Membrane and Drainage/Protection Board.
  - 1. Apply in strict accordance with manufacturer's literature and recommendations.

3.05 FIELD QUALITY CONTROL

- A. Provide manufacturer's field service consisting of periodic site visits by Manufacturer's technical representative for observation of waterproofing coating system installation.

3.06 CLEANING AND PROTECTION

- A. Remove temporary coverings and protection of adjacent work areas. Remove over-spray coating from windows or areas not intended to be coated.
- B. Remove construction debris resulting from work in this section.

END 07 10 00

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DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 54 24 – TPO Membrane Roofing

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified under this section.
- B. Be responsible for the condition of the building and site, and provide necessary provisions to protect the building, adjacent work and contents, and site. Replace/restore items and surfaces damaged in carrying out the work.
- C. It is the intent of this specification to assure weathertight and watertight conditions, during and after completion of the Work. The Contractor performing the work is expected to advise the Architect of any unusual or unforeseen conditions arising during the project.

1.02 SCOPE OF WORK

- A. Demolition
- B. Thermoplastic Polyolefin (TPO) Single-Ply Roof System
  - 1. Furnish and install a TPO Single-Ply Roofing System, Class "A" rated, including incidental and accessory items, including, but not limited to the following:
    - a. Vapor Barrier
    - b. Insulation
    - c. Fasteners
    - d. Adhesives
    - e. Roofing Membrane
    - f. Flashings and Metal Edge
    - g. Expansion Joint
    - h. Accessories
    - i. Slip Sheet
    - j. Wood Nailers
    - k. Warranty

1.03 SUBMITTALS

- A. Shop Drawings: Roof Plan with details to indicate roof edge, flashing, penetrations, and miscellaneous items.
- B. Product Data:
  - 1. Roofing membrane, flashing, adhesive, accessories.
  - 2. Vapor Barrier

3. Protective Membrane
  4. Expansion Joint
  5. Walkway Pads
  6. Slip Sheet
  7. Fasteners
- C. Roofing contractor qualifications.
  - D. Roof system manufacturers approval to proceed with installation.
  - E. Roof system manufacturers periodic inspection and mechanical fastener pull out test results as they occur.
  - F. Written warranty.

#### 1.04 QUALITY ASSURANCE

- A. Roofing Contractor must have a minimum of ten (10) years experience installing TPO Single-Ply Roofing Systems specified. Roofing Contractor must be roofing system manufacturers' current approved premium installers in good standing with corporate office located within 50-mile radius of Rockford Public Schools. Owner reserves the right to reject any contractor with past history with the District of: failure to perform the work meeting specifications; excessive call backs for leaks; ongoing issues not corrected; etc.
- B. Pre-Roofing Conference: A pre-roofing conference shall be held at the project site in advance of the time scheduled for roofing work. The purpose of this conference is to review requirements for the work and conditions which could possibly interfere with successful performance of the work. This conference shall review deck surfaces, roof insulation, roofing, flashing, and any other item related to the roof system. A record of all decisions and agreements made at this meeting, as well as a list of attendees, shall be submitted to the Architect in writing for record.
- C. Roofing system manufacturer: Roofing system mechanical fastener pull out tests on components including but not limited to roof system edge securement, nailers, blocking, underlayment board, insulation, etc. to be performed by the roofing system manufacturer, and meet the requirements of the specified full system warranty.

#### 1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
  1. Materials shall be delivered to the site in an undamaged and dry condition.
  2. Material received which is not dry or is otherwise damaged shall be rejected.
- B. Storage under polyethylene or similar non-breathing film stock shall not be permitted, and materials are never to be in contact with the ground.
  1. Proper storage on or off the site shall be the responsibility of the contractor.
- C. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

#### 1.06 WARRANTY

- A. The Contractor shall furnish to the Owner, the Manufacturer's Full System No Dollar Limit Warranty of watertightness. This warranty shall be fully paid for by the Roofing Contractor.
  - 1. Warranty Period: 30 years from date of Substantial Completion.
  - 2. Warranty shall provide at a minimum, manufacturer's wind speed coverage of maximum 100 mph, 3-second peak gusts, measured at 10 meters (33ft) above ground level.
- B. This Warranty shall cover both labor and materials necessary to effect watertightness, including that required to repair conditions caused by structural movement or standing water on the roof membrane, without limit as to amount required to effect repairs.

### PART 2 - PART 2 - PRODUCTS

#### 2.01 ROOFING MEMBRANE

- A. Thermoplastic polyolefin (TPO) sheet, internally fabric reinforced, meet or exceed ASTM D6878 Requirements, with an initial solar reflectance index (SRI) of not less than 99 and three year aged SRI of not less than 85.
  - 1. Thickness: 80 mils
  - 2. Exposed Face Color: Gray
  - 3. System Type: Fully Adhered
- B. Subject to compliance with requirements, provide products by one of the following:
  - 1. Firestone Building Products, Ultraply Platinum.
  - 2. Carlisle Corp., Sure-Weld EXTRA.
  - 3. Johns-Manville, TPO ST8RA-S.
- C. Provide necessary flashing and accessories as required or recommended by roofing system manufacturer. Flashing shall be 80 mil uncured TPO.
- D. Provide materials, incidentals, and installation procedures required for the manufacturer's specified full system warranty.

#### 2.02 VAPOR BARRIER

- A. Vapor Barrier to be roofing system manufacturers self-adhering, polypropylene reinforced rubberized asphalt air and vapor barrier membrane system, meet or exceed ASTM D1970, E96 and E2178 requirements.
  - 1. Firestone Building Products, V- Force
  - 2. Carlisle Corp., VapAir Seal 725TR
  - 3. Johns-Manville, JM Vapor Barrier SA

#### 2.03 ACCESSORIES

- A. Provide manufacturers accessories as necessary and required to provide a full systems approach, including but not limited to:
  - 1. Pre-molded accessories such as inside corners, outside corners, curb wrap corners, pipe flashing, pipe seals, sealant pockets, etc.
  - 2. Adhesives, sealants, pre-molded and field fabricated flashings, fasteners, and other related components manufactured or recommended by the selected roofing system manufacturer.

#### 2.04 WALKWAY PADS

- A. Manufacturers factory formed, non-porous, heavy duty, slip resistant, surface textured TPO walkway pads, heat weldable, 5/32" min. thickness; standard sizes 24" x 24" or 30" x 30" as indicated.
  - 1. Manufacturers roll type system meeting specified criteria is acceptable.

#### 2.05 NAILERS

- A. Wood nailers and nailer assemblies shall be installed where required and indicated. Height of nailers and assemblies shall be matched to that of the insulation being used and as indicated.
- B. Nailers and nailer assemblies are as specified in Section 061050 – Miscellaneous Rough Carpentry.

### PART 3 - EXECUTION

#### 3.01 GENERAL REROOF

- A. roofing, flashings, metal fascia, metal coping, etc. and rigid insulation down to existing roof deck.
  - 1. Remove an area no larger than can be re-roofed in one day.
- B. Repair existing roof deck and nailers deteriorated or damaged during tear off.
- C. Remove existing soil stack leads and replace with new 4# leads.
- D. Remove existing roof drain leads and provide new 4' x 4' - 4# leads at each drain.
- E. Remove existing dome strainers, clamping rings, lugs, and clamping devices at roof heads and clean prior to installation of new roofing system. After new roof system is installed clean and rod roof drain lines serving reroof area for proper operation from roof to point of discharge onto grade or into storm sewer to provide a complete and proper functioning system to insure positive drainage. Provide new metal dome strainers, clamping rings, lugs, etc. at existing roof drain locations to provide a complete and proper functioning system to insure positive drainage. Provide necessary components and incidentals to provide a complete and proper weathertight installation.
- F. Curb flashing at existing exhaust fans, mechanical units, etc. shall be removed to allow proper flashing installation and then replaced on curbs in proper operating condition and in a manner insuring weather tight installation as recommended by manufacturer.
  - 1. Raise mechanical items, roof hatches, etc. and extend curbs as required to provide 8" minimum height above roof surface to top of exposed flashing

- membrane. Disconnect and extend services by licensed tradesman as required to provide a complete and proper operating condition.
2. Secure flashing and install new metal counterflashing prior to re-installation of unit.
  3. Perimeter nailers must be added to match elevation of new roof insulation.
- G. Remove abandoned mechanical items, roof curbs, piping, conduit, etc. Infill roof deck openings as required to provide a stable, secure, load bearing structural roof deck surface to receive the new roof system as indicated on the Drawings.
1. At mechanical items to be removed with associated roof curb to remain abandoned in place:
    - a. After removal of existing mechanical equipment, conduit, piping, ductwork, etc. by licensed tradesman, repair any damage to the existing roof curb to provide a stable, sound weathertight condition.
    - b. Extend top of curb as required by the new top of roof surface elevation to provide 8" minimum exposed height of vertical roof flashing after cap is set in place.
    - c. Cap top of curb with weathertight, insulated, one piece galvanized metal cap.
- H. Immediately remove debris from roof surface. Demolished roof system may not be stored on the roof surface.

### 3.02 INSPECTION

- A. Examine surfaces for inadequate anchorage, foreign material, moisture, unevenness, or other conditions which could prevent the best quality and longevity of roofing, flashing, and accessory components. Notify the architect of deficiencies.
1. Verify installation conditions as satisfactory to receive work.
  2. Verify that work of other trades penetrating roof deck or requiring workers and equipment to transverse roof deck has been approved by roofing system manufacturer, and contractor.
  3. Check projections, curbs, and deck for inadequate anchorage, foreign material, moisture, or unevenness that would prevent quality and execution of new roofing system. Determine it is free from defects, nails, and other irregularities. Decks to be dry prior to starting roof work.
  4. Do not install new roofing until unsatisfactory conditions are corrected.
  5. Beginning work constitutes acceptance of conditions by the contractor and roofing system manufacturer, and shall imply approval of deck surfaces and site conditions; and no claim in this respect will be considered valid in case of failure of the roofing components within the warranty period.

### 3.03 FIELD QUALITY CONTROL

- A. Contractor to make arrangement for the roofing system manufacturer to perform the required fastener pull out tests, provide initial inspection and periodic inspections of the roofing system as appropriate and as required for warranty inspections, including whenever called upon by the Architect for the duration of the installation.

1. Upon completion of the installation, final inspection shall be made by the roofing system manufacturer to ascertain that the roofing system has been installed according to the manufacturer's published specifications and details, and meets the specified full system warranty requirements. The written warranty is to be issued upon final approval of the installation.
- B. Contractor to accompany the manufacturer's technical inspector and assist with equipment and workmen if necessary to provide access to the roof.
  1. Correct defects noted during the inspections.

#### 3.04 PREPARATION

- A. Ensure that surfaces are clean and dry before starting and during performance of work.
- B. Verify that work of other contractors and subcontractors which penetrates the roof deck or requires men and equipment to traverse the roof deck has been completed.
- C. Provide written confirmation that the roof system manufacturer's fastener pull out test results and initial inspection has indicated the work can proceed meeting the requirements of the specified full system warranty.

#### 3.05 GENERAL

- A. Install Roof System following current manufacturer's written instructions, recommendations, and details. Provide materials, incidentals, and installation procedures required for the manufacturer's specified full system warranty.
  1. Install roofing system only in dry weather.
  2. Comply with manufacturer's climatic restrictions.
  3. Roofing membrane to be installed over manufacturer's slip sheet if required.
- B. Material shall be one-piece roof membrane adhered to roof insulation with roofing manufacturers low VOC bonding adhesive, formed by heat welding meeting manufacturer's requirements for the specified full system warranty. At a minimum seams shall be made by lapping the membrane a minimum of two inches (2") over itself or over flashing, making a continuous seam two inches (2") wide allowing for a minimum 1½" wide continuous weld. This seam shall then be checked for continuity and integrity, and as required for the specified full system warranty sealed with 8" wide membrane joint covers, and sealant. Seams are to be welded and sealed the same day.
  1. Follow manufacturer's requirements for seam lap direction relative to slope, which varies depending on degree of slope.
  2. Provide manufacturers additional membrane securement at areas exceeding 2" slope in 12" horizontal.
- C. Once work is started on a roof or section, it shall continue without undue delay until that section is completed before starting another. The installation of flashings shall follow application of the roofing without delay.
- D. Nailers and nailer assemblies shall be firmly anchored to the structure, perimeter walls, etc. with non-corrosive fasteners to resist a force of 200 pounds per lineal foot in any direction. Masonry walls to have embedded anchor bolts as indicated.

2" vent spaces shall be left between lengths of nailers and assemblies.

1. Anchors in double row conditions to have each row staggered equally from the other.
  2. Provide a minimum of 5 anchors (per row) for each 8' length of nailer and assembly, shorter sections provide a minimum of 3 anchors (per row).
- E. Install insulation as called for in Section 07200 - Insulation. Insulation to be installed over roofing system manufacturers vapor barrier using adhered methods without mechanical fasteners.
1. Mechanical fastener penetrations through the vapor barrier are not acceptable.
- F. Flashing shall be installed at vertical surfaces, roof interruptions and penetrations as detailed, and in accordance with roofing membrane manufacturer's current published details consistent with job conditions. Where details appear to be in conflict with those published, then the details shall govern and control. Flashings and terminations shall be securely fastened in place to the roof deck with suitable fasteners to provide holding force of not less than two hundred (200) pounds per lineal foot in any direction for the expected life of the roof.
1. Fasteners shall be installed at intervals not to exceed eight inches (8"), except where otherwise specified or recommended by the manufacturer.
- G. Water cut-offs shall be made by extending the membrane beyond the insulation and setting the end of the membrane in 4" of roofing system manufacturer's approved roofing cement overlapped to existing membrane. Temporary water cut-offs shall be removed prior to proceeding with the next work period by cutting off that portion of the membrane that has been in contact with the roofing cement.
- H. Expansion joint concealed components to be installed in maximum lengths possible, properly tape and seal tubing and vapor retarder joints. Install roofing system flashing cover over tubing as required to provide a sealed, weathertight condition meeting manufacturer's requirements.
- I. Walkway pads to be installed in accordance with manufacturer's recommendations for an adhered installation to the roofing membrane.

### 3.06 PROTECTION

- A. Roof Traffic: After work on roof is started, no traffic will be permitted on the roof other than that necessary for the roofing application and inspection. Materials shall not be piled on the roof to the extent that the original structural design live and dead loads are exceeded. Roofing materials shall not be transported over unfinished or finished roofing unless adequate protection is provided. Any damage to previously installed roofs shall be repaired at no expense to Owner.
- B. Protection against damage: Surfaces shall be protected as necessary to prevent damage resulting from the application of roofing, or transporting of materials. If surfaces are damaged in any way they shall be repaired, restored, or replaced by the contractor, at no cost to the Owner, in a manner acceptable to the Architect and Owner.

## PART 4 - ADJUST AND CLEAN

- A. Adjustment and Repair: Any roofing damaged or misapplication shall be repaired or replaced as required at no expense to Owner.
- B. Remove debris from the roofing areas and job site. Legally dispose of debris.
- C. Remove tools, equipment, and construction aids.
- D. Prevent storage of materials and equipment on the completed roof. Any damage to previously installed roofs shall be repaired at no expense to Owner.

END 07 54 24

DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 71 00 - Prefabricated Roof Specialties

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified under this section.

1.02 SCOPE OF WORK

- A. Work under this section shall include, but not necessarily be limited to the following:
  - 1. Metal fascia, copings, counterflashing, gutters, downspouts, curb mounted expansion joints.
  - 2. Pipe supports, pipe boots, roof curbs.
  - 3. Roof hatches.
  - 4. Walkway pads.
  - 5. Roof curb metal caps.

1.03 SUBMITTALS

- A. Product data
- B. Shop drawings
- C. Samples of finish color on metal.
- D. Letter from NRCA stating that manufacturer and/or shop fabricator is a NRCA Authorized Fabricator of ANSI/SPRI ES-1 components and systems.
- E. Prior to fabrication, submit certification that edge securement components meet requirements of ANSI/SPRI ES-1, and Roofing System Manufacturer's requirements for the specified full system warranty.
- F. Warranty

1.04 QUALITY ASSURANCE

- A. Materials, components and installation procedures shall be in accordance with Roofing System Manufacturer's requirements for the specified full system warranty.
- B. Edge securement components shall meet requirements of ANSI/SPRI ES-1, and Roofing System Manufacturer's requirements for the specified full system warranty.
- C. Manufacturer and/or shop fabricator shall be a NRCA Authorized Fabricator of ANSI/SPRI ES-1 components and systems meeting Roofing System Manufacturer's requirements for the specified full system warranty.
- D. Installing contractor must have proven experience record on projects of similar scope, and requirements including but not limited to water tightness, aesthetics, adherence to design intent, coordination of components, provide and maintain

manufacturers warranties, etc.

#### 1.05 PROJECT CONDITIONS

- A. Coordinate Work with adjacent Work, including installation of roofing system to prevent roofing terminations being left unprotected.

#### 1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
  - 1. Materials shall be delivered to the site in an undamaged and dry condition.
  - 2. Material received which is not dry or is otherwise damaged shall be rejected.

#### 1.07 WARRANTY

- A. Prefinished Metal: Furnish a written 20 year non-prorated manufacturer's warranty on finish and material for pre-finished metal items.
  - 1. Metal Roof Edge and Copings: Products as specified and required by Roofing System Manufacturer to provide the specified full system warranty.
- B. Roof Hatch: Provide manufacturer's standard written warranty. Materials shall be free of defects in material and workmanship for a period of five years. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.
- C.

### PART 2 - PRODUCTS

#### 2.01 METAL COPING AND FASCIA SYSTEM

- A. Two piece pre-manufactured system:
  - 1. Edge securement components meet requirements of ANSI/SPRI ES-1.
  - 2. Materials and components as required by Roofing System Manufacturer to provide the specified full system warranty.
- B. Coping:
  - 1. Material: 24-gauge galvanized steel; Sizes and shapes as indicated on drawings.
  - 2. Concealed cleat attachment on the outside, exposed fasteners with neoprene gaskets on the inside
  - 3. Finish: Kynar 500. Color as selected by Architect from manufacturer's full range of non-metallic colors.
  - 4. Provide pre-manufactured accessories, concealed splice plates, corner assemblies, miters, etc.
  - 5. Provide manufacturers factory curved sections at curved wall areas

conforming to indicated radius. Lengths to be as long as possible to minimize joints. Short flat segments are not acceptable.

6. Manufacturers:
  - a. Petersen Aluminum Corp.: PAC-TITE
  - b. OMG Roofing Products: Permasnap
  - c. Metal ERA: Perma-Tite
  - d. Manville: Presto Lock
  - e. Roofing System Manufacturers comparable products as required by the specified full system warranty. Above products may be used only if approved in writing by the Roofing System Manufacturer.
7. If approved in writing by the Roofing System Manufacturer as meeting the specified full system warranty requirements, Contractor may use shop-fabricated sheet metal for certain specific components in lieu of specified pre-manufactured system components only due to reasons generated by the Roofing System Manufacturer. In addition to the specified full system warranty requirements, the Contractor certifies in writing prior to fabrication the following:
  - a. Shop-fabricated components meet minimum thickness required by NRCA recommended details which comply with ANSI/SPRI ES-1 requirements or the specified thicknesses, whichever is more.
  - b. Shop-fabricated components were installed in strict accordance with NRCA recommended details which comply with ANSI/SPRI ES-1 requirements.
  - c. Shop-fabricated components are watertight and weathertight.
8. Field-fabricated metal components are not acceptable.

C. Fascia:

1. Material: 24-gauge prefinished galvanized steel; Sizes and shapes as indicated on drawings.
2. Factory-made, 2-piece with water dam and snap-on cover, designed for specified roofing system.
3. Finish: Kynar 500. Color as selected by Architect from manufacturer's full range of non-metallic colors.
4. Provide pre-manufactured accessories, concealed splice plates, corner assemblies, miters, scuppers, etc.
5. Manufacturers:
  - a. Petersen Aluminum Corp.: PAC-LOC 2000
  - b. OMG Roofing Products: Econosnap
  - c. Metal ERA: Perma-Tite System 200

- d. Manville: Comparable to above
  - e. Roofing System Manufacturers comparable products as required by the specified full system warranty
6. If approved in writing by the Roofing System Manufacturer as meeting the specified full system warranty requirements, Contractor may use shop-fabricated sheet metal for certain specific components in lieu of specified pre-manufactured system components only due to reasons generated by the Roofing System Manufacturer. In addition to the specified full system warranty requirements, the Contractor certifies in writing prior to fabrication the following:
- a. Shop-fabricated components meet minimum thickness required by NRCA recommended details which comply with ANSI/SPRI ES-1 requirements or the specified thicknesses, whichever is more.
  - b. Shop-fabricated components were installed in strict accordance with NRCA recommended details which comply with ANSI/SPRI ES-1 requirements.
  - c. Shop-fabricated components are watertight and weathertight.
7. Field-fabricated metal components are not acceptable.

## 2.02 MISCELLANIOUS PREFINISHED METAL ITEMS

- A. Shop fabricated metal counterflashing, gutters, scuppers, downspouts, valley flashings, mechanical equipment flashings, roof edge flashings, fascias and copings on projects without a full system warranty.
- 1. Edge securement components meet requirements of ANSI/SPRI ES-1.
  - 2. Contractor shall certify in writing the following:
    - a. Shop-fabricated components meet minimum thickness required by NRCA recommended details which comply with ANSI/SPRI ES-1 requirements or the specified thicknesses, whichever is more.
    - b. Shop-fabricated components were installed in strict accordance with NRCA recommended details which comply with ANSI/SPRI ES-1 requirements.
    - c. Shop-fabricated components are watertight and weathertight.
  - 3. Field-fabricated metal components are not acceptable.
- B. 24-gauge prefinished galvanized steel by:
- 1. Petersen Aluminum Corp.: Pac-Clad
  - 2. Firestone: Una-Clad
- C. Shop fabricated, shapes and sizes as indicated.
- D. Finish: Kynar 500, color as selected by Architect from manufacturer's full range of non-metallic colors.
- 1. Valley flashings and mechanical equipment flashings to match shingles and may be different color from other items.

## 2.03 PIPE SUPPORTS

- A. Conduit, gas piping, HVAC piping, etc to be supported above roof surface with prefabricated pipe supports. Non-metallic support base with height adjustable galvanized metal bracket type at single conduit and piping, and adjustable channel strut guide type at multiple adjacent conduit and piping runs. Provide roller guide type accessory at gas lines.
  - 1. Portable Pipe Hangers Inc.
  - 2. Cooper Industries, B-Line
  - 3. Miro Industries, Inc.
  - 4. OMG Roofing Products.
  - 5. Roofing System Manufacturers comparable products as required by the specified full system warranty.

## 2.04 PIPE BOOTS

- A. Prefabricated EPDM pipe boot cover
  - 1. Portals Plus, Inc.
  - 2. OMG Roofing Products.
  - 3. Roofing System Manufacturers comparable products as required by the specified full system warranty.
- B. Provide proper single boot or multiple boot cap system as required by the conditions.

## 2.05 ROOF EXPANSION JOINT COVER – CURB MOUNTED

- A. Materials must be approved by the roofing system manufacturer to provide specified warranty requirements.
- B. Prefabricated insulated roof expansion joint cover with neoprene bellows of the proper width and 2" x 0.032" aluminum flanges, mounting type indicated, factory insulated core with integrally attached vapor retarder.
  - 1. Manville, Expand-O-Flash.
  - 2. Balco, Inc., Roof Bellows Expansion Joint.
  - 3. Roofing System Manufacturers comparable products as required by the specified full system warranty.
- C. Provide in maximum lengths possible, factory fabricated corners, properly seal lap joints and install per manufacturer's requirements and as required to provide a weathertight condition.

## 2.06 WALKWAY PADS

- A. Walkway Pads: Provide manufacturer standard walkway pads around perimeter of roof mounted equipment requiring access or service including roof hatches, stairs, ladders, mechanical exhaust fans, air handling units, condensing units, etc. Individual walkway pads shall be nominal 30" by 30".

## 2.07 ROOF HATCH

- A. Roof hatch shall be 2'-6" x 3'-0" single-leaf type, thermally broken, preassembled aluminum unit.
  - 1. Bilco, Type GS-50
- B. Performance:
  - 1. Cover and curb shall be thermally broken to prevent heat transfer between interior and exterior surfaces.
  - 2. Cover shall be reinforced to support a minimum live load of 40 psf with a maximum deflection of 1/150th of the span and 20 psf wind uplift.
  - 3. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing, and shall not be affected by temperature.
  - 4. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
- C. Cover: 11 gauge minimum aluminum with a 5" beaded flange with formed reinforcing members. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Cover shall have a heavy extruded EPDM rubber gasket bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- D. Insulation: 3" minimum rigid polyisocyanurate with an LTTR-value of 18.0, fully covered and protected by an 18 gauge minimum aluminum liner.
- E. Curb: 11 gauge minimum aluminum. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Curb shall have an integral 11 gauge aluminum capflashing fully welded at the corners. Curb to have 5" minimum mounting flange with height to allow for 12" minimum clearance from final roof surface to bottom of capflashing flange. Top of curb to be level, curb to be tapered as required.
  - 1. Insulation: 3" minimum rigid polyisocyanurate with an LTTR-value of 18.0.
- F. Lifting mechanisms: Compression spring operators enclosed in telescopic tubes.
- G. Hardware
  - 1. Heavy stainless steel pintle hinges.
  - 2. Cover shall be equipped with a spring latch with interior and exterior turn handles
  - 3. Hatch shall be equipped with interior padlock hasps.
  - 4. Latch strike shall be a stamped component bolted to the curb assembly.
  - 5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a vinyl grip handle to permit easy release for closing.
  - 6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed.
  - 7. Cover hardware shall be bolted into heavy gauge channel reinforcing

welded to the underside of the cover and concealed within the insulation space.

- H. Finishes: Mill finish aluminum.
- I. Ladder safety post for attachment to roof access ladder with safety yellow finish.
  - 1. Bilco, LadderUP Safety Post, Model LU-1.
  - 2. Babcock-Davis, BSP

## 2.08 EQUIPMENT CURBS/RAILS

- A. Prefabricated, load bearing equipment curbs/rails, double wall 18 gauge minimum galvanized steel with continuous welded and mitered corner seams and internal wood blocking with rigid insulation fill. Provide with integral base mounting plate and counterflashing.
  - 1. The Pate Company
  - 2. RPS Accessories
  - 3. Hranec Sheet Metal Inc.

## 2.09 ROOF CURB METAL CAPS

- A. Existing abandoned roof curbs to remain without use are to be capped with a weathertight, insulated, one piece galvanized metal cap as indicated.
- B. Cap to be shop fabricated, 14 gauge minimum galvanized steel with continuous 3" minimum perimeter flange with drip edge, overlapping exterior edges of roof curb on all four sides, with maximum vertical gap of 1/4". Any seams and joints to be fully welded and sealed. Cap to be fully insulated with 5" total thickness polyisocyanurate rigid board insulation, consisting of two layers fully adhered together and to underside of cap, and abutting inside faces of roof curb. Caps with either dimension exceeding 48" to have horizontal surface cross broken for strength, with peak on exterior side. In addition, caps with either dimension exceeding 60" to be reinforced with concealed 3 x 3 x 14 gauge galvanized steel bent angles spanning the short dimension at 24" centers, tack welded to underside of cap. Follow current SMACNA recommendations.
  - 1. Steel to be commercial quality hot-dipped zinc coated steel that complies with ASTM A653, Coating Designation A60 (Galvanealed).
  - 2. Touch-up any seams, welds, and exposed edges with galvanized paint.
  - 3. Rigid insulation to be closed cell polyisocyanurate foam board, foil faced, square edges, maximum flame spread 25 and smoke developed indexes of 450. ASTM C 1289 Type I Class 1 Grade 3, 25 psi minimum compressive strength, ASTM D 1621. Minimum LTTR-R Value of 28.8.

## PART 3 - EXECUTION

### 3.01 INSTALLATION - GENERAL

- A. Comply with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive roof accessory units, and with roof insulation, roofing and flashing; as required to ensure that each element of the work performs properly, and that combined elements are waterproof and

weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.

1. Except as otherwise indicated install roof accessory items in accordance with construction details of "NRCA Roofing and Waterproofing Manual".
  2. Follow NRCA recommended details which comply with ANSI/SPRI ES-1 requirements for edge securement items.
- B. Where metal surfaces of units are to be installed in contact with non-compatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.
- C. Flange Seals: Except as otherwise indicated, set flanges of accessory units in a thick bed of approved roofing sealant to form a seal.
- D. Operational Units: Test operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

### 3.02 INSTALLATION – PRE-MANUFACTURED COPING AND FASCIA

- A. Install two-piece pre-manufactured coping and fascia system components per manufacturer's requirements.
- B. Provide necessary components, accessories, trim, etc. to provide a complete and proper finished weathertight condition.
- C. Provide manufacturers concealed interlocking splice plates at section joints, properly sealed to provide a weathertight condition and allow for expansion. Lapped joints or exposed cover plates are not acceptable.

### 3.03 INSTALLATION – SHOP FABRICATED METAL

- A. Counterflashing to be set on continuous bead of caulk and secured to wall construction with neoprene gasketed non-corrosive fasteners of the proper type for the supporting substrate at 12" centers. Provide one piece and two piece as indicated. Top edge at one piece to be caulked continuous.
1. Sections to be lapped 4" and fully sealed.
- B. Gutters to be in maximum available lengths and installed with prefinished metal straps of same material as gutters, including expansion joints, etc. following SMACNA recommendations. Gutters to be properly pitched to downspouts and shall have joints properly lapped and caulked to provide a watertight condition. Do not install joints within 5'-0" of exterior passage doors. Metal straps to be non-exposed from grade.
- C. Downspouts to be secure to masonry with prefinished metal rod type anchors at 4'-0" o.c. min. matching downspout finish. Provide concrete splashblocks at discharge end of each downspout, at roof locations set on roofing manufacturers specified walkway pads, full coverage and a minimum of 6" larger than the splashblock in all directions.
- D. Fascias and copings where approved to be shop fabricated, shall be applied to wood backing as detailed and in accordance with manufacturer's recommendations with continuous 22 ga. minimum galvanized metal cleats.

1. Provide concealed 12" closure at section joints of same material, caulked in to provide a weathertight condition and allow for expansion. Provide 3/8" joint between sections centered on closure.
- E. Provide necessary components, accessories, trim, etc. to provide a complete and proper finished weathertight condition.
- F. Rake ends to be drain lapped 3" minimum.
- G. Miscellaneous metal wall flashings to be installed in longest sections possible to minimize joints. Securely fasten concealed to solid substrate backup with non-corrosive flat head fasteners. Joints to be lapped 3" minimum with vertical/horizontal surfaces set together on beads of sealant to ensure watertight condition.
- H. Concealed non-corrosive fasteners to be utilized wherever possible. Exposed fasteners to be non-corrosive, Kynar 500 finish matching adjacent metal.
- I. Exposed edges and cut edges of prefinished metal to be properly treated, and finished, matching faces to provide a finished, corrosion free appearance.

#### 3.04 INSTALLATION – MISCELLANEOUS ROOF COMPONENTS

- A. Install miscellaneous roof components per manufacturer's recommendations to provide complete and proper weathertight installation.
- B. Skylight roof curbs to be securely anchored to roof structure and properly sealed and flashed to provide a complete and proper finished weathertight condition for the items indicated, meeting manufacturer's requirements.
- C. Install walkway pads in accordance with manufacturer's recommendations.
- D. Roof hatch to be securely anchored to roof structure and associated structural supports. Properly sealed and flashed to provide a complete and proper finished weathertight condition meeting manufacturer's requirements. Install units level, plumb, and in proper alignment with adjacent work.
  1. Test units for proper function and adjust until proper operation is achieved.
  2. Repair finishes damaged during installation.
  3. Restore finishes so no evidence remains of corrective work.
- E. Equipment curbs and rails to be securely anchored to roof structure and associated structural supports. Properly sealed and flashed to provide a complete and proper finished weathertight condition for the roof supported equipment, meeting manufacturer's requirements.

#### 3.05 INSTALLATION - ROOF CURB METAL CAPS

- A. Existing abandoned roof curbs to remain: After removal of existing mechanical equipment, conduit, piping, ductwork, etc. by licensed tradesman, repair any damage to the existing roof curb to provide a stable, sound weathertight condition. Extend top of curb as required by the new top of roof surface elevation to provide 8" minimum exposed height of vertical roof flashing after cap is set in place.

- B. Set cap on existing roof curb with a continuous bead of silicone sealant along top surface of curb. Secure cap at 8" centers through the perimeter cap flange with non-corrosive neoprene gasketed fasteners of the proper type for existing material to be anchored to.
- C. Caulk bottom drip edge of perimeter cap flange to the roof curb with silicone sealant. Include incidentals, etc. as needed to provide a complete and proper, secure, weathertight installation.

3.06 CLEANING AND PROTECTION

- A. Remove protective film where applicable. Clean exposed surfaces in accordance with manufacturer's instructions.
- B. Touch up damaged coatings and exposed metal edges with manufacturers Kynar touch up paint.

END 07 71 00

DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 84 13 - Through-Penetration Firestop Systems

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified.

1.02 SUBMITTALS

- A. Product Data

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed firestop systems similar in material, design, and extent to that indicated for this Project and familiar with the requirements and restrictions/limitations of the Firestop Contractors International Associations (FCIA) manual of practice and factory mutual research approved.
- B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements provide products by one of the following:
  - 1. Grace Construction Products
  - 2. Hilti, Inc.
  - 3. Johns Manville
  - 4. 3M Fire Protection Products
  - 5. Tremco, Inc. Tremco Fire Protection Systems Group
  - 6. USG Corporation

2.02 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01- inch wg.
  - 1. F-Rating: Not less than the fire-resistance rating of construction penetrated.
- C. Penetrations in Horizontal Assemblies: Ratings determined per ASTM E 814 or UL 1479 based on a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
  2. T-Rating: At least 1 hour, but not less than the fire-resistance rating of the constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

### 2.03 SYSTEM FIRE SAFING

- A. Manufacturers, subject to system manufacturer's approval:
1. Certainteed: Thermafiber
  2. Johns Manville: MinWool Safing
  3. Owens Corning: Safing Insulation/MW
  4. Industrial Insulation Group, LLC; MinWool Safing
- B. Description: Unfaced mineral wool fire rated safing, thicknesses as required for the system. Greenguard Indoor Air Quality Certified.
- C. Ratings: Non-combustible, ASTM E136; Three hour fire resistance rating, ASTM E119, UL 263, NFPA 251; Flame spread rating 5 and smoke developed rating 0, ASTM E84, UL 723.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
  2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
  3. Remove laitance and form-release agents from concrete.
- C. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products

and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

- D. Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- E. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- F. Install fill materials for firestopping by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.02 FIRE SAFING

- A. Install fire safing per manufacturer's requirements to obtain required Fire Rating, Flame Spread and Smoke Developed ratings. Fill gaps fully and seal with systems fire caulk.

### 3.03 IDENTIFICATION

- A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
  - 1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Date of installation.
  - 4. Through-penetration firestop system manufacturer's name.
  - 5. Installer's name.

### 3.04 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END 07 84 13

DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 92 00 – Joint Sealants

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 PERFORMANCE REQUIREMENTS

- A. Provide and install elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide and install joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.03 SUBMITTALS

- A. Product Data indicating specific location(s) where submitted material(s) is to be installed.
- B. Color Samples consisting of strips of cured sealants showing the full range of colors available for each product exposed to view and indicating specific location(s) where submitted material(s) is to be installed.
- C. Warranty

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
  - 2. When joint substrates are wet.
- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.06 WARRANTY

- A. Installer's Warranty: Submit written warranty, signed by Installer agreeing to repair or replace work that does not comply with performance and other requirements specified herein within Two (2) years from Substantial Completion date.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Perimeter caulking, exterior, at louvers, window and door frames, masonry control joints, and other joints between wood and masonry, metal and masonry, metal and wood, metal flashings, metal copings, metal fascias, conduit, piping, and other dissimilar materials shall be silicone building sealant by:
  - 1. Dow Corning, 790 Building Sealant
  - 2. GE, SCS2000 SilPruf
  - 3. Pecora, 864NST
  - 4. Tremco, Spectrem 1
- B. Perimeter caulking, interior, at louvers, window and door frames, and other joints between wood and masonry, metal and masonry, metal and wood, conduit, piping, and other dissimilar materials shall be paintable white acrylic siliconized building sealant:
  - 1. Pecora, AC-20 + Silicone
  - 2. GE, SCS7000 Paintable
  - 3. Tremco, Tremflex 834
- C. Perimeter caulking, interior, along hard surface finish flooring or floor slabs, at metal door and sidelight frames, steel columns, other metal and wood terminations/joints, etc. shall be colored acrylic siliconized building sealant:
  - 1. Pecora, AC-20 + Silicone
  - 2. GE, SCS7000
  - 3. Tremco, Tremflex 834
- D. Sealing of interior concrete floor slab control joints, construction joints, expansion joints (including perimeter expansion joints at walls), cracks, penetrations through the floor slab, and cast in floor devices to be polyurethane building sealant:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BASF/MasterSeal: NP 2 and SL 2.
    - b. Pecora: Dynatrol II and Dynatrol II SG or NR-200
  - 2. Sealant shall be flush with concrete floor slab. Provide gun grade or pourable as appropriate for the application.
- E. Sealing of exterior concrete slab control joints, expansion joints, penetrations through concrete slab, and cast in items to be high performance, traffic exposure, exterior urethane building sealant:
  - 1. BASF/MasterSeal

2. Pecora
  3. Tremco
  4. Sealant shall be flush with concrete slab. Provide gun grade or pourable as appropriate for the application.
- F. Colors as selected by Architect.
- 2.02 JOINT SEALANT BACKING
- A. Provide sealant backings of material and type which are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
  - B. Backer Rod: ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
    1. Type C: Closed-cell material with a surface skin, unless open cell is indicated or recommended by sealant manufacturer.
    2. Type O: Open-cell material.
    3. Type B: Bicellular material with a surface skin.
  - C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

### 2.03 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
  - 1. Remove foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
    - a. Concrete.
    - b. Masonry.
    - c. GFRC
    - d. Unglazed surfaces of ceramic tile.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
    - a. Metal.
    - b. Glass.
    - c. Porcelain enamel.
    - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.03 INSTALLATION

- A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.
- E. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses provided for each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealants from surfaces adjacent to joint.
  - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
- G. Use masking tape to protect adjacent surfaces of recessed tooled joints.

### 3.04 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### 3.05 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

END 07 92 00

DIVISION 5 – METALS  
Section 07 95 00 - Expansion Control

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified.

1.02 SUBMITTALS

- A. Product Data
- B. Shop Drawings
  - 1. Indicate joint device profiles, dimensions, locations in the Work, affected adjacent construction, anchorage devices, available colors and finish, and locations of splices.
  - 2. Provide details showing intersection between floor areas, floor-to-wall, wall-to-ceiling, corner conditions, transitions between systems, terminations, etc.
- C. Installation Instructions
  - 1. Manufacturer's installation instructions.
- D. Color Samples
  - 1. Manufacturer standard color and finish options for selection.
- E. Assembly Samples
  - 1. Two assembly samples 6 x 6 in. in size illustrating profile, dimension, color, and finish selected.

PART 2 - PRODUCTS

2.01 EXPANSION JOINTS AT NEW/EXISTING CONSTRUCTION

- A. Interior floor expansion joint at doors shall be surface mounted extruded aluminum saddle type expansion joint cover. Unit shall be pedestrian rated and meet ADA requirements.
  - 1. MM Systems Corp., HSC-C Series / Slab to Slab
  - 2. Architectural Art, comparable to 1 above.
  - 3. Balco, Inc., comparable to 1 above.
- B. Interior floor expansion joint at walls shall be surface mounted extruded aluminum saddle type expansion joint cover.
  - 1. MM Systems Corp., HSC-C Series / Slab to Wall
  - 2. Architectural Art, comparable to 1 above.
  - 3. Balco, Inc., comparable to 1 above.
- C. Interior masonry wall expansion joint shall be flexible cellular polyurethane backer with preformed silicone sealing strip.

1. MM Systems Corp., ESS Series
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- D. Fire rated interior gypsum board wall expansion joint shall be surface applied expansion joint system.
1. MM Systems Corp., FSWL-100 Fire Rated
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- E. Interior gypsum board ceiling/soffit expansion joint shall be concealed securement, flush expansion joint with flexible cover.
1. MM Systems Corp., VSWL-500
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- F. Exterior masonry wall expansion joint shall be flexible cellular polyurethane backer with preformed silicone bellows seal.
1. MM Systems Corp., SIF Series
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- G. Sizes as required by joint widths and application.

## 2.02 METAL EXPANSION JOINTS

- A. Interior floor expansion joint shall be classic curved expansion joint cover with recessed flange to accept floor finish. Unit shall be pedestrian rated and meet ADA requirements.
1. MM Systems Corp., Model HFXR
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- B. Interior wall expansion joint shall be surface applied expansion joint system.
1. MM Systems Corp., Model FXK and FXL
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- C. Interior ceiling expansion joint shall be expansion joint with accordion flexible filler. Color as selected by Architect.
1. MM Systems Corp., Model CX (ACT ceiling) and KX (Gypsum board)
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- D. Exterior wall expansion joint shall be silicone expansion joint system. Provide extruded aluminum cover plate, width to be 2" greater than the maximum joint opening width. Anchor cover plate to one side of joint only.

1. MM Systems Corp., Model HFXR
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- E. Sizes as required by joint widths and application.

## 2.03 MISCELLANEOUS REQUIREMENTS

### A. Materials:

1. Extruded Aluminum: 6063-T5
2. Threaded Fasteners: Manufacturers standard non-corrosive
3. Silicone Seal and integral Foam Backer: Colored silicone surface seal factory applied to secondary micro-cell self-expanding foam with impregnated acrylic polymer, watertight, UV stable, flame resistant, chemical resistant meeting ASTM 283, ASTM 518, DIN 18542
4. Elastomeric Seals: ASTM E 1783; preformed elastomeric membranes or extrusions to be installed in metal frames.
5. Compression Seals: ASTM E 1612; preformed elastomeric extrusions having an internal baffle system and designed to function under compression.
6. Fire Barriers: Manufacturers standard to meet performance criteria for required fire-resistance rating.
7. Protective Coatings: Isolate dissimilar materials with manufacturers standard protective coatings for the proper application.

### B. Finish

1. Exposed Extruded Sections on Floors: Mill finish.
2. Exposed Extruded Sections on Walls and Ceilings: Clear anodized.
3. Resilient Fillers/Silicone Seals/Elastomeric Seals: Color as selected by Architect from manufacturers full range of non-custom colors.

C. Back paint components in contact with cementitious materials to prevent electrolysis with manufacturers protective coatings.

D. Galvanize concealed ferrous metal anchors and fastening devices.

E. Shop assemble components and package with anchors and fittings.

F. Provide joint components in single lengths wherever practical. Minimize site splicing.

G. At fire rated locations, provide comparable unit or add standard components that meets required fire rating.

## PART 3 - EXECUTION

### 3.01 PREPARATION

A. Provide anchoring devices for installation and embedment. Modify as required to provide secure installation into each substrate.

B. Provide templates or rough-in measurements.

### 3.02 INSTALLATION

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- A. Install components and accessories in accord with manufacturer's instructions. Provide necessary sealants, fasteners, etc. required for each system.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor and/or adhere to substrate to prevent movement or misalignment.
- D. Provide items and components necessary for continuous transition between roof, wall, floor, and ceiling (soffit) joint covers and as required to provide a uniform finished appearance, and a complete and proper weathertight installation.

3.03 PROTECTION

- A. Protect finished installation.
- B. Provide removable strippable coating reinforced cloth tape to protect finish joint surface.

END 07 95 00

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 PERFORMANCE REQUIREMENTS

- A. Operation-Cycle Requirements: Design overhead coiling door components and operators to operate for normal use of up to 25 cycle per day maximum, not less than 50,000 cycles lifetime.
- B. Wind Loading at Exterior Door Assemblies: Doors to withstand specified design wind loads. Refer to structural drawings.
- C. Safety Requirements:
  - 1. Chain operated doors shall be designed so that the door immediately stops upward or downward travel and is maintained in a stationary position when the hand chain is released by user.
- D. Fire Rated Doors: Doors to be provided with Underwriters' Laboratories, Inc. label for the fire rating classification specified, including smoke label with Underwriters' Laboratories, Inc. label for "Leakage Rated Assembly" or "S" label demonstrating product tested to UL 1784.
  - 1. Comply with NFPA 105 air leakage requirements
- E. Exterior Doors Thermal Performance:
  - 1. Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E84.
  - 2. Minimum R-Value of 7.7.
  - 3. Polyurethane insulation to be CFC Free with an Ozone Depletion Potential (ODP) rating of zero.
- F. Exterior Doors Air Infiltration Performance:
  - 1. Meet or exceed current ASHRAE Standard 90.1 requirements.
  - 2. Meet or exceed IECC 2015 requirements.

1.03 SUBMITTALS

- A. Shop Drawings: Indicate manufacturer's data, size, construction, arrangement and installation details. Include special components and installation not dimensioned or detailed in manufacturer's data sheets but pertinent to project conditions and design intent.
- B. Product Data: Complete printed data for each type overhead coiling door indicating features to be provided and locations. Provide roughing-in diagrams, operating instructions, maintenance information, and wiring diagrams of related fire detection components. Include the following:
  - 1. Summary of forces and loads on walls and jambs.

2. Motors: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.
- C. Certification: Manufacturer's Thermal Performance and Air Infiltration Test Results.
- D. Color Samples: For selection of each finish product specified, set of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches long, representing actual product, color, and patterns.
- F. Operation and Maintenance Manual.
- G. Demonstration and Training Video Recordings.
- H. Warranty.

#### 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is an authorized representative of the overhead coiling door manufacturer for both installation and maintenance of units specified.
- B. Fire-Rated Door Assemblies: Provide assemblies complying with NFPA 80 and NFPA 105 that are identical to door and frame assemblies tested for fire-test-response characteristics per UL 10b, and that are labeled and listed for fire ratings indicated by UL, FM, ITS/Warnock Hersey, or another testing and inspecting agency acceptable to the local authorities having jurisdiction.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging with seals and labels intact until ready for installation.
- B. Store materials off the ground in a dry, warm, ventilated weathertight location.

#### 1.06 WARRANTY

- A. Two year warranty against defects in material and workmanship from date of Substantial Completion.
- B. Five year limited warranty on electric motor operators from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 INSULATED ROLLING SERVICE DOORS

- A. Subject to compliance with requirements, provide products by one of the following.
  1. Cookson; Thermiser Max ESD30
  2. Cornell; Thermiser Max ESD30
  3. Wayne Dalton; ThermoTite 800C
  4. Clopay Building Products Co.; Model CESD20
- B. Mounting: Face of wall mounting type.
- C. Operation Type: Doors shall be manual chain operated type with governor to regulate downward speed. Gear box to completely enclose operating mechanism and be oil-tight. Location of chain shall be as indicated for each door.

- D. Counterbalance Mechanism: Provide manufacturer's standard by means of adjustable-tension steel torsion spring, mounted around a steel shaft and contained in a spring barrel connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- E. Slats: 1" minimum nominal thickness insulated slat with maximum 3" face. 22 gauge minimum G90 galvanized steel exterior skin and 24 gauge minimum G90 galvanized interior skin with foamed in place closed cell polyurethane insulation core, minimum R-Value of 7.7. Provide with continuous end locks, and wind locks.
- F. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head and act as weatherseal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface mounted hoods and fascia for any portion of between jambs mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
  - 1. Steel hoods to be minimum 24 gauge, G90 galvanized (Z275 zinc coating), complying with ASTM A 653M.
- G. Guides:
  - 1. Minimum 3/16 inch G90 galvanized structural steel angles. Provide windlock bars of same material to meet specified wind load. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.
  - 2. Top portion of coil side guide angles to be removable for ease of curtain installation and as needed for future curtain service
- H. Weatherseals: EPDM bulb type compressible bottom bar, severe jamb and head seals, and neoprene/rayon hood baffle to provide a weathertight installation.
  - 1. Replaceable, adjustable, continuous, compressible weather-stripping gaskets, fitted to bottom, top, and jambs of exterior doors. 1/8" minimum thickness. Lintel seal to be nylon brush type fitted at door header. Provide with 2015 IECC air infiltration option.
- I. Locking Device: Adjustable locking bar to engage through slots in tracks.
  - 1. Single-jamb side, operable as follows:
    - a. Unlocking on coil side by slide bolt on bottom bar
- J. Chain Lock Keeper on Manual Doors: Suitable for padlock.
- K. Operator and Bracket Mechanism Cover: Minimum 24 gauge G90 galvanized steel sheet metal trim cover to enclose exposed moving operating components at coil area of unit. Finish to match door hood.
- L. Finishes: Exposed steel items to receive manufacturer's pre-treatment and factory baked on polyester powder coat system.
  - 1. 2.5 mils minimum cured film thickness. ASTM D-3363 pencil hardness, H or better
  - 2. Color as selected by Architect from manufacturers full range of non-custom colors, minimum 32 color selection.

### PART 3 - EXECUTION

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### 3.01 EXAMINATION

- A. Examine substrates upon which work will be installed and verify conditions are in accordance with approved shop drawings, and contract requirements.
- B. Coordinate with contractor to perform corrective work on unsatisfactory substrates.
- C. Commencement of work by installer is acceptance of substrate.

### 3.02 INSTALLATION

- A. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, weatherstripping, hood baffles, seals, anchors, inserts, hangers, and equipment supports according to Shop Drawings, manufacturer's written instructions, and as specified.
  - 1. Rated doors to comply with NFPA 80 and NFPA 105.
- B. Provide concealed hood and motor operators above ceilings where indicated. At gypsum board ceilings and soffits, Contractor to coordinate proper size and location of access doors needed for maintenance, repairs, and replacement of door components.
- C. Insulated exterior coiling doors to be installed properly to not permit air, water, and weather infiltration into building. Provide necessary components and incidentals to provide a complete and proper weathertight installation.

### 3.03 ADJUSTMENT

- A. Test door operations, motor operators, etc. Lubricate bearings and sliding parts; adjust doors to operate easily, free from warp, twist, or distortion and fitting properly for entire perimeter.

### 3.04 FIELD QUALITY CONTROL

- A. Site Test: Test doors for normal operation, and automatic closing at rated doors. Coordinate with authorities having jurisdiction to witness rated doors test, and sign required documentation.

### 3.05 DEMONSTRATION

- A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below:
  - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 2. Test door closing when activated by detector or alarm connected fire-release system. Reset door-closing mechanism after successful test.
  - 3. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance, and procedures for testing and resetting release devices.
    - a. Review data in the Operation and Maintenance Manuals.
    - b. Video tape each training session per Section 01 77 00 – Closeout Procedures.

END 08 33 00

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 commercial door hardware for the following:
1. Swinging doors.
  2. Sliding doors.
  3. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
1. Mechanical door hardware.
  2. Cylinders specified for doors in other sections.
- C. Related Sections:
1. Division 08 Section "Hollow Metal Doors and Frames".
  2. Division 08 Section "Flush Wood Doors".
  3. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
  2. ICC/IBC - International Building Code.
  3. NFPA 70 - National Electrical Code.
  4. NFPA 80 - Fire Doors and Windows.
  5. NFPA 101 - Life Safety Code.
  6. NFPA 105 - Installation of Smoke Door Assemblies.
  7. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:
1. ANSI/BHMA Certified Product Standards - A156 Series.
  2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
  3. ANSI/UL 294 - Access Control System Units.
  4. UL 305 - Panic Hardware.

5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
  2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
  3. Content: Include the following information:
    - a. Type, style, function, size, label, hand, and finish of each door hardware item.
    - b. Manufacturer of each item.
    - c. Fastenings and other pertinent information.
    - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
    - e. Explanation of abbreviations, symbols, and codes contained in schedule.
    - f. Mounting locations for door hardware.
    - g. Door and frame sizes and materials.
    - h. Warranty information for each product.
  4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the 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 Schedule.
- C. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- D. Informational Submittals:

1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.

E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

#### 1.4 QUALITY ASSURANCE

A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.

B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).

C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.

D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.

1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.

F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.

G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:

1. Function of building, purpose of each area and degree of security required.
2. Plans for existing and future key system expansion.
3. Requirements for key control storage and software.
4. Installation of permanent keys, cylinder cores and software.
5. Address and requirements for delivery of keys.

- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
  - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
  - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
  - 3. Review sequence of operation narratives for each unique access controlled opening.
  - 4. Review and finalize construction schedule and verify availability of materials.
  - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

#### 1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. 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. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
  - 1. Structural failures including excessive deflection, cracking, or breakage.
  - 2. Faulty operation of the hardware.
  - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
  - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
  - 1. Five years for exit hardware.
  - 2. Twenty five years for manual overhead door closer bodies.

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 Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
  - 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in

writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

## 2.2 HANGING DEVICES

A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.

1. Quantity: Provide the following hinge quantity:
  - a. Two Hinges: For doors with heights up to 60 inches.
  - b. Three Hinges: For doors with heights 61 to 90 inches.
  - c. Four Hinges: For doors with heights 91 to 120 inches.
  - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:
  - a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
  - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
  - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
  - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
4. Hinge Options: Comply with the following:
  - a. Non-removable Pins: With the exception of electric through wire hinges, provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
5. Manufacturers:
  - a. Hager Companies (HA).
  - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
  - c. Stanley Hardware (ST).

B. Pin and Barrel Continuous Hinges: ANSI/BHMA A156.26 Grade 1-600 certified pin and barrel continuous hinges with minimum 14 gauge Type 304 stainless steel hinge leaves, concealed stainless pin, and twin self-lubricated nylon bearings at each knuckle separation. Factory trim hinges to suit door height and prepare for electrical cut-outs.

1. Manufacturers:

- a. Markar Products; ASSA ABLOY Architectural Door Accessories (MR).
- b. Pemko (PE).

## 2.3 DOOR OPERATING TRIM

### A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
2. Furnish dust proof strikes for bottom bolts.
3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
5. Manufacturers:
  - a. Door Controls International (DC).
  - b. Rockwood (RO).
  - c. Trimco (TC).

### B. Coordinators: ANSI/BHMA A156.3 certified door coordinators consisting of active-leaf, hold-open lever and inactive-leaf release trigger. Model as indicated in hardware sets.

1. Manufacturers:
  - a. Door Controls International (DC).
  - b. Rockwood (RO).
  - c. Trimco (TC).

### C. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
5. Manufacturers:
  - a. Hiawatha, Inc. (HI).
  - b. Rockwood (RO).
  - c. Trimco (TC).

## 2.4 CYLINDERS AND KEYING

- A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.
- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
  - 1. Threaded mortise cylinders with rings and cams to suit hardware application.
  - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
  - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
  - 4. Tubular deadlocks and other auxiliary locks.
  - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
  - 6. Keyway: Match Facility Standard.
- D. Keying System: Each type of lock and cylinders to be factory keyed.
  - 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
  - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
  - 3. Existing System: Field verify and key cylinders to match Owner's existing system.
- E. Key Quantity: Provide the following minimum number of keys:
  - 1. Change Keys per Cylinder: Two (2)
  - 2. Master Keys (per Master Key Level/Group): Five (5).
  - 3. Construction Keys (where required): Ten (10).
- F. Construction Keying: Provide construction master keyed cylinders.
- G. Key Registration List (Bitting List):
  - 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
  - 2. Provide transcript list in writing or electronic file as directed by the Owner.

## 2.5 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:
  - a. Lund Equipment (LU).
  - b. MMF Industries (MM).
  - c. Telkee (TK).

## 2.6 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Cylindrical Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.2, Series 4000, Operational Grade 1 Certified Products Directory (CPD) listed.
  1. Locks shall meet or exceed the requirements of ANSI/BHMA A156.2 Series 4000, Grade 1 with all standard trims, as follows:
    - a. Cycle Test: ANSI/BHMA A156.2 Grade 1 requirements with no lever sag.
    - b. Abusive Locked Lever Torque: Exceed 3,100 in-lb with no entry; lock to maintain egress functionality in compliance with BHMA certification requirements.
    - c. Offset Lever Pull: Exceed 1,600 lbs with no entry (8 times ANSI/BHMA A156.2 requirements).
    - d. Latch Retraction with Preload: Exceed 100 lb preload while maintaining ANSI/BHMA requirements for operation in warped doors (2 times ANSI/BHMA A156.2 requirements).
  2. Vertical Impact: Exceed 100 vertical impacts (20 times ANSI/BHMA A156.2 requirements).
  3. Furnish with solid cast levers, standard 2 3/4" backset, and 1/2" (3/4" at rated paired openings) throw brass or stainless steel latchbolt.
  4. Locks are to be non-handed and fully field reversible.
  5. Manufacturers:
    - a. Sargent Manufacturing (SA) - 10X Line.
    - b. No Substitution.
- B. Knurling: Where required by local code provide knurling or abrasive coating to all levers on doors leading to hazardous areas such as mechanical rooms, boiler and furnace rooms, janitor closets, and as otherwise required or specified.

## 2.7 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
  1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

## 2.8 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
5. Flush End Caps: Provide flush end caps made of architectural metal in the same finish as the devices as in the Hardware Sets. Plastic end caps will not be acceptable.
6. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
  - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
  - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.

7. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.
  8. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
  9. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
  10. Rail Sizing: Provide exit device rails factory sized for proper door width application.
  11. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
    - a. Sargent Manufacturing (SA) - 80 Series.
    - b. No Substitution.
- C. Tube Steel Removable Mullions: ANSI/BHMA A156.3 removable steel mullions with malleable-iron top and bottom retainers and a primed paint finish.
1. Provide keyed removable feature where specified in the Hardware Sets.
  2. Provide stabilizers and mounting brackets as required.
  3. Provide electrical quick connection wiring options as specified in the hardware sets.
  4. Manufacturers:
    - a. Same as exit device manufacturer.

## 2.9 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:
1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
  2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
  3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use.

Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.

4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
  5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
  6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.
1. Manufacturers:
    - a. Corbin Russwin Hardware (RU) - DC8000 Series.
    - b. Norton Rixson (NO) - 9500 Series.
    - c. Sargent Manufacturing (SA) - 281 Series.

## 2.10 ARCHITECTURAL TRIM

### A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
  - a. Stainless Steel: 300 grade, 050-inch thick.

5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
  - a. Hiawatha, Inc. (HI).
  - b. Rockwood (RO).
  - c. Trimco (TC).

## 2.11 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
  1. Manufacturers:
    - a. Hiawatha, Inc. (HI).
    - b. Rockwood (RO).
    - c. Trimco (TC).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.
  1. Manufacturers:
    - a. Norton Rixson (RF).
    - b. Sargent Manufacturing (SA).

## 2.12 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. 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 perimeter gasketing at all smoke labeled openings.
- C. 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 UL-10C.
  1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NPFA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
  1. National Guard Products (NG).
  2. Pemko (PE).

#### 2.13 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

#### 2.14 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, 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. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
  - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically 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. DHI TDH-007-20: Installation Guide for Doors and Hardware.
  - 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
  - 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and 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 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."

- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

### 3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
  - 1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.

### 3.5 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.

### 3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

### 3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

### 3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with

corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.

1. Quantities listed are for each pair of doors, or for each single door.
2. The supplier is responsible for handing and sizing all products.
3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.

B. Manufacturer's Abbreviations:

1. MK - McKinney
2. MR - Markar
3. RO - Rockwood
4. SA - SARGENT
5. RF - Rixson
6. PE - Pemko
7. OT - Other
8. SU - Securitron

Hardware sets contain a prefix that identify the school as follows:

EH = East High School  
F = Flinn  
L = Lincoln  
W = Washington

**Hardware Sets**

**Set: EH1.00**

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	10XG04 LL	US26D	SA
1 Surface Closer	281 O	EN	SA
1 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Wall Stop	403	US26D	RO
1 H & J Smoke Seal	S88D		PE

DIVISION 8 - OPENINGS  
Section 08 71 00 - Finish Hardware

**Set: EH2.00**

3 Hinge (heavy weight)	T4A3786 5" x 4-1/2"	US26D	MK
1 Rim Exit Device, Storeroom	12 19 43 76 8804 ETL	US32D	SA
1 Surface Closer	281 P9	EN	SA
1 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Wall Stop	403	US26D	RO
1 H & J Smoke Seal	S88D		PE
2 Sweep	18061CNB		PE

**Set: EH2.01**

1 Continuous Hinge	FM300	630	MR
1 Rim Exit Device, Storeroom	12 19 43 76 8804 ETL	US32D	SA
1 Surf Overhead Stop	9-X36	630	RF
1 Surface Closer	281 PD10	EN	SA
1 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Threshold	253x3AFG		PE
1 Head Gasketing	2891AS		PE
1 Jamb Gasketing Set	290AS		PE
2 Sweep w/ Drip Cap	345ANB		PE
1 Drip Cap	346C		PE

**Set: F1.00**

1 Continuous Hinge	HG305 AS	630	MR
1 Storeroom Lock	10XG04 LL	US26D	SA
1 Surf Overhead Stop	9-X36	630	RF
1 Surface Closer	281 PD10	EN	SA
1 Armor Plate	K1050 (F) 34" high 4BE CSK	US32D	RO
1 Threshold	253x3AFG		PE
1 Head Gasketing	2891AS		PE
1 Jamb Gasketing Set	290AS		PE
1 Sweep w/ Drip Cap	345ANB		PE
1 Drip Cap	346C		PE

**Set: F1.01**

2 Continuous Hinge	HG305 AS	630	MR
1 Manual Flushbolt Set	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	41 10XG04 LL	US26D	SA
2 Surf Overhead Stop	9-X36	630	RF
1 Surface Closer	281 PD10	EN	SA
2 Armor Plate	K1050 (F) 34" high 4BE CSK	US32D	RO
1 Threshold	253x3AFG		PE
1 Head Gasketing	2891AS		PE
1 Jamb Gasketing Set	290AS		PE
2 Sweep w/ Drip Cap	345ANB		PE

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Section 08 71 00 - Finish Hardware

1 Meeting Stile Seal (2-pc's)	303ASTST	PE
1 Drip Cap	346C	PE

Notes: Hollow metal door vendor to provide welded overlapping astragal to outside of active leaf

**Set: F1.02**

3 Hinge (heavy weight)	T4A3786 5" x 4-1/2"	US26D	MK
1 Storeroom Lock	10XG04 LL	US26D	SA
1 Surface Closer	281 O	EN	SA
1 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Wall Stop	403	US26D	RO
3 Silencer	608		RO

**Set: L1.00**

2 Continuous Hinge	FM300	630	MR
1 Manual Flushbolt Set	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	41 76 10XG04 LL	US26D	SA
1 Surface Closer	281 O	EN	SA
2 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
2 Wall Stop	403	US26D	RO
1 Threshold	273x292AFGPK		PE
1 Head Gasketing	2891AS		PE
1 Jamb Gasketing Set	290AS		PE
2 Sweep w/ Drip Cap	345ANB		PE
1 Meeting Stile Seal (2-pc's)	303ASTST		PE
1 Drip Cap	346C		PE

Notes: Hollow metal door vendor to provide welded overlapping astragal to outside of inactive leaf

**Set: L1.01**

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	10XG04 LL	US26D	SA
1 Surface Closer	281 P9	EN	SA
1 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Wall Stop	403	US26D	RO
3 Silencer	608		RO

**Set: L1.02**

3 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Storeroom Lock	10XG04 LL	US26D	SA
1 Surface Closer	281 P9	EN	SA

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1 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Wall Stop	403	US26D	RO
1 Threshold	171A		PE
1 Adjustable Gasketing Set	379CPK		PE
1 Sweep	18061CNB		PE

**Set: L2.00**

2 Continuous Hinge	FM300	630	MR
1 Key Removable Mullion	L980S	PC	SA
2 Rim Exit Device	19 43 8816 ETL	US32D	SA
1 Mullion Cylinder	980C1	US26D	SA
2 Surface Closer	281 CPS	EN	SA
2 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Mullion Gasketing	5110BL		PE
1 H & J Smoke Seal	S88D		PE

**Set: L2.01**

1 Continuous Hinge	FM300	630	MR
1 Rim Exit Device	12 19 43 8816 ETL	US32D	SA
1 Surface Closer	281 CPS	EN	SA
1 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 H & J Smoke Seal	S88D		PE

**Set: W1.00**

6 Hinge, Full Mortise	TA2314 4-1/2" x 4-1/2"	US32D	MK
1 Manual Flushbolt Set	555	US26D	RO
1 Dust Proof Strike	570	US26D	RO
1 Storeroom Lock	41 10XG04 LL	US26D	SA
1 Surface Closer	281 P9	EN	SA
2 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
2 Wall Stop	403	US26D	RO
2 Silencer	608		RO

**Set: W1.01**

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Self-Latching Flushbolt Set	2845	US32D	RO
1 Dust Proof Strike	570	US26D	RO
1 Coordinator	2600 Series	Blk	RO
2 Coordinator Mounting Bracket	2601 Series	Blk	RO
1 Storeroom Lock	41 10XG04 LL	US26D	SA
2 Surface Closer	281 CPS	EN	SA
2 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Threshold	171A		PE
1 Head Gasketing	S773D		PE
1 Adjustable Gasketing Set	379CPK		PE

DIVISION 8 - OPENINGS  
Section 08 71 00 - Finish Hardware

2 Sweep	18061CNB		PE
1 Adjustable Surf. Mtd. Astragal Set	351C/CS		PE

Notes: Install S773D at head  
install 379CPK at vertical jamb

**Set: W2.00**

6 Hinge, Full Mortise	TA2714 4-1/2" x 4-1/2"	US26D	MK
1 Self-Latching Flushbolt Set	2845	US32D	RO
1 Dust Proof Strike	570	US26D	RO
1 Coordinator	2600 Series	Blk	RO
2 Coordinator Mounting Bracket	2601 Series	Blk	RO
1 Classroom Lock	41 10XG37 LL	US26D	SA
2 Surface Closer	281 CPS	EN	SA
2 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Threshold	171A		PE
1 Head Gasketing	S773D		PE
1 Adjustable Gasketing Set	379CPK		PE
2 Sweep	18061CNB		PE
1 Adjustable Surf. Mtd. Astragal Set	351C/CS		PE

Notes: Install S773D at head  
install 379CPK at vertical jamb

**Set: W3.00**

1 Continuous Hinge	FM300	630	MR
1 Rim Exit Device, Passage	12 19 43 8815 ETL	US32D	SA
1 Surface Closer	281 CPS	EN	SA
1 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 H & J Smoke Seal	S88D		PE

**Set: W3.01**

2 Continuous Hinge	FM300	630	MR
1 Key Removable Mullion-UL	12-L980	PC	SA
2 Rim Exit Device, Passage	12 19 43 8815 ETL	US32D	SA
1 Mullion Cylinder	980C1	US26D	SA
2 Surface Closer	281 CPS	EN	SA
2 Kick Plate	K1050 8" high 4BE CSK	US32D	RO
1 Mullion Gasketing	5110BL		PE
1 H & J Smoke Seal	S88D		PE

END OF SECTION 087100

DIVISION 8 - OPENINGS  
Section 08 80 00 - Glazing

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified.

1.02 SUBMITTALS

- A. Product data.
- B. Glazing schedule indicating glazing types and locations
- C. Samples of colored and/or tinted glazing units, 12" x 12".

1.03 PERFORMANCE

- A. Insulated Glass
  - 1. Conform to ASTM E 774-88. Visible, permanent IGCC Certification Label for CBA rating level.
  - 2. Dual perimeter seals, silicone and polyisobutylene.
  - 3. Manufacturer's continuous warm edge type spacer with desiccant. Manufacturer listed and dated.
- B. Glazing Requirements: Conform to Consumer Products Safety Commission Part 1201 - Safety Standard For Architectural Glazing Materials.
- C. Fire-Rated Glazing and Tempered Glass shall be furnished with an etched label showing conformance with specified requirements and IBC code requirements.

1.04 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass 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 on Laminated Glass: Manufacturer's standard form in which 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 on Insulating Glass: Manufacturer's standard

form in which 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

### 2.01 MATERIALS

- A. Fire-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
  1. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
  2. Manufacturer Size Limitations: Contractor shall coordinate requested glazing sizes with manufacturer production size limitations. Where necessary, Glazing installed in adjacent lites shall be furnished by a single manufacturer in order to produce a consistent appearance.
  3. Products: Subject to compliance with requirements provide one of the following:
    - a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
    - b. Schott North America, Inc.; Laminated Pyran Platinum.
    - c. Vetrotech Saint-Gobain; SGG Keralite FR-L.
  4. At door lites, provide manufacturer's Standard grade fire rated glazing. At locations other than door lites, provide manufacturer's Premium grade fire-rated glazing.
- B. Interior Tempered Glass: At interior doors and frames and as indicated, clear 1/4" thick shall be:
  1. Guardian
  2. PPG
  3. Pilkington
  4. Trulite
- C. Exterior Tempered Glass: At exterior doors and as indicated, tinted to match insulated units with hard coat low emissivity coating on the #2 surface, 1/4" thick, shall be:
  1. Guardian
  2. PPG
  3. Pilkington

4. Trulite
- D. Insulated Glass for aluminum windows, exterior aluminum doors and frames, 1" thick insulated glass. Shading Coeff. 0.37; Solar Heat Gain Coeff. 0.32; LSG 1.31.
  1. Provide tempered insulated units as follows:
    - a. Exterior lite 1/4" tempered PPG Solarbronze tinted.
    - b. Airspace.
    - c. Interior lite 1/4" tempered PPG Solarban 60 clear with high performance soft coat low emissivity coating on the #3 surface.
  2. Provide units fabricated by one of the following for all applications:
    - a. Oldcastle
    - b. Trulite
    - c. Traco
    - d. EFCO
- E. Obscure Glass
  1. 1/4" tempered, acid etched in pattern and transparency as selected by Architect.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Glass shall be new. Each light shall bear manufacturer's label or be delivered in labeled boxes. Labels must remain on until the glass has been set reviewed, and approved by the Architect. When glass is not cut to size by manufacturer and is furnished unlabeled from local stock, the Contractor shall submit an affidavit stating the quality, type, thickness and manufacturer of glass furnished.
- B. Do not set glass until rabbets are prime painted and dry. Glass shall be supported with spring clips or setting blocks. Glazing shall be set in sealants or gaskets. Sealants or gaskets shall engage both sides of glazing.
  1. Where glazing sealant is used, back putty and neatly strike flush with stops.
  2. Where dry gasketing is used, gaskets shall not extend above the stops.
- C. Sizes for glass shall be taken from the actual frames and sash. This work contemplates glass set in place and the Contractor shall assume responsibility in regard to correct sizes. Sizes, if shown on drawings, are approximate, and shall be used for estimate only.
- D. Glass shall be set by skilled workmen in the best possible manner and in such a way that there will be an equal bearing the entire width of each panel. Glass shall be accurately sized to fit the frame and edges shall be smooth, no sharp or ragged edges being left. Contractor shall be held responsible for broken glass due to improper setting. Glazing beads or stops shall be properly reset without marring or injuring the finish.

- E. At interior dual glazed locations provide proper spacers, gaskets, tape, etc. to provide a complete and proper sound isolation installation. Properly clean units prior to installation of glazing.
- F. Wall mirrors shall be installed to minimize distortion.
- G. Security film to be installed on the interior side of exterior units and on the secure side of interior units. Security film shall be installed per manufacturer's requirements with perimeter adhesive attachment type system. New and existing glass must be properly cleaned and prepared prior to installation. Protect as recommended by the manufacturer for the initial 30 days after installation.

### 3.02 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. 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; remove as recommended in writing by glass manufacturer.
- D. Glass provided by the Contractor that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism before Substantial Completion shall be replaced by the Contractor without additional cost to Owner.

END 08 80 00

DIVISION 9 - FINISHES  
Section 09 29 00 - Gypsum Board System

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified under this section.
- B. Provide Level 1 gypsum board level of finish to unexposed gypsum board. At fire rated and/or smoke partitions provide additional requirements meeting codes.
- C. Provide Level 4 gypsum board level of finish to exposed gypsum board to receive paint finish unless otherwise noted.

1.02 SUBMITTALS

- A. Product Data

1.03 QUALITY ASSURANCE

- A. Gypsum Association standards and recommendations
  - 1. GA-214 - Recommended Levels of Gypsum Board Finish.
  - 2. GA-216 - Application and Finishing of Gypsum Panel Products.
  - 3. GA-290 - Area Separation Walls.
  - 4. GA-600 - Fire Resistance Design Manual.
  - 5. GA-801 - Handling and Storage of Gypsum Panel Products.

1.04 DESIGN REQUIREMENTS

- A. Metal Framing: Provide non-load bearing steel stud partitions with deflections conforming to L/240 at 5 psf (239 Pa) typical for gypsum board walls.
- B. Fire-Resistive Rating: Where indicated on Drawings, provide materials and construction that are identical to those assemblies whose fire resistance rating has been determined per ASTM E119 by a testing and inspecting organization acceptable to authorities having jurisdiction.
  - 1. Meet or exceed fire resistance requirements outlined under provisions of the GA-600 Fire Resistance Design Manual for wall and ceiling assemblies.
  - 2. Meet or exceed Class A flame/fuel/smoke requirements of ASTM E84 surface burning characteristics for finish materials.

PART 2 - PRODUCTS

2.01 FRAMING MATERIALS

- A. Steel studs, framing, runners, furring, and associated system components: ASTM C645, 30 mil (20ga) galvanized, sizes indicated. Subject to compliance with requirements, provide products by one of the following.
  - 1. Gypsum Board Manufacturer Products

2. ClarkDietrich
  3. United States Steel
  4. Marinoware
- B. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above. Allow for 1" of movement.
1. Fire Rated Locations: Provide Fire Trak Deflection Trak and Fire Stop System by FireTrak Corp. or comparable fire rated system by metal stud manufacturer.
  2. Non-fire Rated Locations: Provide metal stud manufacturer's slip-type head joint system.

## 2.02 METAL SUSPENSION SYSTEM

- A. Manufacturers:
1. Chicago Metallic Corp./Rockfon, Fire Front 650 System
  2. USG Interiors, Ceiling Suspension Division, Rigid X
  3. Armstrong, Drywall Furring System 8900 Series
- B. Provide proper system and components to support additional loading of multiple layers of gypsum board, light fixtures, etc.
- C. Provide necessary components for a complete and proper installation.
- D. Exterior installations to be galvanized.

## 2.03 GYPSUM BOARD

- A. Gypsum Board: ASTM D3273, 5/8" thick, Type X, Mold Resistant with a score of 10 as rated according to ASTM D 3273 and/or 0 as rated according to ASTM G21.
1. U.S Gypsum; Sheetrock Firecode Core, Mold Tough Board
  2. National Gypsum Co.; Gold Bond XP Fire-Shield, Mold Resistant Board
  3. Georgia-Pacific; ToughRock Fireguard X Mold-Guard Gypsum Board
  4. Continental Building Products; Mold Defense Type X
  5. CertainTeed Corp.; M2Tech Type X

## 2.04 ABUSE RESISTANT GYPSUM BOARD

- A. Abuse Resistant Gypsum Board: ASTM D3273 and C1629 – Level 1, 5/8" thick, Type X, Abuse and Mold Resistant with a score of 10 as rated according to ASTM D 3273 and/or 0 as rated according to ASTM G21.
1. U.S Gypsum; Sheetrock Firecode Core, Mold Tough AR Board
  2. National Gypsum Co.; Gold Bond Hi-Abuse XP Fire-Shield, Mold Resistant Board
  3. Georgia-Pacific; ToughRock Fireguard X Mold-Guard Abuse-Resistant Gypsum Board

4. Continental Building Products; Protecta AR 100 Type X with Mold Defense
5. CertainTeed Corp.; AirRenew Extreme Abuse Type X

## 2.05 EXTERIOR GYPSUM BOARD

- A.
- B. Exterior Gypsum Soffit Board for Protected Horizontal Applications: ASTM C1396 with manufacturer standard edges, 5/8" thick. Firecode C or X core, ASTM E84 flame spread 20 max. and smoke developed 0.
- C.
  1. U.S Gypsum; Sheetrock Exterior Gypsum Ceiling Board
  2. National Gypsum Co.; Gold Bond Exterior Soffit Board
  3. Georgia-Pacific; ToughRock Fireguard C Soffit Board
  4. Continental Building Products; Firecheck Soffitboard
  5. CertainTeed Corp.; Exterior Soffit Type X Board

## 2.06 TRIM

- A. Metal Trim and Finishing Accessories: Manufacturers standard zinc galvanized metal edge trim, corner bead, etc. for use at intended application.
- B. Edge Trim: PVC conforming to ASTM C1047 and D3678 for interior exposure. Include manufacturer's proper intersection and corner trim for continuous monolithic appearance. Mud set type trim with perforated concealed flanges. Provide proper comparable unit rated for exterior exposure at exterior gypsum board soffits.
  1. Corner Bead, at outside corners
  2. J Bead, at exposed board edges not abutting dissimilar materials
  3. L Bead at board edges abutting dissimilar materials; tear away type
  4. L Bead with gasket at board edges abutting exterior window and door frames, plenum walls, and at exterior soffits; tear away type
  5. L Bead at board edges abutting dissimilar materials with 1/4" caulk channel if narrow reveal (uncaulked) or caulk channel is needed; tear away type
  6. Archway Bead at curved surfaces; tear away type
  7. Subject to compliance with requirements, provide products by one of the following:
    - a. Trim-Tex, Inc.
    - b. Plastic Components, Inc.
- C. Control Joint Trim: 1/4" joint, PVC conforming to ASTM C1047 and D3678 for interior exposure. Include manufacturer's proper intersection and corner trim for continuous monolithic appearance. Mud set type trim with perforated concealed flanges. Provide proper comparable unit rated for exterior exposure at exterior gypsum board soffits. Subject to compliance with requirements, provide products

by one of the following:

1. Trim-Tex, Inc., #093V Expansion Joint
  2. Plastic Components, Inc., #2027-16
- D. Reveal Trim: 2" x 2", PVC conforming to ASTM C1047 and D3678 for interior exposure. Include manufacturer's proper intersection and corner trim for continuous monolithic appearance. Mud set type trim with perforated concealed flanges. Provide proper comparable unit rated for exterior exposure at exterior gypsum board soffits. Subject to compliance with requirements, provide products by one of the following:
1. Trim-Tex, Inc., #AS5510 at wall intersection and #AS5110 in field
  2. Plastic Components, Inc., #202 Z Mold Trim at wall intersection and #225 Drywall Reveal in field.

## 2.07 COMPONENTS

- A. Joint compound, tapes, etc.: Gypsum board manufacturer's premium products matching the specified board type and characteristics. Must maintain indicated mold resistance, fire resistance, and abuse resistance. Do not mix manufacturers, provide same manufacturer as board to maintain the integrity of their system.
1. Screws: Type "S" as recommended by gypsum board manufacturer.

## 2.08 CONTINUOUS SOFFIT VENT

- A. Manufacturers:
1. Air Vent, Inc; SV202
  2. Guardian Building Products; 105 Continuous Soffit Vent
  3. Tamlyn; CUV8 Continuous Soffit Vent
- B. Products specified above are intended to be installed against a vertical surface. Provide similar model if vent is to be installed in field of soffit.
- C. Extruded aluminum, 2 inch ventilated width providing nine (9) square inches net free area per lineal foot.
- D. Provide concealed continuous aluminum insect screen sealed to each section.
- E. Provide maximum lengths available.
- F. Factory applied baked enamel finish, color as selected by Architect.

## PART 3 - EXECUTION

### 3.01 METAL STUD FRAMING INSTALLATION

- A. Stud System Erection. Attach metal runners at floor with suitable fasteners located 2" from each end and spaced 16" o.c. Position studs vertically, engaging floor and ceiling runners and spaced 16" o.c. Metal studs shall run full height from floor to height as indicated. When necessary, splice studs with 8" nested lap and one positive attachment per stud flange. Place studs in direct contact with door frame jambs, abutting partitions and partition corners.

- B. Anchor studs for shelf-walls, counter, vanity, and those adjacent to door frames, partition intersections, and corners to ceiling and floor runner flanges with USG Metal Lock Fastener tool. Securely anchor studs to jamb and head anchor clips of door frames by bolt or screw attachment. Over metal door frames, place horizontally a cut-to-length section of runner with a web flange bend at each end, and secure with one positive attachment per flange.
- C. Framing components shall be cut squarely for attachment to perpendicular members, or as required for an angular fit against abutting members. Members shall be held positively in place until properly fastened.
- D. Construct corners using minimum 3 studs, double stud at wall opening, door and windows jambs.
- E. Erect studs 1 piece full length; splicing of studs not permitted.
- F. Attachment of similar materials shall be done by mechanical fasteners. Dissimilar materials may be attached with screws, bolts or properly designed clips. Wire tying of framing components in structural applications shall not be permitted.
- G. Provide necessary stud bracing, etc. as detailed and/or required to support design and anticipated loads.
- H. Install intermediate studs above and below openings to match wall stud spacing.
- I. Provide deflection allowance in stud top track, directly below horizontal building framing for non-load bearing framing. Deflection top track to be installed per manufacturer's requirements to allow for vertical deflection, and fire rating at walls indicated to be fire rated. Provide additional gypsum board layers, etc. required by manufacturer of system.
- J. At locations where the stud top track is not supported on a continuous support, provide misc. items including metal framing, blocking, angles, etc. to properly brace and support the wall.
- K. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- L. Provide substantial intermediate wood blocking properly anchored to metal studs for secure attachment of wall mounted items, toilet accessories, etc.

### 3.02 GYPSUM BOARD INSTALLATION

- A. The suspension system for the suspended gypsum board panels, ceilings and soffits shall consist of necessary components as required and shall be installed as per manufacturer's requirements and/or as detailed to support loads at 1/360 max. deflection. Provide control joints as indicated and required, installed per manufacturer's requirements. Properly glue and screw gypsum board panels to ceiling suspension system.
- B. Suspension system and components to be supported from steel bar joists including but not necessarily limited to framing and hanging wire shall be supported from the top chord of the steel joists unless otherwise specifically indicated.
- C. Gypsum board erection (on studs). Apply gypsum panels vertically. Position edges over studs for vertical application; ends over studs for horizontal application.
- D. Use maximum practical lengths to minimize end joints. Fit ends and edges closely,

but not forced together.

- E. Stagger joints on opposite sides of partition and on laminated sections. Space screws 12" o.c. in field of panels and 8" o.c. staggered along vertical abutting edges.
- F. Gypsum board shall be applied to surfaces where called for the drawings. Joints shall be taped, spackled and neatly sanded to form a smooth even sound surface so as to show no evidence of joints after surfaces have been painted. Provide corner beads at exterior corners and trim at exposed edges of gypsum board surfaces and where gypsum board abuts dissimilar materials, taped flush. Provide indicated level of finish meeting Gypsum Association standards.
- G. Cement board to be provided as the backer board for areas to receive ceramic tile wall finish. Install per manufacturer's requirements.
- H. Exterior gypsum board shall be provided in exterior locations. Install per manufacturer's requirements.
- I. Trim, beads, control joints, reveals, etc. to be taped in flush to provide a uniform monolithic appearance. Installation with mechanical fasteners and adhesives to meet manufacturers requirements.
- J. Work and materials to be per gypsum board manufacturer's requirements to provide and maintain the fire rating, mold resistance, and abuse resistance of their system.
- K. Install continuous soffit vent as required to maintain proper ventilation of soffit systems.

### 3.03 PATCHING

- A. After other trades and contractors have finished their work, damaged areas shall be patched. The Contractor shall accomplish patching and repainting without cost to the Owner.
  - 1. Touch-up, repair or replace damaged products before Substantial Completion.

### 3.04 PROTECTION

- A. Protect adjacent finish surfaces from damage due to operations.
- B. Protect installed products until Substantial Completion.

END 09 29 00

DIVISION 9 – FINISHES  
Section 09 51 00 - Acoustical Ceilings

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

- A. Product Data
- B. Samples
  - 1. Acoustical Tile, 6" square manufacturers sample, one (1) of each tile type
- C. Attic Stock: Written verification of attic stock delivery to Owner's representative.

1.03 STORAGE AND HANDLING

- A. Deliver acoustical ceiling panels, suspension system components, and accessories to Site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, direct sunlight, surface contamination or other causes.
- B. Before installing acoustical ceiling panels, permit them to reach room temperature and stabilized moisture content.
- C. Handle acoustical ceiling panels carefully to avoid chipping edges or damaging units in any way.

1.04 PROJECT CONDITIONS

- A. Space Enclosure: Do not install interior acoustical ceilings until space is enclosed and weatherproof, wet-work (painting, gypsum board, plastering, tiling, and concrete leveling) in space is completed and dry, work above ceilings is complete, and ambient temperature and humidity conditions will be continuously maintained at values indicated for the Project when occupied for its intended use.

PART 2 - PRODUCTS

2.01 ACOUSTICAL TILE

- A. Type 'A', lay-in type white tiles, ASTM E84 Class A rated incombustible mineral tile, 24" x 24" x 5/8" min. with square cut edge design, high temperature and humidity resistant. UL Classified NRC 0.70 min., with CAC 22 min.
  - 1. Armstrong, School Zone Fine Fissured # 1713
  - 2. CertainTeed, Performa Fine Fissured High NRC #HHF-457-HNRC
  - 3. USG Acoustical Products Co., Radar ClimaPlus High-NRC #22111
  - 4. Rockfon, Artic #600
- B. Type 'A', lay-in type white tiles, ASTM E84 Class A rated incombustible tile, 24" x 24" with square cut edge design, high temperature and humidity resistant. UL Classified NRC 0.70 min. and CAC 40 min.

1. Armstrong, School Zone Fine Fissured #1810 (3/4" thickness)
  2. CertainTeed, Performa Adagio High CAC #HCAC-1672-IOF-1 (1-1/2" thickness)
  3. USG Acoustical Products Co., Radar ClimaPlus High-NRC/CAC #22521 (3/4" thickness)
  4. Rockfon, Sonar dB #23100 (2" thickness)
- C. Type 'B', lay-in type white tiles, ASTM E84 Class A rated, incombustible mineral tile, 24" x 24" x 5/8" min., reveal trim edges, high temperature and humidity resistant. UL Classified NRC 0.70 min., with CAC 22 min.
1. Armstrong, School Zone Fine Fissured # 1717
  2. CertainTeed, Performa Fine Fissured High NRC #HHF-454-HNRC
  3. USG Acoustical Products Co., Radar ClimaPlus High-NRC #22121
  4. Rockfon, Artic #660
- D. Type 'B', lay-in type white tiles, ASTM E84 Class A rated incombustible tile, 24" x 24" with reveal cut edge design, factory painted edges, high temperature and humidity resistant. UL Classified NRC 0.70 min. and CAC 40 min.
1. Armstrong, School Zone Fine Fissured #1717 (3/4" thickness)
  2. CertainTeed, Performa Adagio High CAC #HCAC-1672B-IOF-1 (1-1/2" thickness)
  3. USG Acoustical Products Co., Radar ClimaPlus High-NRC/CAC #22523 (3/4" thickness)
  4. Rockfon, Sonar dB #23300 (2" thickness)
- E. Type 'C', lay-in type white tiles, ASTM E84 Class A rated, incombustible fiberglass tile, 24" x 24" x 1" sq. cut edges, high temperature and humidity resistant. UL Classified NRC 0.95 min., with CAC 22 min. and AC 190 min.
1. Armstrong, Optima #3152
  2. CertainTeed, Performa VOC Compliant Symphony #1342-IOF-1
  3. USG Acoustical Products, Halcyon ClimaPlus #98221
  4. Rockfon, Sonar #16100
- F. Touch-Up Edge Paint: Tile manufacturer's touch-up edge paint matching tile color.

## 2.02 METAL SUSPENSION SYSTEMS - GENERAL

- A. Pre-finish exposed members white. Provide hold down clips in vestibules and as required.
- B. Provide additional cross tees, adapter clips, and any necessary components for the proper installation of perimeter and multiple layer gypsum board ceilings and feature areas, and mechanical and electrical items to be secured to this system.
- C. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension

systems indicated and that match width and configuration of exposed runners, formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners; provide in longest standard single piece lengths. For penetrations of ceiling, provide edge moldings fabricated to fit penetration exactly. Provide manufacturer's factory fabricated matching trim, inside and outside corners, including matching radius for outside corner bullnose CMU and/or gypsum board wall locations.

- D. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated or recommended by manufacturer.
1. Anchors in Concrete: Provide one of the following types:
    - a. Postinstalled Expansion Anchors: Suitable for application indicated, fabricated from corrosion resistant materials, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
      1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
    - b. Power-Actuated Fasteners: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to ten times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- E. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641, Class 1 zinc coating, soft temper.
  2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter (12 gage) wire.

## 2.03 LAY-IN SUSPENSION SYSTEM

- A. Manufacturers:
1. Chicago Metallic Corp./Rockfon, 200 System
  2. USG., DX System
  3. Armstrong, Prelude XL
  4. CertainTeed, Classic
- B. Standard 15/16" grid.

- C. Provide heavy duty suspension system at precast insulated wood fiber acoustical panels.

#### 2.04 CONCEALED SUSPENSION SYSTEM

- A. Manufacturer's
  - 1. Chicago Metallic Corp./Rockfon, 1200 System
  - 2. Donn Corp., comparable to (1) above
  - 3. Armstrong, Accessible Tile System
  - 4. Certainteed, comparable to (1) above
- B. Provide for full access without sightlines.

#### 2.05 VERTICAL SUSPENSION TRIM

- A. Extruded aluminum, 12" straight nominal vertical face, pre-finished white.
  - 1. Rockfon, Infinity Standard Perimeter Trim
  - 2. USG, Compasso Elite
  - 3. Armstrong, Axiom Classic Trim
  - 4. CertainTeed, Cloud Perimeter Trim
- B. Provide manufacturer's factory mitered corner trim, concealed splice plates, etc. and components required to provide a complete and proper, finished installation.
- C. Provide factory curved sections meeting radius as indicated.

#### 2.06 HORIZONTAL SUSPENSION TRIM

- A. Extruded aluminum, 6" nominal horizontal face, sharp edged perimeter, pre-finished white.
  - 1. Rockfon, Infinity Z Perimeter Trim
  - 2. USG, Compasso Slim
  - 3. Armstrong, Axiom Knife Edge
- B. Provide manufacturer's factory mitered corner trim, concealed splice plates, etc. and components required to provide a complete and proper, finished installation.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Acoustical panels that are cracked or damaged, wet, moisture damaged, mold damaged, etc. are not acceptable.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

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- A. Install materials in accordance with ASTM C 636, manufacturer's printed instructions, industry standards applicable to the Work, and requirements of authorities having jurisdiction. Exposed fasteners are not acceptable.
- B. Acoustical ceiling systems and ceiling components to be supported from building structural members. Securely hang ceiling from structural system in an approved manner, capable of supporting a minimum of 25 lbs./sq.ft. Provide additional supports at multiple layer gypsum board areas, mechanical, and electrical items as required.
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum, which are not part of supporting structural or ceiling suspension system.
  - 2. Splay hangers only where required to miss obstructions and offset resulting horizontal force by bracing, counters playing or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Do not support ceilings directly from permanent metal forms or composite floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or epoxy adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  - 5. When steel or wood framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  - 6. Do not attach hangers to steel or wood, roof or floor decking. Attach hangers to structural members or top chord of trusses as designed for the ceiling loads.
  - 7. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated, leveling to tolerance of 1/8 inch per 12 feet. Provide hangers not more than 8-inches from ends of each member. Provide additional hangers and locate hangers as recommended by ceiling manufacturer to support pendant lighting and other similar items.
  - 8. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for substrate, and which will not deteriorate or fail due to age, corrosion, or elevated temperatures. Secure wire hangers with not less than three (3) full, closely spaced turns.
  - 9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications and as indicated.
- C. Set ceilings level with laser beam in straight lines and paralleled with rectangular walls.

- D. Lay out pattern in coordination with other trades to eliminate off-centering of units in tile pattern.
- E. Lay tile pattern out in order that there shall be no tile less than half.
- F. Certain rooms have grilles, recessed light fixtures recessed into ceilings, access panels and other required openings. Where such occur, furring shall be framed properly to permit the installation of such fixtures, panels and openings. This Contractor shall install frames, panels, etc., as furnished by the other contractors.
- G. System Runners: Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- H. Ceiling Panels: Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit with edges matching edge design of panel.
  - 1. Install square-edged panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
  - 2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces with manufacturers touch-up edge paint.

### 3.03 ADJUST AND CLEAN

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Clean exposed surfaces of acoustical ceilings; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work, which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

### 3.04 ATTIC STOCK

- A. Provide four (4) full, unopened boxes of each tile type delivered to Owner at site at Substantial Completion. This material shall be in full tiles in unopened cartons with identifying labels.
- B. Store extra stock where directed by the Owner. Provide written verification of attic stock delivery to Owner's representative, submit to Architect.

END 09 51 00

## DIVISION 9 – FINISHES

### Section 09 65 13 - Resilient Base

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#### PART 1 - GENERAL

##### 1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

##### 1.02 SUBMITTALS

- A. Samples for color selection
  - 1. Base
- B. Product Data
  - 1. Base
  - 2. Adhesive
- C. Operation and Maintenance Instructions
- D. Attic Stock: Written verification and sign off of attic stock delivery to Owner's representative.

##### 1.03 QUALITY ASSURANCE

- A. Single-Source Responsibility: Obtain each type, color, and pattern of resilient flooring materials from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- B. Fire-Test-Response Characteristics: As determined by testing identical resilient flooring products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 w/sq. cm.

##### 1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in original packages and containers with seals unbroken and bearing manufacturer's original labels, including manufacturer's name, product name, and directions for storing, handling, and use.
- B. Store resilient flooring materials in clean, dry interior spaces protected from the weather, extreme temperature and humidity range, and freezing, with ambient temperature and humidity maintained within the range of minimum and maximum allowable by each manufacturer.
  - 1. Store on flat surfaces.
  - 2. Limit stacking to five (5) boxes high.
- C. Move materials into spaces where they will be installed at least 48 hours prior to installation.

##### 1.05 PROJECT CONDITIONS

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- A. Maintain temperatures within the range of minimum and maximum allowable by each manufacturer for at least 48 hours before, during, and for not less than 48 hours after installation. Protect materials from the direct flow of heat from hot-air registers, radiators, or other heating fixtures and appliances. After installation period, maintain a temperature of not less than 55 deg F.
- B. Close spaces to traffic during base installation and for not less than 48 hours after base installation.

#### 1.06 RELATED SECTIONS

- A. Section 07 92 00 – Joint Sealants

### PART 2 - PRODUCTS

#### 2.01 WALL BASE

- A. Base: On-top type 4" x 1/8" thermoset rubber, cove type.
  - 1. Roppe, Pinnacle
  - 2. Johnsonite, BaseWorks
  - 3. Burke, BurkeBase Type TS
- B. Adhesive:
  - 1. Manufacturer's contact type on non-porous surfaces.
  - 2. Manufacturer's acrylic type on porous surfaces.
- C. Manufacturer's pre-formed inside and outside corners shall be used.
- D. Colors as selected by Architect.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Contractor shall examine substrates prior to installation to determine that surfaces are smooth and free from cracks, holes, ridges, and other defects that might prevent adhesive bond, or impair durability or appearance of the resilient materials.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone.
- D. Broom sweep and vacuum clean substrates to be covered immediately before installation. Ensure substrates are free of moisture, alkaline salts, carbonation, dust, dirt, grease and debris.
- E. Apply primer to substrates if recommended by manufacturer, prior to application of adhesive. Apply primer in accordance with manufacturer's instructions.

#### 3.02 INSTALLATION

- A. The installer shall be competent in the installation of the resilient materials.
- B. Install in strict accordance with the manufacturer's requirements, and as required to meet manufacturer's warranty requirements.

- C. Install rubber base on each wall including casework with manufacturers approved adhesives for the existing substrate to be applied. Provide additional sealing methods as indicated to assure a watertight installation.

### 3.03 CLEANING AND PROTECTION

- A. Perform the following operations immediately after completing resilient materials installation:
  - 1. Remove adhesive and other surface blemishes using clean cloth and cleaner recommended by flooring manufacturer.
  - 2. Sweep and vacuum areas thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- B. Protect resilient materials against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer to ensure the resilient materials will be free of damage at Substantial Completion.
- C. Immediately prior to Substantial Completion, remove protective covers and panels, thoroughly clean flooring in accordance with manufacturer's instructions.

### 3.04 ATTIC STOCK

- A. Provide a minimum of 12 linear feet of rubber base in each color selected.
- B. Store extra stock where directed by the Owner. Provide written verification of attic stock delivery to Owner's representative, submit to Architect.

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END 09 65 13

DIVISION 9 – FINISHES

Section 09 68 13 – Modular Tile Carpeting

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified under this section.

1.02 SCOPE OF WORK

- A. Work shall consist of the furnishing of modular carpet in areas so designated.

1.03 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics, sizes, patterns, colors available, and method of installation.
- B. Samples for initial selection.
- C. Shop Drawing showing columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required as well as direction of carpet pile and pattern, location of edge moldings and edge bindings shall be submitted to the Architect for approval prior to installation.
- D. Floor schedule using same room designations indicated on drawings.
- E. Verification Samples: Submit full size samples illustrating color and installation laying pattern for each carpet material specified.
- F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- G. Maintenance Data: Include maintenance procedures, recommendations for maintenance materials and equipment, and suggested schedule for cleaning.
- H. Manufacturer's Product Warranty.
- I. Test Reports: Floor slab moisture content level test reports from an independent agency. Testing procedures, number of test locations, and physical locations shall meet manufacturer=s requirements.
- J. Attic Stock: Verification of delivery of attic stock to Owner.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications
  - 1. Company specializing in manufacturing specified carpet with minimum 10 years documented experience.
  - 2. Upon request, manufacturer to provide representative to assist in project start-up and to inspect installation while in process and upon completion. Representative will notify designated contact if any installation instructions are not followed.
  - 3. Single Source Responsibility: Obtain each type of product from one

source and by a single manufacturer.

B. Installer Qualifications

1. Flooring contractor must be certified by the manufacturer prior to bid.
2. Flooring contractor to be a specialty contractor normally engaged in this type of work and shall have prior experience in the installation of these types of materials.
3. Flooring contractor to provide Owner a written installation warranty that guarantees the completed installation to be free from defects in materials and workmanship for a period of one year after job completion.

1.05 DELIVERY, STORAGE, & HANDLING

- A. Deliver materials to the site in manufacturer's original packaging listing manufacturer's name, product name, identification number, and related information.
- B. The temperature of the interior environment, including the sub floor should be no lower than 65°F and no higher than 90°F at least 72 hours prior to, during and after the tile installation. Flooring products and installation materials should be stored between 65°F and 90°F for at least 48 hours prior to installation. Relative humidity should be no more than 65%.
- C. Make stored materials available for inspection by the Owner's representative.
- D. Store materials in area of installation for minimum period of 48 hours prior to installation.

1.06 PROJECT CONDITIONS

- A. Sub-floor preparation is to include required work to prepare the existing floor for installation of the product as specified in this document and manufacturer's installation instructions.
- B. Material used in sub-floor preparation and repair shall be recommended by the carpet manufacturer and shall be chemically and physically compatible with the carpet system being bid.
- C. Maintain minimum 65 degrees F ambient temperature and 65% relative humidity for 72 hours prior to, during, and 48 hours after installation.
- D. Do not install flooring until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

1.07 PRODUCT WARRANTY

- A. Provide a non-prorated lifetime limited warranty which shall specifically warrant against the following:
  1. Excessive Surface Wear: More than 15% loss of pile fiber weight
  2. Excessive Static Electricity: More than 3.0 kV per AATCC 134
  3. Resiliency Loss of the Backing: More than 10% loss of backing resiliency

4. Delamination
  5. Edge Ravel
  6. Zippering
    - a. Tuft Bind warranty in lieu of edge ravel and zippering is not acceptable.
- B. Warranty to be sole source responsibility of the manufacturer. Second source warranties and warranties that involve parties other than the carpet manufacturer are unacceptable.
- C. If the product fails to perform as warranted when properly installed and maintained, the affected area will be repaired or replaced at the discretion of the manufacturer.
- D. Chair pads are not required, but are recommended for optimum textural performance. Absent the use of chair pads, more intensive maintenance will be required for areas in direct contact with chair caster traffic, and some degree of appearance change is to be expected.

## PART 2 - PRODUCTS

### 2.01 MODULAR CARPET

- A. Tandus; Accentuate and/or Emphasize Modular
1. Construction: Stratatec Patterned Loop
  2. Gauge: 5/64
  3. Stitch Rate: 9.6 stiches / inch
  4. Pile Height Average: 0.187 inch
  5. Fiber System: Dynex Nylon
  6. Dye Method: 70% Solution Dyed / 30% Yarn Dyed
  7. Static Coefficient of Friction: ASTM C-1028; Passes ADA requirements.
  8. Static Propensity: AATCC 134: less than 3.5 kv
  9. Flooring Radiant Panel: ASTM E-648 or NFPA 253: Class 1
  10. Secondary Backing: Ethos
  11. NSF140: Platinum
- B. Shaw Contract Group; Diffuse and/or Disperse Modular
1. Construction: Multi-level Pattern Loop
  2. Gauge: 1/12
  3. Stitch Rate: 9.0 stiches / inch
  4. Pile Height Average: 0.092 inch
  5. Fiber System: Eco Solution Q Nylon
  6. Dye Method: 100% Solution Dyed

7. Static Coefficient of Friction: ASTM C-1028; Passes ADA requirements.
8. Static Propensity: AATCC 134: less than 3.5 kv
9. Flooring Radiant Panel: ASTM E-648 or NFPA 253: Class 1
10. Secondary Backing: Ecoworx Tile
11. Protective Treatments: SSP Shaw Soil Protection
12. NSF140: Platinum

## 2.02 MISCELLANEOUS MATERIALS AND CARPET ACCESSORIES

- A. Materials recommended by manufacturer for patching, leveling, priming, etc.
- B. Nonmetallic Edge Guard: Rubber of size and profile adequate for location. Color as selected by Architect.
  1. Roppe
  2. Mercer
  3. Johnsonite
- C. Miscellaneous Materials: Adhesives, tapes, thread, nails, staples and similar products of type recommended by manufacturer and installer.
- D. Moisture Sealer: Apply to areas to receive carpet flooring even when the slab meets the moisture content requirements. Provide moisture sealer appropriate for moisture conditions present and approved in writing by the finish floor manufacturer(s) for the conditions present.
  1. Where moisture levels are below manufacturer recommended levels, provide a moisture sealer with a minimum resistance capacity of 3 pounds, per 1000 sq. ft. for a 24 hour period, as per calcium chloride test ASTM F1869-98.
  2. The required pH range is 9.0 or less as tested according to ASTM F-710-05.

## PART 3 - EXECUTION

### 3.01 EXAMINATION / PREPARATION

- A. Prepare sub-floor to comply with criteria established in manufacturer's installation instructions. Use only preparation materials that are acceptable to the manufacturer.
  1. Remove deleterious substances from substrate(s) that would interfere with or be harmful to the installation.
  2. Remove sub-floor ridges and bumps. Fill cracks, joints, holes, and other defects.
- B. Verify that sub-floor is smooth and flat within specified tolerances and ready to receive carpet.
- C. Verify that substrate surface is dust-free and free of substances that would impair bonding of product to the floor.

- D. Verify that concrete surfaces are ready for installation by conducting moisture and pH testing. Results must be within limits recommended by manufacturer.
- E. There will be no exceptions to the provisions stated in the manufacturer's installation instructions.

### 3.02 INSTALLATION – GENERAL

- A. Install product in accordance with manufacturer's installation instructions. Product must have low VOC, factory applied, "dry" adhesive. A peel & stick method applied to the back at the time of manufacture is preferred.
- B. Adhesive must meet the requirements of CRI's Green Label Plus program for adhesive. Provide documentation. Provide documentation showing third-party certification of VOC content.
- C. Product as installed to be securely attached to the floor in compliance with Americans with Disabilities Act (ADA), Section 4.5.3.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.
- E. Provide fully adhered installation by trimming and fitting carpet widths into each space prior to application of adhesive. At adhesive backing installation, peel back adhesive backing sheet and lay down meeting manufacturer's requirements.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Install borders parallel to walls.
- H. Roll with appropriate roller for complete contact of product with adhesive to sub-floor.
- I. Trim carpet neatly at walls and around interruptions. Completed product is to be smooth and free of bubbles, puckers, and other defects.
- J. Install edge guards at exposed edges. Bind edges with cloth tape and thread where not concealable.
- K. Apply vinyl cove base to walls, columns, pilasters, casework, concrete islands, and other permanent fixtures in rooms or areas where base is scheduled. Base is not required on moveable partition walls where metal base is present.
  - 1. Install base in lengths as long as practicable, with job-formed corners.
  - 2. Tightly bond base to backing throughout length of each piece, with continuous contact at horizontal and vertical surfaces.
  - 3. On masonry surfaces, or other similar irregular surfaces, fill voids along top edge of wall base with base manufacturer's recommended adhesive filler material.

### 3.03 PROTECTION & CLEANING

- A. Remove excess adhesive and/or other from floor and wall surfaces without damage. Replace carpet which cannot be cleaned.

- B. Rubbish, wrappings, debris, trimmings, etc. to be removed from site and disposed of properly.
- C. Clean and vacuum surfaces using a beater brush/bar commercial vacuum.
- D. After each area is installed, protect from soiling and damage by other trades.
- E. In order to allow the adhesive to cure properly, hot water extraction cleaning should not be used within the first 30 days after installation, otherwise warranties are null and void.

#### 3.04 RESTORATION

- A. Damage done to paint, walls, woodwork, floors, and/or similar finishes as a result of this work, shall be corrected by the responsible contractor.
- B. Required repairs shall be made by the proper trade contracted on the work of this project, who shall make the necessary repairs and shall be paid by the responsible subcontractor for the repair work.

#### 3.05 CLEANING

- A. Upon completion of the installation, remove waste materials, tools and equipment.
- B. Using commercial vacuums, thoroughly vacuum the entire floor surface.
- C. Remove spots or replace carpet where spots cannot be removed.
- D. Remove debris, sorting pieces to be saved from scraps to be disposed of.
  - 1. Usable pieces of carpet, roll ends of less than nine feet in length, and pieces of more than three square feet in area not more than one foot wide and necessary to complete the work, are to be left on the job site and placed in orderly manner in such area as designated by the Owner.
  - 2. Dispose or smaller pieces as construction waste.
- E. Provide protection methods and materials needed to ensure that carpeting will be without deterioration or damage at time of substantial completion.
- F. In order to allow the adhesive to cure properly, hot water extraction cleaning should not be used within the first 30-45 days after installation, otherwise warranties are null and void.

#### 3.06 ATTIC STOCK

- A. Upon completion of installation, deliver a minimum of 5% of the total area of modular carpet to the Owner.
- B. Package attic stock materials with protective covering with identifying labels.
- C. Store attic stock materials where directed by the Owner.

END 09 68 13

DIVISION 10 – SPECIALTIES  
Section 09 69 00 - Access Flooring

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified.

1.02 SUBMITTALS

- A. Product Data.
- B. Shop drawings indicating understructure plan, panels layout, and air grille locations.
- C. Samples of panel, understructure and finishes.

1.03 MANUFACTURER'S QUALIFICATIONS

- A. Manufacturers of Access Flooring shall have not less than five (5) years experience in the design and fabrication of access flooring systems.
- B. Manufacturers shall have successfully completed not less than five (5) other installations which are similar in size and construction.

1.04 GENERAL REQUIREMENTS

- A. The access floor system shall consist of removable panels supported by adjustable steel pedestal assemblies and shall accommodate electrical conduit, communication and mechanical service lines.
- B. The finished floor height shall be 12"  $\square$  form the slab to the top of removable panels.
- C. The access floor contractor shall be a duly authorized and approved installer of the manufacturer and shall submit shop drawings, sample, literature and certifications of performance for approval.
- D. The access floor contractor shall furnish labor, materials, equipment and services necessary for the installation of the access floor in accordance with the specifications and approved shop drawings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Tate Access Floors, Inc.; ConCore SF 1000 access floor system 2'-0" x 2'-0" panels.
- B. Maxcess Technologies, Inc.; Products to match "A." above.
- C. Interface AR; Products to match "A." above.

2.02 MATERIALS

- A. Panels: 2'-0" x 2'-0" x 1", top steel sheet welded to a formed steel bottom pan and painted inside and outside with a baked epoxy paint. Panels shall be filled with a lightweight cementitious product. Panels to have carpet tile factory applied

to allow carpet tile and panel to be removed as one unit.

- B. Understructure: Galvanized steel support system. Pattern to be 2'-0" x 2'-0". System to be adjustable height type to accommodate a height of +/- 1'-0" above concrete floor slab. Provide adjustable pedestals, pedestal bases, and pedestal heads, and accessories for a complete installation. Securely anchor system to concrete floor slab with expansion type anchors, two (2) minimum per base.
1. Type of Understructure: Freestanding, laterally restrained on pedestal without fasteners.
  2. Pedestal Assembly:
    - a. Shall provide a 8000 lb. axial load without permanent deformation.
    - b. Assembly shall provide a range of adjustment from 1" to 2" total.
    - c. Provide a means of leveling and locking the assembly at a selected height which requires deliberate action to change height setting and which prevents vibrating displacement.
  3. Pedestal Bases: Fabricated of a square base with not less than 16 square inches of bearing area and assembled to a stud or tube which is designed to engage the pedestal head assembly; secure subfloor in accordance with manufacturer's instructions.
  4. Pedestal Heads: Fabricated of a head plate with corresponding stud or tube which is designed to engage the pedestal bases assembly. The head must be the proper type to positively locate the floor panel. When specified, the head shall provide a means to fasten the floor panels or stringer directly to the head.
- C. Include miscellaneous items for a complete installation including but not limited to trim edging, access boxes, cable cut-outs, grommets, and panel lifters.

## 2.03 SYSTEM PERFORMANCE

- A. Concentrated Load Performance:
1. Panels shall be capable of supporting a concentrated load of 1000 lbs. placed on a one square inch area at any location on the panel with a maximum top surface permanent set not to exceed 0.010 inches after load is removed.
- B. Uniform Load Performance:
1. Panels shall be capable of supporting a uniform load of 250 lbs. placed on a one square foot area.
- C. Ultimate Load Performance:
1. Panels shall be capable of supporting an ultimate load of 3200 lbs. on one square inch area without failure. Failure is defined as point at which the panel will not longer accept the load.
- D. Rolling Load Performance: Local and overall surface deformation shall not exceed 0.040 inches.

- E. Impact Load Performance: Panels and supporting understructure shall withstand without failure an impact load anywhere on the panel of 100 lbs. dropped from a height of 36" onto a one square inch area.

#### 2.04 FLOOR SURFACE COVERING

- A. Carpet Tiles: Provide modular carpet tiles by Lees Carpets, Durastyle (Antron Legacy yarn with DuraTech Soil Protection. Continuous conductive filament to provide maximum conductivity.) 5/64" gauge, 22 oz. face yarn weight, backing material to be Self Loc. Tiles to be factory applied. Color and pattern as selected by Architect.

#### 2.05 ACCESSORIES

- A. Provide spare parts consisting of at 2% of total plus 1 carton of carpet tile to owner. Deliver to project in manufacturer's standard packages clearly marked with the contents.
- B. Provide two (2) panel lifting devices.
- C. Provide flush mounted data/phone/power outlets as shown on Electrical Drawings.
- D. Provide aluminum air grilles with dampers as shown on Mechanical Drawings. Provide 32 round grommets with sliding cover 1 per panel. Install panels at locations indicated by owner.

### PART 3 - EXECUTION

#### 3.01 SURFACE PREPARATION

- A. Preparation: Before commencing installation examine the substrate and surrounding conditions to insure that there is nothing to prevent proper and timely execution of the installation. Start of work shall indicate acceptance of substrate and surrounding conditions.

#### 3.02 INSTALLATION

- A. Install system in strict accordance with manufacturer's recommendations.
- B. Coordinate work with other trades.

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END 09 69 00

DIVISION 9 - FINISHES  
Section 09 91 00 – Painting

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified.
- B. The Contractor is directed to read the specification pertaining to the work and materials of other trades in order to understand the extent of various materials used and the provisions regarding their painting. Surfaces that are left unpainted or unfinished shall be finished as part of this work. Complete finished painting is required for every item whether scheduled, noted or not. Work requiring finish but not scheduled or noted shall be finished with products as specified for similar and/or adjacent work.
  - 1. Paint new and existing exposed surfaces unless noted otherwise. If the drawings and/or Schedule of Painting does not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
  - 1. Prefinished items include, but are not limited to, the following factory-finished components:
    - a. Architectural woodwork.
    - b. Metal lockers.
    - c. Elevator equipment.
    - d. Finished mechanical and electrical equipment.
    - e. Light fixtures and supports.
  - 2. Concealed surfaces refers to surfaces, materials, assemblies, or items that cannot be accessed without moving a building element, such as within a chase, wall, or ceiling cavity; as in the following generally inaccessible spaces:
    - a. Furred areas.
    - b. Ceiling plenums.
    - c. Pipe spaces.
    - d. Duct shafts.
    - e. Elevator shafts.
  - 3. Finished metal surfaces include, but are not limited to, the following:
    - a. Anodized aluminum.
    - b. Stainless steel.
    - c. Chromium plating.
  - 4. Operating parts include moving parts of operating equipment and the following:

- a. Valve and damper operators.
  - b. Linkages.
  - c. Sensing devices.
  - d. Motor and fan shafts.
5. Labels: Do not paint over:
- a. UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
  - b. Labels designating materials or assemblies as accessible.

## 1.02 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats. If single source responsibility is not possible, furnish written approval of manufacturer of finish coat indicating acceptance of proposed under coats.
- B. For shop primed materials by others, verify compatibility between primer and finish coats. Notify the Architect in writing of problems anticipated with using the specified finish coat materials. Where finish coats are incompatible with primer coats or existing finishes, provide additional barrier coat or surface preparation as required by the manufacturer of the primer and finish coats.
- C. Verify compatibility between primer and substrate. Notify the Architect in writing of problems anticipated with using the specified primer and finish coat materials. Where primer and finish coats are incompatible with substrates, for issues such as non-acceptable alkalinity levels, moisture levels, or poor adhesion. Provide additional barrier coat or surface preparation as required by the manufacturer of the primer and finish coats.
- D. Preparatory work to be performed as indicated, and at a minimum shall be performed in strict accordance with coating manufacturer's requirements including applicable Society for Protective Coatings (SSPC) and the National Association of Corrosion Engineers International (NACE) standards.

## 1.03 SUBMITTALS

- A. Product data: Include information regarding recommended usage, drying times, preparation and primers, surface compatibility, and application instructions which are to be followed. Material Safety Data (MSD) sheets are not acceptable as product data and if submitted, will be returned without review and comment.
- B. Schedule: Submit schedule showing materials to be used, locations, and number of coats to be applied. See SCHEDULE OF PAINTING for format.
  - 1. Products listed on the SCHEDULE OF PAINTING have been recommended by the paint system manufacturers for the intended use and establish a level of quality. If the Contractor submits and/or uses the specified products, the Contractor agrees that the specified products are proper for the intended use. If the Contractor does not agree with the use of the specified products, and recommends the use of alternative products, the Contractor shall submit written explanation and supporting data from the manufacturer for the proposed products. If accepted, proposed products shall be covered under the provisions of the warranty.

- C. Color Samples: Provide manufacturer's color fans and/or samples for color selection purpose. Provide full line of standard, custom and premium colors. Provide samples on actual stock when requested by the Architect.
- D. Verification Samples: Provide "Draw-Downs" of each paint color for verification purposes. Provide actual samples of each stain or varnish on actual stock. Each sample shall be marked on the backside with the manufacturer, material, and color code.
- E. Adhesion Testing Reports: Provide manufacturer's recommended adhesion testing meeting ASTM D 3359 and/or ASTM D 667 as appropriate for substrate being tested. Perform in a non-conspicuous area for each substrate to receive the specified coatings. Do not proceed further until positive results are achieved. Provide additional preparatory work, primer and/or barrier coats, etc. as necessary for proper adhesion; perform additional adhesion testing to confirm proper conditions have been met.
- F. Alkalinity Testing Reports: Provide manufacturer's recommended alkalinity testing of plaster, concrete, and concrete masonry surfaces scheduled to receive paint in order to confirm that surfaces do not exceed manufacturer's required alkalinity levels.
- G. Moisture Testing Reports: Provide manufacturer's recommended moisture testing of concrete, concrete masonry, gypsum board, plaster, wood, finished woodwork, and other non-metallic surfaces scheduled to receive paint in order to confirm that surfaces do not exceed manufacturer's required moisture levels.
- H. Warranty: Submit a written warranty, executed by the Contractor.
- I. Coating Maintenance Manual: At project closeout for Owners Record Documents, provide a coatings maintenance manual including area summary with finish schedule, area detail designating location where each product/color/finish was used, product data pages, material safety data sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.
- J. Attic Stock: Verification of delivery of attic stock to Owner.

#### 1.04 DELIVERY, STORAGE AND HANDLING

- A. Materials used on the job shall be stored as recommended by the manufacturer. Storage areas shall be kept neat and clean. Damage to these areas or surrounding areas shall be repaired to original condition by the Contractor. Oily rags, waste, etc., must be removed from the building every night and precautions must be taken to avoid fire or indoor contamination. Paints may not be stored, mixed or applied in rooms which have installed finished flooring without taking necessary methods for protection.

#### 1.05 PROTECTION OF WORK

- A. Contractor shall provide drop cloths for protecting the floors and finishes from damage during the execution of the work. When necessary, the Contractor shall remove temporary coverings in order to execute the work and shall replace same in a proper manner. In case the covering cannot be replaced, the Contractor shall protect the work as necessary.
- B. Before painting, remove hardware, accessories, plates, lighting fixtures and other similar items or provide necessary protection of such items. Upon completion of

the work, remove protections and reinstall above items. Verify proper operation of affected items and replace damaged items as directed by the Architect.

- C. Contractor shall be responsible for staining of floors or other work, and must either entirely remove the stains or replace the stained materials with materials to match original condition as acceptable to the Architect.

#### 1.06 PROJECT CONDITIONS

- A. Conditions must fall within the paint manufacturers requirements, coordinate with below criteria, the more stringent shall apply.
  - 1. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are:
    - a. Exterior surfaces between 50 deg F and 90 deg F.
    - b. Interior surfaces between 60 deg F and 90 deg F.
  - 2. Apply solvent-thinned paints only when the temperature of exterior surfaces to be painted and surrounding air temperatures are between 45 deg F and 95 deg F.
  - 3. Interior and exterior painting shall not be performed when satisfactory results cannot be obtained due to high humidity, excessive temperatures or other conditions affecting application and performance.
    - a. Do not apply in snow, rain, fog, or mist.
    - b. Do not apply when the relative humidity exceeds 85 percent.
    - c. Do not apply at temperatures less than 5 deg F above the dew point
    - d. Do not apply to damp or wet surfaces.
- B. Do not apply paint in areas where dust is being generated or will be generated while the applied paint is drying.
- C. In rooms and spaces where paint is being applied, ensure there is adequate ventilation to allow for proper paint drying, as well as to exhaust paint fumes and minimize odors.

#### 1.07 WARRANTY

- A. The Contractor accepts the responsibility of providing proper workmanship, including but not limited to proper cleaning and preparation of surfaces, proper application of product based upon manufacturer's requirements, and acceptance that specified products are proper for the intended use. Contractor agrees that if paint system fails in any manner, it will be due to improper workmanship. Should any failure occur within the specified warranty period, the Contractor agrees to remedy the affected area(s). Work shall include removal of failing paint system (if necessary or if required by the paint system manufacturer), proper cleaning and preparation of surfaces, proper application of product(s) based upon manufacturer's recommendations and requirements, and use of proper products for intended use.
  - 1. The warranty described above shall cover a period of 2 years from the date of Substantial Completion.

2. An additional warranty shall be issued for areas that have failed and have been corrected. This additional warranty shall cover a period of 2 years from the date of acceptance of the corrected work.
- B. The warranty shall not deprive the Owner of other rights or remedies the Owner may have under other provisions of the Contract Documents, and is in addition to and runs concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

#### 1.08 ATTIC STOCK

- A. Furnish extra paint materials for Owners use:
1. Deliver to project site 1 gallon of each finish paint product in each color required for painting. Mark each container with color identification and room names, numbers, or areas where paint was used, without obscuring manufacturer's label.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Paints, varnishes, enamels, lacquers, stains, paste fillers and similar materials, must be delivered in their original containers with the seals unbroken and labels intact. Materials shall be used only as specified by the manufacturer's label on the container. Thinners and accessory materials shall be of best quality and of reputable brands.
- B. Material Compatibility: Furnish block fillers, primers, finish coat materials, and related materials that are compatible with one another and with the existing painted substrates, as demonstrated by the manufacturer, based on testing or field experience.
- C. Patching Material Compatibility: Furnish surface preparation products, including patching compounds, that are compatible with selected paint products.
- D. Gasoline, benzene or other materials not provided for under this specification shall not be brought on the job site.
- E. Colors shall be selected or approved by Architect. Colors shall be mixed as directed and sample panels shall be submitted for approval. Paint products shall be factory-tinted and not tinted on the job site.
- F. The completed work of the Contractor shall match colors and surface finishes of approved samples. The Contractor shall do additional mixing and blending as necessary to achieve this result.
- G. Rooms and spaces may have wall(s) painted a different color(s) than other walls in the same room. Ceilings, soffits, trim and reveals may be painted a different color(s) than the walls. Steel roof joists, bridging and related work may be painted a different color(s) than the roof deck in areas with exposed structural elements. Ductwork, conduits, piping and other mechanical/electrical items may be painted a different color(s) than surrounding items where such items are exposed.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Comply with the specifications and manufacturer's requirements for condition of surfaces.
  - 1. Conform with manufacturer's requirements for warranty to be furnished by the manufacturer.
- B. Surface preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified herein.
- C. Coordination of Work: Review other Sections in which primers are specified to ensure compatibility of the total system for various substrates.
- D. Test Reports: Review alkalinity, moisture, and adhesion test results.
  - 1. Provide required work and materials necessary to meet specification criteria, and provide for the manufacturer's warranty.
- E. Notify the Architect in writing a minimum of 14 days prior to painting, regarding anticipated problems using the specified materials over substrates previously finished with incompatible materials.
- F. Do not begin to apply paint or finishes until unsatisfactory conditions have been corrected.
  - 1. The application of paint or finishes shall be an indication of the Contractor's acceptance of the surface.

### 3.02 PREPARATORY WORK

- A. Preparatory work to be performed as indicated, and at a minimum shall be performed in strict accordance with coating manufacturer's requirements including applicable Society for Protective Coatings (SSPC) and the National Association of Corrosion Engineers International (NACE) standards.
- B. Surfaces to be painted shall be cleaned free of rust, dirt, foreign and deleterious materials before painting is started. Contractor shall do necessary preparatory work, sizing, sanding, etc. to produce a surface suitable to receive paint, natural finish, etc.
  - 1. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 2. Use an appropriate cleaner compatible with the coating systems and surfaces as approved by the coating system manufacturer. Properly repair or replace items damaged by this work if repair work is not acceptable to Architect. Properly protect areas and items not to receive above cleaning methods.
  - 3. Confirm compatibility of shop applied primers with specified finish coats to determine proper preparatory methods, and if a barrier primer coat is recommended by the coating system manufacturer.
- C. Knots, pitch streaks and sappy spots shall be first touched up with shellac or sealer where the finish calls for paint or enamel.
- D. Provide necessary filling of nail holes, cracks, etc., after the application of the first coat using a putty or filler of a color to match the finish. Putty and filler shall be brought flush with the adjoining surfaces in a neat and workmanlike manner.

Necessary filling and repair operations shall also be performed to produce a sound and suitable surface to receive the new paint and finish.

- E. Metal surfaces shall be first washed with appropriate solvent to remove any dirt or grease before applying materials. Where rust or scale is present, surfaces shall be properly cleaned and prepared as required by the manufacturer before painting.
  - 1. Rust shall be removed by sanding, wire brushing, etc.
    - a. Treat existing surfaces with a rust conversion primer/sealer compatible with the specified finishes.
  - 2. Shop coats of paint that become marred shall be sanded, cleaned, and touched up with required products. Necessary touch-up operations shall also be performed to produce a sound and suitable surface to receive the new paint and finish.
- F. Galvanized steel should be tested for pre-treatments using the procedure from the National Coil Coaters Association, Technical Bulletin No. II-9 or from ASTM D-2092, Method B201, Volume 06.01. Galvanized metal surfaces that has been treated for wet storage stain control must have the treatment removed prior to painting. If the metal has been treated, solvent clean the steel per SSPC-SP1 and apply a test patch. If adhesion is unacceptable, Brush-Off Blasting per SSPC-SP7/NACE No. 4 is required to remove the treatment.
- G. Existing glossy painted surfaces shall be washed thoroughly with a bi-sodium phosphate solution recommended by the paint manufacturer. Rinse, and allow to dry thoroughly. Properly repair or replace items damaged by this work if repair work is not acceptable to Architect. Properly protect areas and items not to receive above cleaning methods.
- H. Test substrates for proper adhesion of paint and finish. Provide manufacturer's recommended adhesion testing meeting ASTM D 3359 and/or ASTM D 667 as appropriate for substrate being tested.
- I. Test plaster, concrete, and concrete masonry surfaces scheduled to receive paint for alkalinity levels in order to confirm that surfaces do not exceed manufacturer's required alkalinity levels. Where alkalinity levels exceed required levels, provide manufacturer's proper high pH blocker primer.
- J. Test surfaces scheduled to receive paint for moisture levels in order to confirm that surfaces do not exceed manufacturer's required moisture levels.
- K. Where concrete and concrete masonry surface moisture levels exceed required levels, provide manufacturer's proper moisture blocker primer.
- L. All other non-metallic surfaces such as gypsum board, plaster, wood, finished woodwork, etc. follow manufacturer's written requirements.
- M. Test substrates for proper paint coverage. Provide manufacturer's recommended dry opacity testing meeting ASTM D 344.
- N. Following required preparatory work, Contractor shall inspect surfaces for suitability to receive the specified paint or finishes. The application of paint or finishes shall be an indication of the Contractor's acceptance of the surface.

### 3.03 APPLICATION

- A. Painting products shall be applied in strict accordance with manufacturer's requirements.

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1. Drying time of primer, initial finish coat, and subsequent finish coats is temperature and humidity dependent and must follow the manufacturer's requirements before any coats are applied.
2. Cure time of the completed coating application is temperature and humidity dependent and must follow the manufacturer's requirements for a fully cured painted surface before any further contractual work occurs to the painted surface, or that could adversely affect the painted surface.
  - a. Painted surfaces must be fully cured prior to installing items subject to direct contact with said surfaces.
- B. Materials shall be thoroughly mixed immediately before application of paint. Materials shall be evenly spread and smoothly flowed on without runs or sags or other defects.
- C. Painting and finishing shall not be done while surfaces are damp. Coats shall be thoroughly dry and cured before applying succeeding coats. Interior work except on masonry, pipe covering or other soft or rough surfaces, shall be sanded between coats with fine sandpaper to produce an even, smooth finish, unless otherwise specified.
- D. Final interior finish coat shall not be applied until other work has been finished and materials and debris have been removed and the premises have been left in a broom clean condition.
  1. Painted surfaces must be fully cured prior to installing items subject to direct contact with said surfaces.
- E. Final exterior finish coat shall not be applied until other work has been finished and materials and debris have been removed.
  1. Painted surfaces must be fully cured prior to installing items subject to direct contact with said surfaces.

#### 3.04 WORKMANSHIP

- A. Workmanship shall be of the very best. Only skilled mechanics shall be employed.
- B. Finish work shall be uniform and of approved color and shall be smooth, free from runs, sags and defective application. Edges of paint adjoining other materials or colors shall be sharp and clean, without overlapping. Before applying succeeding coats, primers and undercoats shall be completely integral and performing the function for which they are specified. Scratches, abrasions or any other disfigurements shall be properly prepared, sanded, and touched up, and any foreign matter removed before proceeding with the following coat.
- C. Paint shall be applied by a brush, roller or spray. Materials when brushed shall be evenly flowed on with brushes best suited for the type of material being applied. When using a roller, covers shall be of a type most suited for approved materials and textures. Spray applied paint shall be uniformly applied under pressure using recommended equipment.
- D. Apply paint to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks. Where applicable due to project conditions blend in with previously painted surfaces not indicated to receive new finishes.
  1. Finished surfaces shall have uniform color, dry opacity, and sheen.

### 3.05 CLEANING AND PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, and leave in an undamaged condition.
- B. Provide "Wet Paint" signs to warn occupants of and to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
- C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- D. At the end of each work day, remove empty cans, rags, cleaning pads, rubbish, and other discarded paint materials from the site.
- E. Just prior to final completion and acceptance, the Contractor shall examine painted and refinished surfaces and retouch or refinish as necessary and required to leave surfaces in perfect condition.
- F. Upon completion of work, painting contractor shall remove paint and varnish spots from floors and other surfaces and remove rubbish and accumulated materials of whatever nature not caused by other trades from premises and leave work in a clean, orderly and acceptable condition. Clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces or to generate dust.

### 3.06 SCHEDULE OF PAINTING

- A. Products listed on the SCHEDULE OF PAINTING have been recommended by the paint system manufacturers for the intended use and establish a level of quality. If the Contractor submits and/or uses the specified products, the Contractor agrees that the specified products are proper for the intended use. If the Contractor does not agree with the use of the specified products, and recommends the use of alternative products that meet or exceed the level of quality of the specified products, the Contractor shall submit written explanation and supporting data from the manufacturer for the proposed products. Only products confirmed in writing by the paint manufacturer that meet or exceed the level of quality of the specified products will be considered. If accepted, proposed products shall be covered under the provisions of the warranty.
- B. Painting and finishing to new and existing surfaces shall be done in accordance with the following schedule except as otherwise noted herein.
  - 1. Prior to application of finishes, perform proper cleaning and preparatory work, moisture/alkalinity/adhesion testing, etc. to all surfaces to be painted/coated as specified within this section. The application of paint or finishes shall be an indication of the Contractor's acceptance of the surface.
  - 2. Paint exposed surfaces unless noted otherwise. Exposed surfaces include areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
  - 3. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of permanently

- fixed equipment or furniture, paint surfaces behind such equipment or furniture with prime coat only.
4. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
  5. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
  6. Paint access panels, electrical panels, air diffusing outlets, supply and exhaust grilles, louvers, exposed conduit, primed hardware items, primed outlet covers, primed wall and ceiling plates and other items in painted areas to match the areas in which they occur unless otherwise directed by the Architect.
  7. Finish doors on tops, bottoms, and side edges the same as exterior faces.
  8. Sand lightly using low-dust emission wet methods between each succeeding enamel or varnish coat, and any other coating products meeting manufacturer's requirements.
  9. Do not paint prefinished surfaces.
- C. It is the intent that the indicated enumeration of coats on surfaces will give approved coverage coatings and each coat shall be applied heavy enough to obtain this result or additional coat(s) will be required at no additional cost. Finished surfaces shall have uniform color, dry opacity, and sheen.
- D. The indicated enumeration of coats is the minimum acceptable number of each item. Substitution of one heavy coat is not an acceptable substitution for two coats.
1. Each coat at a minimum must achieve the manufacturers recommended minimum dry film thickness for the specified item.
- E. Abbreviations shown are:
1. S-W = Sherwin-Williams
  2. PPG = PPG Paints
- F. Exterior Painting
1. Non-ferrous and galvanized metal, except pre-finished metal work, but including stacks, flues, vents, vent enclosures, fan enclosures, etc. on roof regardless of metal type; eggshell sheen finish, 2 finish coats over 1 primer coat:
    - a. Primer Coat
      1. S-W, Pro Cryl Metal Primer B66-310
      2. PPG, Pitt-Tech DTM Primer 90-712
    - b. First and Second Finish Coats
      1. S-W, Pro Industrial Zero VOC Acrylic B66 Series
      2. PPG, Pitt-Tech DTM Finish 90-374
    - c. Notes:

1. At flues and vents subject to high temperatures, in lieu of above provide manufacturer's high temperature resistant primer coat and finish coats to assure a proper, stable coating.
  2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
  3. Provide specified TSP cleaning to existing surfaces to remove dirt, grease, etc. before painting.
2. Galvanized ferrous metal including railings, guardrail assemblies, pipe bumpers, and wall mounted ladders; gloss sheen finish, 2 finish coats over 1 primer coat:
    - a. Primer Coat
      1. S-W, Pro Cryl Metal Primer B66-310
      2. PPG, Pitt-Tech DTM Primer 90-712
    - b. First and Second Finish Coats
      1. S-W, Pro Industrial Urethane Enamel B54 Series
      2. PPG, Glyptex Urethane Enamel PP4139
    - c. Notes:
    - d. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
  3. Ferrous metal, including but not limited to metal doors and frames; gloss sheen finish, 2 finish coats over shop primer coats:
    - a. First and Second Finish Coats
      1. S-W, Pro Industrial Urethane Enamel B54 Series
      2. PPG, Glyptex Urethane Enamel PP4139
    - b. Notes:
      1. Bare metal surfaces shall be touched up with manufacturers required primer before painting, confirm compatibility with shop primer coats
        - a. S-W, DTM Primer B66W1
        - b. PPG, Pitt-Tech DTM Primer 90-712
      2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
  4. Exposed structural steel, steel lintels, pipe bollards, railings and guardrails, metal doors and frames, wall mounted ladders, entrance skylight canopies including columns, plates, etc.; gloss sheen finish, 2 finish coats over 1 primer coat:

- a. Primer Coat
    - 1. S-W, Macropoxy 646 Fast Cure Epoxy B58 Series
    - 2. PPG, Amerlock 2 Epoxy
  - b. First and Second Finish Coats
    - 1. S-W, Acrolon 218 HS Acrylic Polyurethane B65 Series
    - 2. PPG, Amercoat 450H Polyurethane
  - c. Notes:
    - 1. Clean surfaces prior to application of finishes with:
      - a. S-W, Great Lakes Lab Extra Muscle Prepaint Cleaner
      - b. PPG, Dura Prep 120 Cleaner
    - 2. Galvanized surfaces to receive manufacturers required preparatory methods including any required barrier coats.
    - 3. Shop primed or existing painted surfaces to receive a barrier coat prior to application of Primer Coat:
      - a. S-W, ProIndustrial ProCryl Metal Primer
      - b. PPG, the specified Amerlock 2 Epoxy primer is a “surface tolerant” epoxy mastic that does not require a separate barrier coat over shop primed steel.
5. Precast concrete wall panels, concrete, and CMU; flat sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    - 1. S-W, Loxon Primer A24 series for Concrete and Masonry
    - 2. PPG, Permacrete 4-100 Concrete Block and Masonry Filler
  - b. First and Second Finish Coats
    - 1. S-W, Loxon XP A24 series
    - 2. PPG, Permacrete 4-22 100% Acrylic Coating
  - c. Notes:
    - 1. System to be installed per manufacturers requirements for a pure acrylic water-repellant coating system
    - 2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer’s proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
    - 3. Existing painted surfaces to be media blasted to remove paint down to bare concrete.
    - 4. Provide specified TSP cleaning to existing surfaces to remove dirt, grease, etc. before painting.

6. Exposed surfaces of concrete, and non-textured GFRC to receive textured acrylic elastomeric field applied coating system; flat sheen, fine sand texture finish, 2 finish coats over 1 primer coat:
  - a. Primer Coat
    1. PPG, Permacrete 4-2 High Build Acrylic Primer
    2. Dryvit Systems, Inc., Weatherprime Acrylic Primer
  - b. First and Second Finish Coats
    1. PPG, Permacrete 4-50 Texture Coatings Fine
    2. Dryvit Systems, Inc., Weatherlastic Sandpebble Fine
  - c. Note:
    1. System to be installed only after surface imperfections have been corrected, cracks have been treated, and proper preparatory work has been completed per manufacturer's requirements.
7. Finished wood trim, fascia, soffits, sills, siding, fencing, trash enclosures, etc.; Semi-Transparent Stain, 2 finish coats:
  - a. First and Second Finish Coats
    1. S-W, Woodscapes Semi-Transparent Exterior Stain
    2. PPG, Flood Pro Series, Semi-Transparent Stain, Acrylic/Oil
8. Finished wood trim, fascia, soffits, sills, siding, fencing, trash enclosures, etc.; Opaque Stain, 2 finish coats:
  - a. First and Second Finish Coats
    1. S-W, Woodscapes Solid Color Exterior Stain
    2. PPG, Flood Pro Series, Solid Color Stain, 100% Acrylic Latex

G. Interior Painting

1. Exposed ferrous metal work including but not limited to steel lintels, pipe bollards, railings and guardrails, metal doors and frames; semi-gloss sheen finish, 2 finish coats over shop primer coats:
  - a. First and Second Finish Coats
    1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd B34W08251
    2. PPG, Speedhide WB Alkyd 6-1510
  - b. Notes:
    1. Bare metal surfaces shall be touched up with manufacturers required primer before painting, confirm compatibility with shop primer coats
      - a. S-W, ProCryl Universal Metal Primer
      - b. PPG, Seal Grip 17-921 Acrylic Primer

2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
2. Metal work not primed; semi-gloss sheen finish, 2 finish coats over 1 primer coat:
    - a. Primer Coat
      1. S-W, ProCryl Universal Metal Primer
      2. PPG, Seal Grip 17-921 Acrylic Primer
    - b. First and Second Finish Coats
      1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd B34W08251
      2. PPG, Speedhide WB Alkyd 6-1510
  3. Structural steel, including associated plates, brackets, etc., steel joists, bulb tees, metal floor and roof deck; semi-gloss sheen finish, 2 finish coats over shop primer coats:
    - a. First and Second Finish Coats
      1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd B34W08251
      2. PPG, Speedhide WB Alkyd 6-1510
    - b. Notes:
      1. Bare metal surfaces shall be touched up with manufacturers required primer before painting, confirm compatibility with shop primer coats
        - a. S-W, ProCryl Universal Metal Primer
        - b. PPG, Seal Grip 17-921 Acrylic Primer
      2. At galvanized metal surfaces provide manufacturer's required Primer Coat before applying the 2 finish coats
        - a. S-W, DTM Primer B66W1.
        - b. PPG, Pitt-Tech DTM Primer 90-712
      3. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
  4. Concrete block surfaces; semi-gloss sheen finish, 2 finish coats over 1 primer coat:
    - a. Primer Coat
      1. S-W, Interior/Exterior Latex Block Filler
      2. PPG, Speedhide Block Filler 6-7
    - b. First and Second Finish Coats
      1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd, B34W08251
      2. PPG, Speedhide WB Alkyd 6-1510

- c. Notes:
  - 1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
- 5. Concrete block surfaces indicated to receive epoxy wall coating; semi-gloss sheen finish, 2 finish coats over 1 primer coat:
  - a. Primer Coat
    - 1. S-W, Heavy Duty Block Filler B42W46
    - 2. PPG, Speedhide Block Filler 6-7
  - b. First and Second Finish Coats
    - 1. S-W, Pro Industrial Pre-Catalyzed Waterbased Epoxy K46-150
    - 2. PPG, Pitt-Glaze WB1 Pre-Catalyzed Water-Borne Acrylic Epoxy 16-510
  - c. Notes:
    - 1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
- 6. Concrete block surfaces, indicated to receive epoxy wall coating; gloss sheen finish, 2 finish coats over 1 primer coat:
  - a. Primer Coat
    - 1. S-W, Heavy Duty Block Filler B42W46
    - 2. PPG, Speedhide Block Filler 6-7
  - b. First and Second Finish Coats
    - 1. S-W, Pro Industrial Water Based Catalyzed Epoxy B73 Series
    - 2. PPG, Aquapon WB Water Base Epoxy 98-101 Series
  - c. Notes:
    - 1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
- 7. Gypsum board, impact resistant cement board, plaster, acoustic diffuser ceiling and wall panels, spandrel panels, MDF panels, wood trim indicated to be painted, etc.: finish sheen as noted, 2 finish coats over 1 primer coat:
  - a. Primer Coat
    - 1. S-W, ProMar 200 Zero VOC Interior Latex Primer B28W2600
    - 2. PPG, Speedhide Zero VOC Interior Latex Primer 6-4900xi

- b. First and Second Finish Coats
    - 1. S-W, ProMar 200 Zero VOC Interior Latex B20W12651 / B30W02651
    - 2. PPG, Speedhide Zero VOC Interior Latex 6-4340xi / 6-4110xi
  - c. Notes:
    - 1. Walls and trim to have eggshell sheen finish, ceilings and soffits to have flat sheen finish.
    - 2. MDF panels to have coatings spray applied to achieve the desired results.
    - 3. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
8. Gypsum board surfaces indicated to receive epoxy wall coating; eggshell sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    - 1. S-W, ProMar 200 Zero VOC Wall Primer B28W2600
    - 2. PPG, Speedhide Zero VOC Primer 6-4900xi
  - b. First and Second Finish Coats
  - c. First and Second Finish Coats
    - 1. S-W, Pro Industrial Pre-Catalyzed Waterbased Epoxy K45-150
    - 2. PPG, Pitt-Glaze WB1 Pre-Catalyzed Water-Borne Acrylic Epoxy 16-310
  - d. Notes:
    - 1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
9. Faces and edges of wood base, trim, field finished wood doors, etc., to receive stain finish; satin top coat sheen finish, 3 finish coats over 1 stain coat:
- a. Stain Coat
    - 1. S-W, Wood Classics 250 Oil Stain A49 Series
    - 2. PPG, Deft Oil Based Stain DFT 400
  - b. First and Second Finish Coats, and Third Finish Top Coat (Satin)
    - 1. S-W, Wood Classics WB Poly Satin
    - 2. PPG, Deft WB Poly Satin DFT 157
  - c. Notes:

1. Sand lightly between finish coats per manufacturers requirements.
10. Insulation covering of exposed piping in finished areas; flat sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    1. S-W, ProMar 200 Zero VOC Interior Latex Primer B28W2600
    2. PPG, Speedhide Zero VOC Interior Latex Primer 6-4900xi
  - b. First and Second Finish Coats
    1. S-W, ProMar 200 Zero VOC Interior Latex B30W02651
    2. PPG, Speedhide Zero VOC Interior Latex 6-4110xi
  - c. Notes:
    1. Verify and coordinate compatibility of finish materials with insulation covering materials and provide necessary products for a complete and proper finish.
    2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
11. Exposed uncovered piping, electrical conduit, wiremold, gas lines, unfinished radiation and heating units, in finished areas; low sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    1. S-W, ProCryl Universal Metal Primer
    2. PPG, Seal Grip 17-921 Acrylic Primer
  - b. First and Second Finish Coats
    1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd B33W08251
    2. PPG, Speedhide WB Alkyd 6-1410
  - c. Notes:
    1. At galvanized metal surfaces provide manufacturer's required Primer Coat before applying the 2 finish coats
      - a. S-W, DTM Primer B66W1
      - b. PPG, Pitt-Tech Plus DTM Primer 90-912
    2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
12. Exposed galvanized sheet metal, including ductwork, in finished areas; flat sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    1. S-W, DTM Primer B66W1

2. PPG, Pitt-Tech Plus DTM Primer 90-712
- b. First and Second Finish Coats
    1. S-W, ProMar 200 Zero VOC Interior Latex B30W02651
    2. PPG, Speedhide Zero VOC Interior Latex 6-4110xi
- c. Notes:
    1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.

END 09 91 00

## SECTION 01 11 00 - SUMMARY OF WORK

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. Work covers HVAC improvements at Washington Elementary School, Lincoln Middle School, Flinn Middle School, and East High School in the Rockford School District No. 205..

#### 1.2 CONTRACTS

- A. Project shall be constructed under a single contract(s) that shall include the General, HVAC, Piping and Plumbing, and Electrical work.

#### 1.3 WORK OF CONTRACTORS

- A. In addition to fulfilling Contract Requirements, Contractor shall fulfill the requirements of all drawings, specifications, and the requirements of the General Conditions, Supplementary Conditions, and Division 1, General Requirements, all of which are hereby made a part of each division and section of the project specifications.
- B. Contractor shall provide work and/or services as may be specified in all the respective specification sections and/or indicated on the drawings for all divisions of work. Contractor shall review specification sections and drawings for all divisions of work to determine extent of work and/or services each section requires for other divisions as well as its own division of work.

#### 1.4 WORK BY OWNER

- A. Items not in contract: Asbestos abatement
- B. Owner to remove and/or retain: Turn over existing equipment to Owner where noted on the drawings.

#### 1.5 CONTRACTOR'S USE OF SITE

- A. Access: Hours of access shall be as allowed by RSD 205, typically 6am to 5pm.
- B. Time restrictions for performing work: All work performed during the school year must be coordinated directly with the Owner and coordinated with the school schedule to be determined whether the work can occur.
- C. Utility outage and shutdown: Coordinate all utility shutdowns with the Owner two weeks in advance.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 11 00

## SECTION 01 21 00 - ALLOWANCES

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF REQUIREMENTS

A. Types of allowances scheduled herein for the work include the following:

1. Owner Contingency Allowance in accordance with the following paragraph:

- a. Contingency allowance shall be used only as directed for Owner's purposes, and only by change orders that designate amounts to be charged to contingency allowance carried by the Owner. Contractor's related costs are not included in the Contract Sum for work so ordered to be charged to contingency allowance. The change orders will include costs and allowable overhead/profit margins. At time of project closeout, unused amounts remaining in contingency allowance shall remain the Owner's.

### PART 2 - PRODUCTS (Pre-ordered items assigned to Contractor)

### PART 3 - EXECUTION

#### 3.1 SCHEDULE OF ALLOWANCES

A. Contingency Allowances to be included in General Contractor's Base Bid:

1. None.

B. Lump Sum Allowances:

1. None.

END OF SECTION 01 21 00

## SECTION 01 23 00 - ALTERNATES/ALTERNATIVES

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and other Division 1 specification sections, apply to this section.

#### 1.2 SUMMARY

- A. This section specifies administrative and procedural requirements for alternates.
- B. Definition: An alternate is an amount proposed by Bidders and stated on the Bid Form for certain construction activities defined in the Bidding Requirements that may be added to or deducted from the Base Bid amount if the Owner decides to accept a corresponding change in either the amount of construction to be completed, or in the product, material, equipment, systems, or installation methods described in the Contract Documents.
- C. Coordination: Coordinate related work and modify or adjust adjacent work as necessary to ensure that work affected by each accepted alternate is complete and fully integrated into the project.
- D. Notification: Immediately following the award of the Contract, prepare and distribute to each party involved, notification of the status of each Alternate. Indicate whether Alternates have been accepted, rejected or deferred for consideration at a later date. Include a complete description of negotiated modifications to Alternates.
- E. Schedule: A "Schedule of Alternates" is included under Part 3 of this Section. Specification sections referenced in the Schedule contain requirements for materials and methods necessary to achieve the work described under each Alternate.
  - 1. Include as part of each Alternate, miscellaneous devices, accessory objects, and similar items incidental to or required for a complete installation, whether or not mentioned as part of the alternate.

### PART 2 - PRODUCTS (Note Used)

### PART 3 - EXECUTION

#### 3.1 SCHEDULE OF ALTERNATES

- A. Alternate Bid No. 1: East High School - All work associated with installing air conditioning within the existing air handling units that serve the Fieldhouse as shown on the drawings.

- B. Alternate Bid No. 2: East High School - All work associated with replacing the existing HVAC system within the 1980 Addition as shown on the drawings. Base Bid will leave this area as existing to remain.

END OF SECTION 01 23 00

## SECTION 01 31 19 - PROJECT MEETINGS

### PART 1 - GENERAL

#### 1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 1 specification sections apply to this section.

#### 1.2 SUMMARY

- A. This section specifies administrative and procedural requirements for project meetings including but not limited to:
  - 1. Preconstruction conference.
  - 2. Coordination meetings.
  - 3. Progress meetings.
  - 4. Construction schedule.

#### 1.3 PRECONSTRUCTION CONFERENCE

- A. Architect will schedule a preconstruction conference and organizational meeting at the project site or other convenient location no later than 15 days after execution of the Agreement between Owner and Contractor and prior to commencement of construction activities. Architect will conduct the meeting to review responsibilities and personnel assignments.
- B. Attendees: The Owner, Architect, Contractor and superintendent, major subcontractors, manufacturers, suppliers, and other concerned parties shall each be represented at the conference by persons familiar with and authorized to conclude matters relating to the work.
- C. Agenda: Discuss items of significance that could affect progress, including such topics as:
  - 1. Tentative construction schedule.
  - 2. Critical work sequencing.
  - 3. Designation of responsible personnel.
  - 4. Procedures for processing field decisions and Change Orders.
  - 5. Procedures for processing Applications for Payment.
  - 6. Distribution of Contract Documents.
  - 7. Submittal of shop drawings, product data, and samples.
  - 8. Preparation of record documents.
  - 9. Use of the premises.
  - 10. Office, work and storage areas.
  - 11. Equipment deliveries and priorities.
  - 12. Housekeeping.
- D. Architect will record and issue preconstruction conference meeting minutes.

#### 1.4 COORDINATION MEETINGS

- A. Contractor shall conduct project coordination meetings on an as-needed basis convenient for all parties involved. Project coordination meetings are in addition to specific meetings held for other purposes, such as regular progress meetings and special pre-installation meetings.
- B. Contractor shall request representation at each meeting by every party currently involved in coordination or planning for the construction activities involved.

#### 1.5 CONSTRUCTION PROGRESS MEETINGS

- A. Contractor shall conduct construction progress meetings at the project site at intervals convenient for all parties involved. The meetings for the duration of the project will be regularly scheduled at the pre-construction conference.
- B. Attendees: In addition to representatives of the Owner and Architect, each Subcontractor, supplier or other entity concerned with current progress or involved in planning, coordination, or performance of future activities shall be represented at these meetings by persons familiar with the project and authorized to conclude matters relating to progress.
- C. Contractor's Construction Schedule: Review progress since the last meeting. Determine where each activity is in relation to the Contractor's Construction Schedule, whether on time, ahead of, or behind schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the contract time.
- D. Review the present and future needs of each entity present, including such items as:
  - 1. Interface requirements
  - 2. Time
  - 3. Sequences
  - 4. Deliveries
  - 5. Off-site fabrication problems
  - 6. Access
  - 7. Site utilization
  - 8. Temporary facilities and services
  - 9. Hours of work
  - 10. Hazards and risks
  - 11. Housekeeping
  - 12. Quality and work standards
  - 13. Change orders
  - 14. Documentation of information for payment requests
- E. Contractor shall record and issue meeting minutes for all construction progress meetings to all attendees and parties involved.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 31 19

## SECTION 01 50 00 - CONSTRUCTION FACILITIES & TEMPORARY CONTROLS

### PART 1 - GENERAL

#### 1.1 JOB CONDITIONS AND WORK SEQUENCE

- A. Contractor(s), Subcontractor(s), and Material Supplier(s) shall inform themselves as to conditions relating to the execution of work. Neglect of this requirement will not be accepted as cause for additional compensation and/or additional time for completion.
- B. Existing building will remain in operation during construction. Contractor shall schedule work in consultation with the Owner so there will be no interruption of existing building operations.

#### 1.2 SITE EXAMINATION

- A. The Contractor shall take all measurements related to the existing building as required for the new work and to locate existing utilities. Contractor shall contact the City, Owner, and all utilities to carefully review all records of exposed, concealed, and buried points of connections, as to location, size, type, depth, operating characteristics, etc., including but not limited to, electrical service, telephone service, and water, gas, and sewer lines.

#### 1.3 GRADES, LINES, AND LEVELS

- A. The Contractor shall lay out the building and establish all lines and levels for the work as required by drawings and specifications. The General Contractor shall maintain proper base lines, levels, and benchmarks outside or inside the building, where necessary, for the use by all trades.
- B. Each trade shall lay out and establish at the job all other lines and levels necessary for own work.
- C. The Contractor is responsible for coordination of work by all trades to ensure that potential conflicts are eliminated prior to installation beginning.

#### 1.4 SUBMITTAL PROCEDURES FOR SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES

- A. Shop Drawings:
  - 1. Each Contractor shall prepare and submit shop drawings, where requested, to the Architect for review. All shop drawings shall bear verification of Contractor's review and approval prior to submittal. No work shall be fabricated by the Contractor except at Contractor's own risk, until shop drawings have been reviewed in accordance with review procedure.
  - 2. Unless otherwise specified in the respective specification sections of Division 1 through 31, the Contractor shall submit one (1) reproducible transparency and three (3) opaque prints of all fabricated work and line type shop drawings to the Architect for review. The reviewed reproducible transparency will be returned to the Contractor for reproduction and distribution purposes. For products covered by catalog cuts or brochures, unless

otherwise specified, the Contractor shall submit a minimum of eight (8) copies of each item for review.

3. Corrections or changes indicated on shop drawings shall not be considered as extra work orders. Final drawings will be considered reviewed only if they bear the stamp and signature of Architect.
4. Contractor shall be responsible for final distribution of reviewed shop drawings to the various Subcontractors or Trades.

B. Samples:

1. The Contractor shall furnish for review, with reasonable promptness, all samples as directed by the Architect. The Architect will review such samples, with reasonable promptness, only for conformance with the design concept of the project and for compliance with the information given in the Contract Documents. The work shall be in accordance with reviewed samples approved for design concept conformance.
2. The Contractor shall submit transmittal letter requesting sample review and prepay transportation charges to Architect's office on samples forwarded.
3. The Contractor shall order no material until receipt of written approval of shop drawing submitted.

1.5 SITE LIMITS AND MATERIALS STORAGE

- A. Space Limitations: No areas outside construction limits may be used for any purpose by Contractor(s) or Subcontractor(s).
- B. Contractor(s) or Subcontractor(s) shall not store their materials or equipment on the structure or permit any part of any structure to be loaded to such an extent as to endanger its safety.
- C. Contractor(s) and Subcontractors(s) shall confine equipment, storage of materials, parking, and operations of their workers to limits indicated or by direction of Architect. Storage space will be confined to area of site.
- D. Store, place, and handle material and equipment delivered to job site to preclude inclusion of foreign substances or causing of discoloration. Pile neatly and compactly; barricade to protect public from injury. Protect materials as required to prevent damage thereto from weather or the ground. Should it be necessary at any time to move materials, sheds, or storage platforms, Contractor shall move same, as and when required, at Contractor's expense.
- E. Owner assumes no responsibility for materials stored in buildings or on site. Contractor assumes full responsibility for damage due to storage of materials.
- F. Repairing of areas used for parking, placing of sheds, offices, and storage of materials shall be done by Contractor at Contractor's expense.
- G. Contractor's personnel shall not use the existing building for any purpose except as required to perform the work of this Contract unless otherwise specified.

## 1.6 CLEANING

- A. General Cleaning: The Contractor and each Subcontractor shall remove rubbish and debris from the building site promptly as it accumulates but, in any case, not less frequently than each Friday afternoon. The Contractor shall perform an overall cleanup of the entire site including a broom cleaning of all appropriate surfaces as required but, in any case, not less frequently than each Friday afternoon.
- B. No burning of rubbish or debris will be allowed at site, nor shall rubbish at any time be thrown from structure. No debris shall be buried at the site. Do not dispose of wastes into streams or waterways.
- C. All dumpsters used on the project site shall have lids or canvas covers securely fastened to prevent debris from blowing about site.
- D. Keep streets and public roadways clean of dirt and mud tracked onto such surfaces by vehicles or equipment used or parked on construction site.

## 1.7 PROTECTION

- A. The Contractor shall:
  - 1. Provide, and maintain fences, planking, guard lights, barricades, warning signs, and guards as necessary for protection of material storage, curbs, sidewalks, streets, drives, and adjoining property, public, and new building. Use caution at all times to protect persons against injury resulting from job operations, movement of materials, and standing equipment.
  - 2. Notify in writing, the Owners of corporate or private property that interferes with work and arrange with them for disposition of such property.
  - 3. Provide and maintain proper shoring and bracing to prevent earth from caving or washing into excavation, and/or undermining present building. Provide temporary protection around openings through and at floors and roofs.
  - 4. Provide and maintain proper shoring and bracing for existing underground utilities, sewer, etc., encountered during excavation work, to protect them from collapse or other type of damage until they are to be removed, incorporated into work of new building, or can be properly backfilled upon completion of new work.
  - 5. Protect trees, shrubs, lawn, and landscape work from damage. Provide guards and covering. Provide and maintain plank covering over walks, drives, newly installed service facilities, etc., to prevent damage by trucking or otherwise. This shall include areas outside of grading and/or construction limits.
  - 6. Provide protection against rain, snow, wind, ice, storms, or heat to maintain work, materials, apparatus and fixtures free from damage. At the end of a day's work, cover new work likely to be damaged. Remove snow and ice, as necessary for safety and proper execution of work.
  - 7. Protect building from damage at all times from rain water, ground water, backing up of drains or sewers and other water. Provide pumps, equipment, and enclosures to provide this protection.
  - 8. Provide temporary fence or barricade at least 5'-0" high. Snow fencing or similar type fencing acceptable. Posts for fencing shall be spaced a maximum of 10'-0" OC.

- B. Each Contractor and Subcontractor shall protect own materials, work, and equipment not normally covered by above protection; protect work of other trades, adjust damage when performing work; protect work outside of building lines such as trenches and excavations, as specified above; when performing work, maintain protection provided above. Contractor causing damage to any work shall repair or replace damaged work at Contractor's expense.
- C. Work outside of property line shall be repaired in accordance with requirements of authority having jurisdiction.
- D. Provide temporary dust barriers as required to protect existing areas during work of the contract.

#### 1.8 TEMPORARY OFFICES/TRAILERS, EQUIPMENT AND SHEDS

- A. Offices/Trailers: The Contractor shall provide and maintain temporary watertight office of suitable size for use by Contractor, Subcontractors, and Architect. Contractor's space shall be as required for general use and to provide space and furnishings for project meetings. Telephone service in this office, local and long distance, shall be paid for by the Contractor. Location of office/trailer shall be approved by the Owner.
- B. Equipment: The Contractor shall provide and maintain a plain paper copier, telephone, and fax machine in the office for use by the Architect for job related business. The operating cost of all electronic equipment shall be paid for by the Contractor.
- C. Sheds: The Contractor and each Subcontractor shall provide sheds for storing tools and materials. Storage sheds shall be watertight and storm proof, and shall have floors raised above ground. The Contractor and each Subcontractor will be held responsible for water or storm damage to stored tools or materials.

#### 1.9 ENCLOSURES

- A. Definitions of Enclosures:
  1. Temporary: Sufficient preliminary enclosures of an area or structure, or of an entire building, to prevent entrance or infiltration of rain water, wind, and other elements, and which will prevent undue heat loss from within enclosed areas.
  2. Permanent: Stage of construction at which all moisture and weather protection elements of construction have been installed in accordance with the Contract, either for a portion of structure or for entire building.
- B. The Contractor shall construct temporary enclosures as required during construction in areas where interior work may proceed.
  1. Temporary enclosures shall be provided and maintained by the Contractor until the areas temporarily enclosed become permanently enclosed.
  2. The Contractor shall remove temporary enclosures at completion of construction or when directed by Architect.

3. Temporary enclosures shall consist of fire resistive plywood panels or one layer of 3-ply fire resistive, reinforced polyethylene film fastened to wood framework, consisting of fire resistant 2" x 4" fire resistive wood studs spaced 24" OC, securely spiked to wood plates top and bottom. Provide fire resistive intermediate girts between studs as required for fastening of plywood or film.
4. Make suitable provisions for passage of air to permit proper drying out of building.
5. Windows will not require temporary enclosures if glazed promptly when approved. If Contractor considers it impractical or is unable to glaze windows when approved, Contractor shall provide temporary enclosures as specified above.
6. At the end of the day's work, the Contractor shall securely close temporary enclosures, supervise effectiveness of enclosures, see that every precaution is used to prevent unnecessary escape of temporary heat, and take additional precautions as may be directed by Architect.

#### 1.10 CONSTRUCTION HEAT AND VENTILATION

- A. The Contractor shall provide construction heat and ventilation as specified in enclosed areas throughout construction period as required to:
  1. Facilitate progress of work.
  2. Protect work and products against dampness and heat.
  3. Prevent moisture condensation on surfaces.
  4. Provide suitable ambient temperatures for installation and curing of finish materials.
  5. Provide adequate ventilation to meet health regulations for safe working environment.
  6. Prevent hazardous accumulations of dusts, fumes, mists, vapors, or gases in areas occupied during construction.
- B. The Contractor shall maintain, as construction heat, an even temperature of at least 60°F in the building or buildings under construction for all trades.
  1. No salamanders or open fires will be permitted in the building or buildings.
- C. The Contractor shall provide own fuel, apparatus, and heat as necessary for the thawing or heating of frozen ground and material, and in the case of the latter, sufficient heat shall be maintained until material incorporated in construction has set and all danger of frost has passed.
- D. The Contractor shall furnish, install, maintain, and operate oil or gas-fired, blower type portable heating units for providing construction heat.
  1. Heating units shall be self-contained units and furnished in sufficient number and adequate capacity to conform to the requirements for construction heat stated above.
  2. Ventilation shall be adequate for specific operations, but not less than one (1) air change per hour in work areas.
  3. Each heating unit shall be properly vented if required to dissipate noxious fumes and prevent discoloration of building construction.
  4. Each heating unit shall be provided with the normal safety devices to prevent injury to building and workers.
  5. All oil or gas-fired equipment and methods used for construction heat, shall be presented to the Architect for review.
  6. All fuel oil and gas for self-contained units shall be provided and paid for by the Contractor.

- E. The Contractor, at all times, will be held responsible for the damage to all materials and work due to insufficient heat. The Contractor shall also remove all construction heating equipment upon conclusion of its use.
1. NOTE: No new permanent equipment shall be used for construction heating unless in the opinion of the Architect's representative, the building and the mechanical work has progressed to a stage where the use of the new heating equipment would be expedient and permanent. The Contractor shall pay for all maintenance and attendance required for the permanent heating system up to the time of Substantial Completion. The Contractor shall pay the cost of fuel for the permanent system up to the time of Substantial Completion. The percentage of the utility bill to be paid by the Contractor shall be determined by the percentage of square footage of the total building that is being used for construction purposes as opposed to that being occupied by the Owner.
- F. The Subcontractor for the heating work shall have the heating system and units, as described by the Contract Documents, in place and ready for operation as soon as the Contractor has enclosed the building with glass and temporary wood doors that can be locked, has completed all interior masonry partitions, and has swept the building clean inside. The Subcontractor for the heating work shall, at this time, make available the contractual heating system for the purposes of construction heat and ventilation.
- G. The Subcontractor for the heating work shall provide specified filters in all air handling units before same are started up for use in furnishing construction heat and ventilation and shall maintain clean filters in the units for duration of construction heat and ventilation period. No fan units shall be run for construction heat without filters.
- H. Failure of the Subcontractor for heating work to make available the contractual central heating system shall in no way relieve the Contractor of the responsibility to provide heating and ventilating protection for all work.
- I. The Subcontractor for electrical work shall provide electrical services to the contractual heating units when they are ready for use.
- J. When the building is ready to be accepted by the Owner, the Subcontractor for heating work shall leave the heating system and units clean and in proper and acceptable condition. All fan units for construction heat shall be provided with new filters by Subcontractor for heating and ventilating work.
- K. Guarantee period for contractual heating system and units shall not begin until date of Substantial Completion.
- L. The Contractor shall provide, without cost to the Owner, such ventilation as may be necessary during construction to adequately dry out the construction, and prevent the buildup of fumes, humidity, gases, etc., that may be detrimental to the construction. This will not alter any other provisions of this specification.
- M. Contractual duct systems shall not be used during construction unless such use is authorized in writing by the Architect.

## 1.11 CONSTRUCTION ELECTRICITY

- A. The Contractor shall make the necessary application, pay all fees and charges, including power consumed, take out all permits and provide and maintain construction electric power service from sources other than the Owner, for power and light for all electric machinery and lights required for carrying on the work of all trades. Power service requirements shall be coordinated with all Contractors and be of size, phase, and voltage required for construction purposes, but in no case shall be less than 400 amp, single phase, 120/240 volts, located at temporary office area with a separate meter. At the Owner's option, the Contractor may be permitted to pay all fees and charges including power consumed, take out all permits and provide and maintain construction electric power service by extending from the Owner's source and providing a separate meter.
- B. Existing power sources may be used for work in areas to be remodeled. The Contractor shall provide and maintain construction electricity as required for the Work by extending power feeder switches, etc., from the Owner's existing system. Owner will pay cost of power used. Do not connect any equipment requiring more than 110 volts to Owner's system.
- C. During the construction period, the Contractor shall provide and pay for all wiring, switches, outlets, lamps, etc., required to provide construction electric service for light and power throughout the building and shall maintain these services as the work progresses, providing the necessary temporary feeders and extensions therefrom to provide sufficient construction lighting and power in all spaces as required for carrying on the work of all contracts.
- D. All temporary wiring shall be erected and maintained by the Contractor in accordance with rules of the Underwriters Laboratory and the local electrical utility company, and shall be arranged as not to interfere with the progress of the work throughout the building. Remove all temporary wiring, etc., upon conclusion of its use.
- E. Until permanent services are available, the Contractor shall provide construction electric services to all points not more than 50 feet from where the work is in progress. All extensions, controls, and equipment beyond the point of construction electric services shall be provided under the work of the respective contractors requiring such extensions. Subcontractors shall make their own arrangements with the Contractor for lighting their construction offices, sheds, or fabrication shanties.
- F. The Contractor shall provide wiring for single phase power for electric construction lighting and for normal equipment used by the various Subcontractors or trades.
- G. If a Subcontractor requires power different than initially agreed, Contractor shall arrange and pay for the necessary wiring and power needed.
- H. Heavy equipment such as welders, winches, air compressors, etc., shall be gasoline driven or energized from gasoline or diesel engine generators. This equipment shall be furnished and the fuel paid for by the party who requires this equipment.
- I. The Contractor shall maintain general lighting in all spaces not receiving sufficient daylight as required for safety. The Contractor shall furnish and maintain lamps required to properly light the work.

- J. Use of the permanent electrical system will be permitted for construction purposes as soon as use of construction services becomes impractical. However, any use of the permanent electrical system before the project is completed or accepted by the Owner, shall be subject to the approval of the Owner or Architect. If the permanent systems are permitted to be used prior to acceptance by the Owner, the Contractor shall remove all temporary work as rapidly as allowed by the installation of the permanent work. As the permanent electrical systems are put into service, the Contractor shall replace all burned out bulbs, tubes, and all other damaged elements, fixtures, receptacles, etc., and turn the entire system over to the Owner, whole and undamaged.

#### 1.12 CONSTRUCTION TELEPHONES AND FAX

- A. Cost of installation, removal, and all service charges for telephones and fax lines in the construction trailer shall be paid by the Contractor.

#### 1.13 CONSTRUCTION WATER AND SEWER

- A. The Contractor shall make arrangements for and furnish, at Contractor's expense, from sources within existing building, all water required for drinking and construction purposes, and shall install and maintain necessary supply connections and piping for same at such locations and in such manner as may be approved by Architect. Before final acceptance, temporary connections and piping shall be removed by the Contractor in a manner acceptable to the Architect.

#### 1.14 CONSTRUCTION TOILETS

- A. The Contractor shall construct and maintain, in such manner and location as the Architect may approve, temporary toilet facilities for use by all personnel engaged in the work. Toilet facilities shall have approved plumbing fixtures and shall be serviced twice weekly; including emptying tanks, recharging with a germicidal and deodorizing solution, and scrubbing entire interior with a germicidal solution. Portable chemical units will be acceptable if they meet the above conditions. Permanent toilets shall not be used for temporary toilet facilities.

#### 1.15 TEMPORARY STAIRS, LADDERS, RAMPS, AND RUNWAYS

- A. Contractor shall provide and maintain temporary stairs, fixed ladders, ramps, chutes, and runways as required for proper execution of work by all trades.

#### 1.16 TEMPORARY ROADWAYS AND PARKING

- A. Contractor shall construct temporary access roads and parking area with limestone as required for the work of the project. Temporary roads and parking areas shall be located only where finished roads and parking areas are to be constructed and shall be maintained until building is complete or finish surfaces are installed.
- B. The Contractor shall construct parking area and access roads from the streets to the building with limestone. After completion of the building, Contractor shall scrape clean and level, leaving site ready for the finish grading, walks, drives, etc., as called for. The temporary roadway shall remain until all phases of construction have been completed.
- C. Construction personnel may park vehicles on site (within the limits of construction area) as directed by Owner.

1.17 PROJECT SIGN

- A. The Contractor shall provide and maintain in good condition, a 4' x 8' x 3/4" thick exterior grade plywood sign. This sign shall contain the name of the Institution, Owner, Architect, and General Contractor. The sign shall remain until all phases of construction have been completed. No other signs will be permitted on the site, other than the Contractor's name on trailer or on the construction building.
- B. Paint the entire sign, frames, and supports, with a primer coat and one finish coat of oil-based paint; colors as directed by the Architect.

1.18 REPLACEMENT OF BROKEN GLASS

- A. Contractor shall be held responsible for damaged, broken, or scratched glass and at completion of contract shall replace such glass without cost to Owner. Include existing glass damaged, broken, or scratched due to work of Contract.
- B. In general, glass which is merely cracked will be considered damaged due to faulty setting and shall be replaced by glass installer.
- C. It shall be the Contractor's prerogative to charge cost of replaced glass to the party responsible. Building shall be turned over to Owner with glazing work complete and in perfect condition.

1.19 MANUFACTURER'S DIRECTIONS

- A. The Contractor shall apply, install, connect, erect, use, clean, and condition manufactured articles, materials, and equipment as directed by manufacturer unless specified to contrary.

1.20 CUTTING AND PATCHING

- A. Cutting and patching requirements specified herein, apply to all sections and divisions of the specifications, and all drawings covering demolition, remodeling, and new construction work to be performed by the Contractor and Mechanical and Electrical Subcontractors.
- B. All on site welding shall conform to the requirements and techniques of FM Global Engineering Division.
- C. Portions of the existing structure where existing work is to be demolished or removed, and where new work is to be done, connections made, materials handled, or equipment moved and relocated, shall be temporarily protected. Temporary protection shall be such that the interior of existing structure will at all times be protected from dust and weather inclemency and interior heat and/or air conditioning conserved. Temporary openings in exterior walls shall be protected by temporary weatherproof closures. Contractor will be held responsible for any damage to the existing structure or contents due to the insufficiency of such protection.
- D. Cutting and Patching Requirements:
  - 1. Where new work connects with present building and where remodeling of existing work occurs, the Contractor shall do all cutting, notching, keying, removal and trimming of existing construction required to make connections between the new and the old work and shall do all patching, repairing or refinishing of cut and immediately adjacent

surfaces to provide a finish in conformance with industry standards and appropriate to finish materials intended to be used.

2. Holes through existing floors, walls, and roofs for Mechanical and Electrical work shall be cut, patched, sealed, fire proofed, and flashed by the trade requiring the opening.
  3. Before breaking of surfaces, cut primary saw-cut 1" to 1-1/2" deep around areas where portions of work will be removed. Lines shall be straight.
  4. Materials and workmanship employed in patching, repairing, or refinishing existing surfaces and/or involving new construction shall conform to that of original work, unless otherwise shown or specified.
  5. Clean existing surfaces remaining exposed as a result of demolition work and/or new construction. Clean entire wall faces, floor surfaces, column faces, etc., using sandblasting, wire brushing, or carborundum wheel. Where dovetail or other insert slots are exposed, they shall be filled with grout.
- E. Keep property adjacent to buildings clean and free from accumulation of rubbish. Remove excess debris resulting from demolition operations, as it accumulates.
- F. Walls, floors, etc., required to carry the excess weight of stored materials and equipment during demolition, removal and remodeling work, or which will be subjected to undue pressure from waste material, shall be shored or braced to withstand these excess loads.

#### 1.21 CODE REQUIREMENTS

- A. The Contractor shall conform to all requirements of local, state, and national codes, laws, ordinances, and utility company requirements and other regulations having jurisdiction over this installation.
- B. If there is a discrepancy between the codes and regulations having jurisdiction over this installation and these specifications, the codes and regulations shall determine the method of the Work.
- C. If the Contractor notes, at the time of bidding, any parts of the drawings and specifications that are not in accord with the applicable codes or regulations, Contractor shall inform the Architect in writing, requesting a clarification. If there is insufficient time to allow this procedure, Contractor shall submit, with proposal, a separate price required to make the system shown on the drawings comply with the codes and regulations.
- D. All changes to the system made after the letting of the contract in order to comply with the applicable codes or requirements of the Inspector, shall be made by Contractor without cost to the Owner.

#### 1.22 PROGRESS SCHEDULE

- A. Immediately after being awarded the contract, the Contractor shall prepare an estimated Progress Schedule and submit same for the Architect's approval. It shall indicate the dates for the starting and completion of the various stages of construction.

## 1.23 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
1. General Contractor shall erect and maintain dust barriers throughout the construction work. These barriers shall be reasonably airtight and shall prevent entry into the construction zone by unauthorized persons. Reasonably airtight means construction equivalent to full-height temporary or permanent walls with joints taped or sealed, and shafts and other penetrations sealed as well as possible. Fire resistant polyethylene is acceptable; if flame spread/smoke developed ratings are demonstrated to conform to the applicable building codes and licensing acts.
  2. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
    - a. Minimizing the amount of dust generated.
    - b. Reducing solvent fumes and VOC emissions.
    - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
  3. Request that the Owner designate an IAQ representative.
  4. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
  5. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
  6. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
  7. Request copies of and follow all Owner's IAQ and infection control policies.
  8. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
  9. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
  10. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction."

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 50 00

DIVISION 1 - GENERAL REQUIREMENTS  
Section 01 73 20 - Cutting and Patching

PART 1 - GENERAL

1.01 DESCRIPTION

- A. The Contractor shall provide connections, repairs, watertight facilities, etc., as required in new construction. Each subcontractor shall furnish information to the Contractor as to size, location, etc., or accept the responsibility of doing the necessary cutting, patching at his own expense.
- B. The Contractor shall provide cutting, fitting or patching for work that may be required to make several parts come together properly, in accordance with the Contract Documents.
- C. Do not endanger the stability of the structure or any part thereof by cutting, digging or otherwise.
- D. The Contractor shall patch and match existing surfaces and materials, etc., affected by the work or patch and match existing surfaces with new materials, etc. as noted.

END 01 73 20

## SECTION 01 75 00 - STARTING AND ADJUSTING

### PART 1 - GENERAL

#### 1.1 DESCRIPTION OF REQUIREMENTS

- A. This section applies to all new HVAC, plumbing, and electrical including, but not limited to, air handling units, fan coil units, pumps, etc.

#### 1.2 STARTING SYSTEMS

- A. Coordinate schedule for startup of various equipment and systems suppliers.
- B. Notify Architect, Owner, and Equipment/Systems Representative, seven (7) days prior to startup of each item or system.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or for other conditions that may cause damage.
- D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify wiring and support components for equipment are complete and tested.
- F. Execute startup under supervision of applicable manufacturer's representative in accordance with manufacturer's instructions.
- G. When specified in Divisions , 22, or 23 or Division 26, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to startup, and to supervise placing equipment or system in operation.
- H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

#### 1.3 DEMONSTRATION AND INSTRUCTIONS

- A. Demonstrate operation and maintenance of products to Owner's personnel prior to date of Substantial Completion.
- B. Contractor and System Representative to demonstrate project equipment operations and provide instructions by a qualified manufacturer's representative who is knowledgeable about the product and/or system. Instructions to be of adequate length for Owner to understand and be able to operate and maintain the product and/or systems.
- C. For equipment or systems requiring seasonal operation, perform demonstration for other season shall be given at the start of the season.
- D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

- E. Demonstrate startup, operation, control, adjustment, troubleshooting, servicing, maintenance, and shutdown of each item of equipment at agreed time with Owner.
- F. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.
- G. Specify the amount of time required for instruction on each item of equipment and system that is specified in Divisions 21, 22, and 23 and Division 26.

1.4 TESTING, ADJUSTING, AND BALANCING

- A. The Contractor will perform services specified in Divisions 22, 23 and 26.
- B. Reports will be submitted by the testing and balancing firm to the Architect indicating observations and results of the tests and indicating compliance or non-compliance with the requirements of the Contract Documents. Non-compliance items will be corrected by the Contractor immediately and the testing and balancing shall be performed again to verify that the corrective action was taken.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 75 00

DIVISION 1 - GENERAL REQUIREMENTS  
Section 01 77 00 – Closeout Procedures

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PART 1 - GENERAL

1.01 SUMMARY

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Substantial Completion procedures
  - 2. Final Completion procedures
  - 3. Extended Warranties
  - 4. Record Drawings
  - 5. Record Topographic Survey
  - 6. Operation and Maintenance Manuals
  - 7. Attic stock materials
  - 8. Allowances accounting
  - 9. Final cleaning
  - 10. Repair of the Work

1.02 SUBMITTALS

- A. Submittals Prior to Substantial Completion
  - 1. Letter from the Contractor to the Architect stating the project has achieved Substantial Completion
  - 2. Contractor's List of Items to be Completed or Corrected
  - 3. Specified certifications
- B. Submittals Prior to Final Completion
  - 1. Written notice that the Work is ready for final inspection and acceptance
  - 2. Letter stating that items included in the Architect's (Amended) List of Items to be Completed or Corrected have been completed or otherwise resolved for acceptance
  - 3. Evidence of final, continuing insurance coverage complying with insurance requirements
  - 4. Demonstration and training video recordings
  - 5. Extended Warranties
  - 6. Record Drawings
  - 7. Record Topographic Survey
  - 8. Operation and Maintenance Manuals
  - 9. Attic stock materials
  - 10. Allowances accounting

11. Waste Management Plan documenting a summary of recycling and salvage on-site logs, manifests, weight tickets, receipts, etc.

### 1.03 SUBSTANTIAL COMPLETION PROCEDURES

- A. Inspection Procedures: Submit a written request for inspection to determine Substantial Completion a minimum of ten (10) calendar days prior to date the work will be completed and ready for inspection. On receipt of request, Architect will either schedule an inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection or will notify Contractor of critical items that must be completed or corrected before a certificate will be issued.
  1. Reinspection: Request reinspection when the critical items previously identified have been completed or corrected.
  2. On receipt of the reinspection request, Architect will either schedule an inspection or notify Contractor of unfulfilled requirements. Architect will prepare the Certificate of Substantial Completion after inspection has confirmed that the critical items have been completed or corrected.
  3. Substantial Completion is contingent upon the issuance of the Occupancy Permit by the Authority Having Jurisdiction (AHJ), therefore the date of Substantial Completion is subject to change to coincide with the date of Occupancy.
- B. List of Incomplete Items: When the Contractor considers the Work to be Substantially Complete, the Contractor shall prepare and submit a list of items to be completed and corrected (Contractor's punch list).
  1. When the Architect determines the Work is Substantially Complete, the Architect will issue the Amended List of Items to be Completed or Corrected (Architect's punch list) to the Contractor.
- C. Submittals Prior to Substantial Completion: Complete the following a minimum of ten (10) calendar days prior to requesting inspection for determining date of Substantial Completion.
  1. Submit specified certifications through the electronic submittal process. Non-reviewed, non-approved and incomplete documentation is not acceptable.
  2. After the electronic submittals have been accepted for contract compliance, submit three (3) clean, legible, approved copies of the specified certifications to the Architect at least ten (10) calendar days prior to the occupancy walk through by the AHJ. Each set of the approved documentation shall be bound in a three ring binder with tab divisions. Approved documentation binders will be transmitted by the Architect to the AHJ and subsequently delivered to Owner.
  3. Following is the list of specified certifications to be included in each binder.
    - a. Contractor Certification that no asbestos containing materials were used on the Project.

- b. Environmental Remediation Clearance Documents filed by the Contractor to the AHJ.
  - c. Environmental Testing Report including Indoor Air Quality (IAQ) test results which demonstrate that the factors tested are within permissible exposure limits.
  - d. Roofing System Manufacturer Inspection Report describing deficiencies with the roofing work and items that are to be completed or corrected.
  - e. Plumbing Systems Site: Chlorination test results for water main work indicating satisfactory compliance with Contract Documents transmitted under letterhead of the responsible Trade Contractor.
  - f. Mechanical Systems: Contractor Certification indicating the Heating, Ventilating, and Air Conditioning Systems have been inspected and start up procedures have been completed by the manufacturer and the systems are fully operational including functional temperature controls.
  - g. Boiler Systems: Certification that the boiler system has been inspected and tested by the manufacturer and is fully operational including functional temperature controls. The boiler system shall be inspected and approved by the Office of State Fire Marshal.
  - h. Mechanical Systems Testing and Balancing: Complete test and balance report including Contractor Certification indicating that at a minimum, code compliant fresh air changes are provided.
  - i. Mechanical System Ductwork Tightness Testing Report including test results which demonstrate the required results to pass.
4. Other items which are required to achieve Substantial Completion include but are not necessarily limited to the following: completed finishes and suspended ceiling systems; functional door hardware; corridors clear of debris and construction equipment; operational plumbing fixtures; electrical panels properly labeled; and interior signage indicating room numbers, directions, offices, and occupancy loads properly posted in assembly areas. Fire extinguishers, furnished by the Owner, must be installed in each cabinet and wall mounted at locations indicated.
- D. Procedures Prior to Substantial Completion: Complete the following a minimum of ten (10) calendar days prior to requesting inspection for determining date of Substantial Completion. List items below that are incomplete at time of request.
- 1. Advise Owner of pending insurance changeover requirements.
  - 2. Complete startup and testing of systems and equipment.
  - 3. Advise Owner of changeover in heat and other utilities.
  - 4. Participate with Owner in conducting inspection and walkthrough with local emergency responders.
  - 5. Complete final cleaning requirements, including touchup painting.

6. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- E. Procedures Following Substantial Completion: Complete the following items immediately after Substantial Completion.
1. Maintenance of seed, sod, plantings and landscaping areas.
  2. Removal of temporary facilities and protections. Restore modifications to existing facilities to the original design or configuration.
  3. Make final changeover of permanent locks and coordinate delivery of keys to Owner. Advise Owner's personnel of changeover in security provisions.
  4. Perform preventive maintenance on equipment used prior to Substantial Completion.
  5. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings.
  6. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.

#### 1.04 FINAL COMPLETION PROCEDURES

- A. Preliminary Procedures: Before requesting final inspection for determining Final Completion, complete the following:
1. Submit letter stating that items included in the Architect's (Amended) List of Items to be Completed or Corrected have been completed or otherwise resolved for acceptance.
  2. Certificate of Insurance: Submit evidence of final, continuing insurance coverage complying with insurance requirements.
  3. Instruct Owner's personnel in operation, adjustment, and maintenance of products, equipment, and systems. Submit demonstration and training video recordings.
  4. Submit Extended Warranties
  5. Submit Record Drawings
  6. Submit Operation and Maintenance Manuals
  7. Deliver attic stock materials
  8. Submit allowances accounting
- B. Inspection: Submit a written request for final inspection to determine acceptance. On receipt of request, Architect will either proceed with inspection or notify Contractor of unfulfilled requirements. Architect will review the final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Reinspection: Request reinspection when the Work identified in previous inspections as incomplete is completed or corrected.

#### 1.05 DEMONSTRATION AND TRAINING VIDEO RECORDINGS

- A. General: Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice.
  - 1. At beginning of each training module, record each chart containing learning objective and lesson outline.
  - 2. Training recordings must include both high quality video and audio.
  - 3. Coordinate with Owner for required staff to be in attendance. Include a sign-in sheet to verify attendance.
- B. Demonstration and Training Video Recordings: Submit two copies within seven days of end of each training module.
- C. Video Recording Format: Provide high-quality color video recordings with menu navigation.
- D. Instructor Qualifications: A factory-authorized service representative experienced in operation and maintenance procedures and training.
- E. Narration: Describe scenes on video recording by audio narration by microphone while video recording is recorded. Include description of items being viewed.

#### 1.06 EXTENDED WARRANTIES

- A. Submit written extended warranties, as defined as warranties beyond the standard one year warranty period from the date of Substantial Completion, via the electronic submittal process.
  - 1. Warranty shall include the following information:
    - a. Name of the project.
    - b. Name of the warranty provider.
    - c. Description of the item being warranted.
    - d. Effective dates of the warranty, starting with the date of Substantial Completion.
    - e. Terms and conditions in conformance with the specified warranty.
- B. Upon acceptance of the warranties through the submittal process, the Contractor shall collect and assemble hard copy originals of the accepted warranties. Organize extended warranty documents into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Bind warranties in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
  - 2. Provide heavy paper dividers with plastic-covered tabs for each separate warranty. Mark tab to identify the product or installation. Provide a typed description of the product or installation, including the name of the product and the name, address, and telephone number of Installer.
  - 3. Identify each binder on the front and spine with the typed or printed title "WARRANTIES," Project name, and name of Contractor.

- C. Where applicable, provide additional copies of each warranty to include in operation and maintenance manuals.

#### 1.07 RECORD DRAWINGS

- A. The Contractor and the Site Utilities, Mechanical, Electrical, Plumbing and Fire Protection Trade Contractors shall each maintain during construction a set of record drawings which shall be kept on site. Each set of these drawings shall be labeled in neat large printed letters "RECORD DRAWINGS". Contractors shall record information concurrently with construction progress and shall not conceal work until the required information is recorded. Concealed portions of the work which have not been documented shall be opened to fully document conditions at the Contractor's own cost.
- B. Record drawings shall be copies of the Contract Document drawings and shall be clearly and legibly marked to record actual construction, including the following.
  - 1. Changes made by Addenda, Change Directives, and/or Change Orders; clarifications not on Contract Documents drawings.
  - 2. Fully document horizontal and vertical locations of underground site utility and storm sewer lines and appurtenances referenced to permanent surface improvements with depths of various elements in relations to finish floor datum.
  - 3. Fully document horizontal and vertical locations of underground and under-slab service lines (plumbing, fire protection, mechanical, electric) and appurtenances referenced to permanent improvements with depths of various elements in relations to finish floor datum.
  - 4. Location of interior service lines (plumbing, fire protection, mechanical, electric) and devices concealed in above ground construction referenced to visible and accessible features of the structure.
  - 5. Location of concealed equipment, valves, ducts, dampers, access panels, outlets, etc. referenced to visible and accessible features of the structure.
  - 6. Field changes of dimensions and details.
  - 7. Other deviations made from the original Contract Document drawings.
- C. The Contractor shall make available record drawings for review for compliance. The frequency of review shall be at a minimum, 50% gross completion of the Contract and at Substantial Completion. The Contractor shall provide complete sets to facilitate review. If it is determined that the record drawings are not being maintained concurrently with construction progress, subsequent pay applications will not be reviewed until the record drawings are brought up to date.
- D. At the completion of the preparation of the record drawings, each contractor shall clearly indicate on the cover sheet of the drawings, "NAME OF CONTRACTOR" and "DATE" identifying the contractor who prepared the record drawings and the date of the record drawings.
- E. Prior to Final Completion, the Contractor shall deliver an electronically scanned copy of the record drawings in PDF format to the Architect for delivery to the Owner.

## 1.08 OPERATION AND MAINTENANCE MANUALS

- A. Submit operation and maintenance manuals via the electronic submittal process.
- B. Upon acceptance of the operation and maintenance manuals through the submittal process, the Contractor shall submit a final corrected version of the operation and maintenance manuals via the electronic submittal process and shall also collect and assemble hard copies of the accepted operation and maintenance manuals. Organize operation and maintenance manuals into an orderly sequence based on the table of contents of the Project Manual.
  - 1. Bind operation and maintenance manuals in heavy-duty, three-ring, vinyl-covered, loose-leaf binders, thickness as necessary to accommodate contents, and sized to receive 8-1/2-by-11-inch paper.
  - 2. Where documents do not allow for hole punching (such as under-sized documents or full size drawings), provide plastic sleeve for insertion into the three-ring binder.
  - 3. Provide heavy paper dividers with plastic-covered tabs for each separate section. Mark tab to identify the section. Provide a typed description of the sections, including the name of the product and the name, address, and telephone number of Installer.
  - 4. Identify each binder on the front and spine with the typed or printed title "OPERATION AND MAINTENANCE MANUAL", Project name, and name of Contractor.
  - 5. Provide additional documentation as specified elsewhere.
- C. Where applicable, provide additional copies of each warranty to include in operation and maintenance manuals.
- D. Submit three (3) copies of each operation and maintenance manual binder to the Architect for processing and distribution.

## 1.09 ATTIC STOCK

- A. Submit attic stock to the Owner as required. Coordinate time and location of delivery of attic stock with designated Owner's representative. Prepare a sign-off form for signature by the designated Owner's representative indicating acceptance and quantity of the attic stock items. Failure to obtain the designated Owner's representative sign-off shall represent that the attic stock delivery did not occur. A copy of the fully executed sign-off form shall be submitted to the Architect.

## 1.10 ALLOWANCE ACCOUNTING

- A. The Contractor shall submit a comprehensive accounting of each specified allowance with appropriate supporting documentation to justify the actual quantities used.
- B. Each allowance accounting item shall include the specified allowance amount and the actual amount of the allowance used and the net difference.
- C. A Change Order(s) will be prepared indicating the corresponding adjustments to the contract amount based upon adjusted allowance amounts.

## PART 2 - PRODUCTS

## 2.01 MATERIALS

- A. Cleaning Agents: Use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.

## PART 3 - EXECUTION

### 3.01 FINAL CLEANING

- A. Cleaning: Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
  - 1. Complete the following cleaning operations before requesting inspection for Certification of Substantial Completion for entire Project or for a designated portion of Project:
    - a. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
    - b. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
    - c. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
    - d. Remove tools, construction equipment, machinery, and surplus material from Project site.
    - e. Remove snow and ice to provide safe access to building.
    - f. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
    - g. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
    - h. Sweep concrete floors broom clean.
    - i. Remove protections used to prevent dust accumulation and damage to furniture and equipment in the work area.
    - j. Vacuum and wipe clean surface, furniture and equipment in the work area. Books within the work area shall be individually dusted.
    - k. Vacuum carpet and similar soft surfaces, removing debris and excess nap; clean according to manufacturer's recommendations if visible soil or stains remain.
    - l. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Replace chipped or broken glass and

other damaged transparent materials. Polish mirrors and glass, taking care not to scratch surfaces.

- m. Remove labels, wrapping and protective films that are not permanent.
- n. Wipe surfaces of mechanical and electrical equipment, elevator equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
- o. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
- p. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
- q. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
- r. Leave Project clean and ready for occupancy.

### 3.02 REPAIR OF THE WORK

- A. Complete repair and restoration operations before requesting inspection for determination of Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
  - 1. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  - 2. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
    - a. Do not paint over "UL" and other required labels including door and frame fire ratings.
    - b. Do not paint over identifications including mechanical and electrical nameplates.
    - c. Remove paint applied to required labels and identification.
  - 3. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
  - 4. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and HID fixtures to comply with requirements for new fixtures.

### 3.03 ELECTRONIC CLOSEOUT DOCUMENTATION

- A. General: Provide a complete project closeout documentation package in electronic format. This package shall include:
1. Project Record Drawings
  2. Project Manual
  3. Approved Submittals
  4. Operation and Maintenance Manuals
  5. Warranties
  6. Owner training DVD's
  7. Project Contact Directory including sub-contractors
- B. The Electronic Closeout Documentation shall be prepared by Digital Revolution Inc./BHFX LLC Contact TJ Hurckes at 847-899-3414 or [tj.hurckes@bhfx.net](mailto:tj.hurckes@bhfx.net).
- C. In order to facilitate the Electronic Closeout Documentation process, comply with the following procedures:
1. Contact Digital Revolution, Inc. a minimum of three months prior to the date of Substantial Completion to schedule a pre-closeout meeting. Review the following:
    - a. Format of documents: PDF electronic format for documents.
    - b. Folder structure for storage and transfer of files.
    - c. Schedule for collection and turn-over of closeout documentation.
    - d. Record Document format procedures: Provide clean and accurate paper copies of the marked-up Record Documents (Drawings and Specifications) for scanning.
    - e. Provide contact information for the individual responsible for the collection and transfer of the electronic closeout Documentation package contents.
    - f. Review a complete listing of closeout documentation package contents.
  2. Provide Documentation to Digital Revolution, Inc. for processing no later than 30 days after the date of Substantial Completion.
  3. Schedule a training conference with the Owner's Representative, Architect, Construction Manager and Digital Revolution, Inc. to present the completed Electronic Closeout Documentation Package.

END 01 77 00

## SECTION 01 77 00 - CONTRACT CLOSEOUT

### PART 1 - GENERAL

#### 1.1 CLOSEOUT PROCEDURES

- A. Submit written certification that Contract Documents have been reviewed, work has been inspected, and that work is complete in accordance with Contract Documents and ready for Architect's review, normally referred to as "final punch list."
- B. Provide submittals to Architect that are called for in other specification sections.
- C. Submit final Application for Payment identifying total adjusted Contract Sum, previous payments, and remaining sum due.

#### 1.2 FINAL CLEANING

- A. The Contractor and each Subcontractor shall perform thorough cleaning, sweeping, washing, and polishing of the entire new structure and site. The Contractor and each Subcontractor shall remove from work and equipment, provided under their respective divisions of work, all foreign matter, spots, and soil so as to put all such work and equipment, including finishes, in a complete and finished condition to the satisfaction of the Architect.
  - 1. Cleaning shall include removal of foreign matter from all drains, exterior and interior.
  - 2. Clean debris from roofs, gutters, downspouts, and drainage systems.
  - 3. Clean and sweep all paved areas; rake clean all landscaped areas.
- B. Initial protection of aluminum will be provided by Subcontractor providing work. Maintenance and any additional protection and repair work required shall be the responsibility of Contractor who shall have damaged work refinished where possible or replaced where required.
- C. Immediately prior to the occupancy of this project or parts thereof, the Contractor shall have all glass cleaned by a professional window washing contractor. Work shall include the removal of labels, paint spattering, excess glazing sealant, etc. Surfaces shall include mirrors, both sides of all glass in windows, borrowed lights, partitions, and doors.
- D. Upon completion of the work, the Contractor and each Subcontractor shall remove and dispose of all equipment, unused materials, waste, and construction facilities provided for the Contractor's work.
- E. After all outside cleanup work has been completed, interior cleanup shall be completed as follows:
  - 1. Subcontractor for plumbing work shall wash and leave free of stains and dust, all fixtures, and all piping, etc. This Contractor shall also clean all faucet aerators.
  - 2. Subcontractor for heating work shall wash and leave clean all radiation covers, etc. Vacuum clean all air handling units, unit ventilators, unit heaters, and finned radiation, inside and out, cap, replace all filters with new filters if units have been used for temporary heating, and clean all motors.

3. Subcontractor for electrical work shall wash and clean all plates on switches and receptacles, light fixture lenses and trim reflectors, etc., and vacuum clean all panels (inside), etc.
4. The Contractor shall, after the above work has been done, completely vacuum all floors and walls, dust and clean all cabinet and wall materials, exposed steel and wood, clean all glass and scrub and clean all floors.
5. If Contractor does not remove rubbish or clean building as specified above, Owner reserves the right to have work done by others at Contractor's expense. If Subcontractors fail to perform their cleaning, the Contractor shall perform such work at the offending Subcontractor's expense.

### 1.3 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.

### 1.4 PROJECT RECORD DOCUMENTS

- A. Maintain one set of drawings with changes marked on record documents on site; record actual revisions to the work and turn over the following to the Architect:
  1. Drawings.
  2. Specifications.
  3. Addenda.
  4. Change orders and other modifications to the Contract.
  5. Reviewed shop drawings, product data, and samples.
  6. Manufacturer's instruction for assembly, installation, and adjusting.
- B. Ensure entries are complete and accurate, enabling future reference by Owner.
- C. Store record documents separate from documents used for construction.
- D. Record information concurrent with construction progress.
- E. Specifications: Legibly mark and record at each Product Section description of actual products installed, including the following:
  1. Manufacturer's name and product model and number.
  2. Product substitutions or alternates utilized.
  3. Changes made by Addenda and modifications.
- F. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
  1. Measured depths of foundations in relation to finish main floor datum.
  2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
  3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
  4. Field changes of dimension and detail.
  5. Details not on original Contract drawings.

- G. Submit documents to Architect with claim for final Application for Payment.

1.5 OPERATION AND MAINTENANCE INSTRUCTIONS

- A. Submit three properly indexed and bound copies, in 'D' Ring style notebooks, of the Operations and Maintenance Instructions to the Architect. Make all corrections or additions required.
- B. Operation and Maintenance Instructions shall include:
  - 1. Notebooks shall be heavy duty locking three ring binders and incorporate clear vinyl sheet sleeves on the front cover and spine for slip-in labeling. "Peel and stick" labels are not acceptable. Sheet lifters shall be supplied at the front of each notebook. Provide "Wilson-Jones" or equal, color black. Size notebooks a minimum of 1/2" thicker than material for future inserts. Label the spine and front cover of each notebook. If more than one notebook is required, label in consecutive order. For example; 1 of 2, 2 of 2. No other forms of binding will be acceptable.
  - 2. Prepare binder covers (front and spine) with printed title "Operation and Maintenance Instructions", title of project and subject matter of binder when multiple binders are required.
  - 3. Title page with project title, Architect, Contractor and Subcontractors, with addresses, telephone numbers, and contacts.
  - 4. Table of Contents describing all index tabs.
  - 5. Listing of all Subcontractors and major equipment suppliers with addresses, telephone numbers, and contacts.
  - 6. Index tabs dividing information by specification section, major equipment, or systems. All tab titling shall be clearly printed under reinforced plastic tabs.
  - 7. Copies of warranties.
  - 8. Copies of all final approved shop drawings and submittals.
  - 9. Copies of all factory inspections and/or equipment start-up reports.

1.6 WARRANTIES

- A. Provide duplicate notarized copies.
- B. Execute and assemble transferable warranty documents from Subcontractors, suppliers, and manufacturers.
- C. Provide table of contents and assemble in three-ring binder with durable plastic cover.
- D. Submit prior to final Application for Payment.
- E. For items of work delayed beyond date of Substantial Completion, provide updated submittal within 15 days after acceptance, listing date of acceptance as start of warranty period.

1.7 SPARE PARTS AND MAINTENANCE MATERIALS

- A. Provide products, spare parts, maintenance and extra materials in quantities specified in individual specification sections.
- B. Deliver to project site; obtain receipt prior to final payment.

1.8 RECORD DRAWINGS

- A. At completion of work and prior to final payment, the Contractor and each Subcontractor shall provide the Architect with a complete, accurate, clean, and legible set of record drawings that indicate exact location of all material items recorded on a day to day basis during the construction period.

1.9 GUARANTEES AND WARRANTIES

- A. The Contractor shall deliver all guarantees and warranties to the Owner prior to final completion.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION (Not Used)

END OF SECTION 01 77 00

## SECTION 01 78 23 - OPERATIONS AND MAINTENANCE MANUALS

### PART 1 - GENERAL

#### 1.1 SUMMARY

- A. Description of Work: This Section includes administrative and procedural requirements for preparing operation and maintenance manuals, including the following:
  - 1. Operation and maintenance documentation directory.
  - 2. Emergency manuals.
  - 3. Operation manuals for systems, subsystems, and equipment.
  - 4. Maintenance manuals for the care and maintenance of products, materials, and finishes, and systems and equipment.

#### 1.2 RELATED WORK

- A. Specific commissioning requirements are given in the following sections of these specifications. All the following sections apply to the Work of this section:
  - 1. Section 01 79 00 - Demonstration and Training
  - 2. Section 01 91 00 - Commissioning
  - 3. Section 23 08 00 - Commissioning of HVAC

#### 1.3 DEFINITIONS

- A. System: An organized collection of parts, equipment, or subsystems united by regular interaction.
- B. Subsystem: A portion of a system with characteristics similar to a system.

#### 1.4 SUBMISSION OF MANUALS

- A. Initial Submittal: Submit two draft copies of each manual at least 15 days before requesting inspection for Substantial Completion. Include a complete operation and maintenance directory. Architect/Engineer will return one copy of draft and mark whether general scope and content of manual are acceptable.
- B. Final Submittal: Submit one copy of each manual in final form at least 15 days before final inspection. Architect/Engineer will return copy with comments within 15 days after final inspection.
  - 1. Correct or modify each manual to comply with Architect/Engineer's comments. Submit two copies of each corrected manual within 15 days of receipt of Architect/Engineer's comments.

## 1.5 COORDINATION

- A. 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.

## PART 2 - PRODUCTS

### 2.1 OPERATION AND MAINTENANCE DOCUMENTATION DIRECTORY

- A. Organization: Include a section in the directory for each of the following:
  - 1. List of documents.
  - 2. List of systems.
  - 3. List of equipment.
  - 4. Table of contents.
- B. List of Systems and Subsystems: List systems alphabetically. Include references to operation and maintenance manuals that contain information about each system.
- C. List of Equipment: List equipment for each system, organized alphabetically by system. For pieces of equipment not part of system, list alphabetically in separate list.
- D. Tables of Contents: Include a table of contents for each emergency, operation, and maintenance manual.
- E. Identification: In the documentation directory and in each operation and maintenance manual, identify each system, subsystem, and piece of equipment with same designation used in the Contract Documents. If no designation exists, assign a designation according to ASHRAE Guideline 4, "Preparation of Operating and Maintenance Documentation for Building Systems."

### 2.2 MANUALS, GENERAL

- A. Organization: Unless otherwise indicated, organize each manual into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following materials, in the order listed:
  - 1. Title page.
  - 2. Table of contents.
  - 3. Manual contents.
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information:
  - 1. Subject matter included in manual.
  - 2. Name and address of project.
  - 3. Name and address of Owner.
  - 4. Date of submittal.
  - 5. Name, address, and telephone number of Contractor.
  - 6. Name and address of Architect/Engineer.

7. Cross-reference to related systems in other operation and maintenance manuals.
- C. Table of Contents: List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to specification section number in the Project Manual.
1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents alphabetically by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
1. Binders: Heavy-duty, three-ring, vinyl-covered, loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2 by 11-inch paper; with clear plastic sleeve on spine to hold label describing contents and with pockets inside covers to hold folded oversize sheets.
    - a. If two or more binders are necessary to accommodate data of a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    - b. Identify each binder on front and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," project title or name, and subject matter of contents. Indicate volume number for multiple-volume sets.
  2. Dividers: Heavy paper dividers with plastic-covered tabs for each section. Mark each tab to indicate contents. Include typed list of products and major components of equipment included in the section on each divider, cross-referenced to specification section number and title of Project Manual.
  3. Protective plastic sleeves: Transparent plastic sleeves designed to enclose diagnostic software diskettes for computerized electronic equipment.
  4. Supplementary text: Prepared on 8-1/2 by 11-inch white bond paper.
  5. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.
    - b. If drawings are too large to be used as foldouts, fold and place drawings in labeled envelopes and bind envelopes in rear of manual. At appropriate locations in manual, insert typewritten pages indicating drawing titles, descriptions of contents, and drawing locations.

## 2.3 EMERGENCY MANUALS

- A. Content: Organize manual into a separate section for each of the following:
1. Type of emergency.
  2. Emergency instructions.
  3. Emergency procedures.

- B. Type of Emergency: Where applicable for each type of emergency indicated below, include instructions and procedures for each system, subsystem, piece of equipment, and component:
1. Fire.
  2. Flood.
  3. Gas leak.
  4. Water leak.
  5. Power failure.
  6. Water outage.
  7. System, subsystem, or equipment failure.
  8. Chemical release or spill.
- C. Emergency Instructions: Describe and explain warnings, trouble indications, error messages, and similar codes and signals. Include responsibilities of Owner's operating personnel for notification of Installer, supplier, and manufacturer to maintain warranties.
- D. Emergency Procedures: Include the following, as applicable:
1. Instructions on stopping.
  2. Shutdown instructions for each type of emergency.
  3. Operating instructions for conditions outside normal operating limits.
  4. Required sequences for electric or electronic systems.
  5. Special operating instructions and procedures.

## 2.4 OPERATION MANUALS

- A. Content: In addition to requirements in this section, include operation data required in individual specification sections and the following information:
1. System, subsystem, and equipment descriptions.
  2. Performance and design criteria if Contractor is delegated design responsibility.
  3. Operating standards.
  4. Operating procedures.
  5. Operating logs.
  6. Wiring diagrams.
  7. Control diagrams.
  8. Piped system diagrams.
  9. Precautions against improper use.
  10. License requirements including inspection and renewal dates.
- B. Descriptions: Include the following:
1. Product name and model number.
  2. Manufacturer's name.
  3. Equipment identification with serial number of each component.
  4. Equipment function.
  5. Operating characteristics.
  6. Limiting conditions.
  7. Performance curves.
  8. Engineering data and tests.
  9. Complete nomenclature and number of replacement parts.

- C. Operating Procedures: Include the following, as applicable:
  - 1. Startup procedures.
  - 2. Equipment or system break-in procedures.
  - 3. Routine and normal operating instructions.
  - 4. Regulation and control procedures.
  - 5. Instructions on stopping.
  - 6. Normal shutdown instructions.
  - 7. Seasonal and weekend operating instructions.
  - 8. Required sequences for electric or electronic systems.
  - 9. Special operating instructions and procedures.
- D. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.
- E. Piped Systems: Diagram piping as installed, and identify color coding where required for identification.

## 2.5 PRODUCT MAINTENANCE MANUAL

- A. Content: Organize manual into a separate section for each product, material, and finish. Include source information, product information, maintenance procedures, repair materials and sources, and warranties and bonds, as described below.
- B. Source Information: List each product included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of installer or supplier and maintenance service agent, and cross-reference specification section number and title in Project Manual.
- C. Product Information: Include the following, as applicable:
  - 1. Product name and model number.
  - 2. Manufacturer's name.
  - 3. Color, pattern, and texture.
  - 4. Material and chemical composition.
  - 5. Reordering information for specially manufactured products.
- D. Maintenance Procedures: Include manufacturer's written recommendations and the following:
  - 1. Inspection procedures.
  - 2. Types of cleaning agents to be used and methods of cleaning.
  - 3. List of cleaning agents and methods of cleaning detrimental to product.
  - 4. Schedule for routine cleaning and maintenance.
  - 5. Repair instructions.
- E. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.

- F. Warranties and Bonds:
  - 1. Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  - 2. Include procedures to follow and required notifications for warranty claims.

## 2.6 SYSTEMS AND EQUIPMENT MAINTENANCE MANUAL

- A. Content: For each system, subsystem, and piece of equipment not part of a system, include source information, manufacturers' maintenance documentation, maintenance procedures, maintenance and service schedules, spare parts list and source information, maintenance service contracts, and warranty and bond information, as described below.
- B. Source Information: List each system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of installer or supplier and maintenance service agent, and cross-reference specification section number and title in Project Manual.
- C. Manufacturers' Maintenance Documentation: Manufacturers' maintenance documentation including the following information for each component part or piece of equipment:
  - 1. Standard printed maintenance instructions and bulletins.
  - 2. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly.
  - 3. Identification and nomenclature of parts and components.
  - 4. List of items recommended to be stocked as spare parts.
- D. Maintenance Procedures: Include the following information and items that detail essential maintenance procedures:
  - 1. Test and inspection instructions.
  - 2. Troubleshooting guide.
  - 3. Precautions against improper maintenance.
  - 4. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - 5. Aligning, adjusting, and checking instructions.
  - 6. Demonstration and training videotape, if available.
- E. Maintenance and Service Schedules: Include service and lubrication requirements, list of required lubricants for equipment, and separate schedules for preventive and routine maintenance and service with standard time allotment.
  - 1. Scheduled Maintenance and Service: Tabulate actions for daily, weekly, monthly, quarterly, semiannual, and annual frequencies.
  - 2. Maintenance and Service Record: Include manufacturers' forms for recording maintenance.
- F. Spare Parts List and Source Information: Include lists of replacement and repair parts, with parts identified and cross-referenced to manufacturers' maintenance documentation and local sources of maintenance materials and related services.

- G. Maintenance Service Contracts: Include copies of maintenance agreements with name and telephone number of service agent.
- H. Warranties and Bonds:
  - 1. Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
  - 2. Include procedures to follow and required notifications for warranty claims.

## PART 3 - EXECUTION

### 3.1 MANUAL PREPARATION

- A. Operation and Maintenance Documentation Directory: Prepare a separate manual that provides an organized reference to emergency, operation, and maintenance manuals.
- B. Emergency Manual: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies indicated.
- C. Product Maintenance Manual: Assemble a complete set of maintenance data indicating care and maintenance of each product, material, and finish incorporated into the Work.
- D. Operation and Maintenance Manuals: Assemble a complete set of operation and maintenance data indicating operation and maintenance of each system, subsystem, and piece of equipment not part of a system.
  - 1. Engage a factory-authorized service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system.
  - 2. Prepare a separate manual for each system and subsystem, in the form of an instructional manual for use by Owner's operating personnel.
- E. Manufacturers' Data:
  - 1. Where manuals contain manufacturers' standard printed data, include only sheets pertinent to product or component installed. Mark each sheet to identify each product or component incorporated into the Work. If data include more than one item in a tabular format, identify each item using appropriate references from the Contract Documents. Identify data applicable to the Work and delete references to information not applicable.
  - 2. Prepare supplementary text if manufacturers' standard printed data are not available and where the information is necessary for proper operation and maintenance of equipment or systems.
- F. Drawings: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in Record Drawings to ensure correct illustration of completed installation.
  - 1. Do not use original Project Record Documents as part of operation and maintenance manuals.

2. Comply with requirements of newly prepared Record Drawings in Division 01 Section PROJECT RECORD DOCUMENTS.
- G. Comply with Division 01 Section CLOSEOUT PROCEDURES for schedule for submitting operation and maintenance documentation.

END OF SECTION 01 78 23

## SECTION 01 79 00 - DEMONSTRATION AND TRAINING

### PART 1 - GENERAL

#### 1.1 DESCRIPTION

- A. This Section includes administrative and procedural requirements for instructing the Owner's and operations and maintenance personnel, including the following:
  - 1. Demonstration of operation of systems, subsystems, and equipment. Contractor shall develop training sessions for systems, subsystems, and equipment.
  - 2. Training in operation and maintenance of systems, subsystems, and equipment.
- B. Demonstration and training requirements are described in this section, Section 01 91 00, and in the technical sections of Divisions 02 through 28. The Contractor shall comply with the requirements for demonstration and training data described in all specification sections.

#### 1.2 RELATED WORK

- A. Specific commissioning requirements are given in the following sections of these specifications. All the following sections apply to the Work of this section
  - 1. Section 01 78 23 - Operations and Maintenance
  - 2. Section 01 91 00 - Commissioning
  - 3. Section 23 08 00 - Commissioning of HVAC

#### 1.3 SUBMITTALS

- A. Instruction Program: No later than two (2) months following acceptance of equipment and system submittals, the responsible contractor shall submit written training plans to the CxA and Owner for review and approval per Section 01 91 00 and this section.
- B. Documentation: After each training session, submit the following:
  - 1. Attendance Roster: Submit list of participants and length of instruction time.
  - 2. Evaluations: For each participant and for each training session, submit results and documentation of performance-based test and student evaluations of training.

#### 1.4 COORDINATION

- A. Coordinate instruction schedule with Owner.
- 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 operation and maintenance manuals.

## 1.5 QUALITY ASSURANCE

- A. Facilitator Qualifications: Training shall be facilitated by a firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
- B. Instructor Qualifications: Instructors shall be factory-authorized representatives experienced in operation and maintenance procedures and training.
- C. Pre-instruction Conference: Conduct conference at project site. Review methods and procedures related to demonstration and training including, but not limited to, the following:
  - 1. Inspect and discuss locations and other facilities required for instruction, including classroom training and field training.
  - 2. Review and finalize instruction schedule and verify availability of educational materials, instructors' personnel, and audio/visual equipment.
  - 3. Review required content of instruction.
  - 4. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.

## PART 2 - PRODUCTS

### 2.1 INSTRUCTION PROGRAM

- A. Program Structure: Develop a comprehensive instruction program. Include individual training sessions for each system and equipment not part of a system as required by technical specification sections and the Cx Plan.
- B. Training Sessions: Coordinate training with the CxA. Develop a learning objective and teaching outline for each system, subsystem, and product specified in Section 01 91 00 and Divisions 02 through 28. Include a description of specific skills and knowledge that participants are expected to learn.
- C. The following list of topics should be applied to each training plan for each equipment or system being presented. Not all will apply, but each major category should be addressed in the training plan with a brief description of how it pertains to the particular training sessions.
  - 1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
    - a. System, subsystem, and equipment descriptions.
    - b. Performance requirements.
    - c. Operating standards.
    - d. Regulatory requirements.
    - e. Equipment function.
    - f. Operating characteristics.
    - g. Limiting conditions.
    - h. Performance curves.

2. Documentation: Review the following items in detail:
  - a. Operations manuals.
  - b. Maintenance manuals.
  - c. Project Record Documents.
  - d. Identification systems.
  - e. Warranties and bonds.
  - f. Maintenance service agreements and similar continuing commitments.
  
3. Emergencies: Include the following:
  - a. Instructions on meaning of warnings, trouble indications, and error messages.
  - b. Instructions on stopping.
  - c. Shutdown instructions for each type of emergency.
  - d. Operating instructions for conditions outside normal operating limits.
  - e. Sequences for electric or electronic systems.
  - f. Special operating instructions and procedures.
  
4. Operations: Include the following:
  - a. Startup procedures.
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Control sequences.
  - f. Safety procedures, including lockout/tagout requirements.
  - g. Instructions on stopping.
  - h. Normal shutdown and restart instructions.
  - i. Operating procedures for system, subsystem, or equipment failure.
  - j. Seasonal and weekend operating instructions.
  - k. Required sequences for electric or electronic systems.
  - l. Special operating instructions and procedures.
  
5. Adjustments: Include the following:
  - a. Alignments.
  - b. Checking adjustments.
  - c. Noise and vibration adjustments.
  - d. Economy and efficiency adjustments.
  
6. Troubleshooting: Include the following:
  - a. Diagnostic instructions.
  - b. Test and inspection procedures.
  
7. Maintenance, Care and Cleaning: Include the following:
  - a. Inspection procedures.
  - b. Types of cleaning agents to be used and methods of cleaning.
  - c. List of recommended cleaning agents and methods of cleaning and list of agents and cleaning methods detrimental to product.

- d. Procedures for routine cleaning.
  - e. Procedures for preventive/predictive maintenance.
  - f. Procedures for routine maintenance.
  - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
  - b. Repair instructions.
  - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
  - d. Instructions for identifying parts and components.
  - e. Review of spare parts needed for operation and maintenance.
- D. Training Shifts: Training shall be provided for one shift, unless otherwise noted. Training shall be accomplished during normal business hours.
- E. Training Duration: Duration of training and demonstration is addressed in Section 01 91 00. Training and demonstration duration for specific items within a training session may be adjusted with Owner approval to meet the overall goals of the training session.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Assemble educational materials necessary for instruction, including documentation and training sessions. Assemble training sessions into a combined training manual.
- B. Set up instructional equipment at instruction location.

#### 3.2 INSTRUCTION

- A. Scheduling: Provide instruction at mutually agreed-on times. For equipment that requires seasonal operation, provide instruction on actions necessary to prepare for and execute seasonal changeover.
  - 1. Schedule training through the Owner with at least 30 days' notice. This requirement for notice takes precedence over other advance notice requirements in the specification.
- B. Quality and Contents of Training Sessions: Each training session shall include the following.
  - 1. Training plan for each class. Training plan shall contain:
    - a. Class objectives (what the student will learn).
    - b. Script of lecture and demonstrations.
    - c. Duration of each instruction period.
    - d. Participant attendance roster.
    - e. Participant evaluation survey form.

2. Names of instructors, name of company where employed, their credentials and affiliation with product if applicable and their qualifications as instructor.
- C. Evaluation: At conclusion of each training session, assess and document training.
1. Assess and document each participant's comprehension of session by use of an oral performance-based test.
  2. Obtain each participant's evaluation of the training.
- D. Cleanup: Collect used and leftover educational materials. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.
- E. Record of Training. Submit the attendance roster as part of the completed training plan upon successful completion of the training session.

END OF SECTION 01 79 00

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified in this section.

1.02 SCOPE OF WORK

- A. Work included under this section shall include but not necessarily be limited to the following:
  - 1. Perform demolition work as necessary to accomplish the work, including the removal and proper disposal of items which are exposed and not to remain in use, including but not necessarily limited to pavement, walks, plantings, foundations, slabs, structural items, walls, roofing, flashings, doors, frames, windows, curtain wall, glazing, finishes, ceilings, flooring, framing, trim, specialties, equipment, casework, plumbing, mechanical and electrical items, etc.
  - 2. Include items exposed such as sewer, water and electrical lines which may require capping per city or utility company requirements.
  - 3. Properly dispose of demolished material and such other obstacles required for a complete and proper installation of new work and the disposition of materials incidental to this work.
  - 4. Erection of barricades, etc., to protect existing building areas.
  - 5. Protection of existing utilities.
  - 6. Repair to building areas, utilities damaged during demolition.
  - 7. Demolition in specific building locations to the extent described on the drawings and/or required to construct the work shown.
  - 8. Remove protection when work is complete.
  - 9. Rubbish and debris shall be promptly removed from building as to minimize dust within the building.
  - 10. Coordinate with Owner Operations. Portions of the school building will be in operation during the construction phase.
- B. Existing surfaces and finishes which are marred or defaced as a result of demolition work shall be patched and matched as required.
- C. Demolition shall include the removal of debris materials associated with demolition procedures. Debris shall be properly deposited of into project dumpsters and subsequently taken to a legal dump site.

1.03 JOB CONDITIONS

- A. Visit the site and be informed as to the character and type of work to be removed. Owner assumes no responsibility for the condition of existing construction to be removed or demolished. Later claims for additional payment for conditions reasonably foreseeable shall not be allowed.

1.04 PROTECTION

- A. Provide and maintain, during demolition operations, barricades and temporary environmental protection to separate the working area from other areas.
- B. Remove protections and temporary enclosures when work is complete.
- C. Properly protect existing building, walks, paving, grass, trees, shrubs, etc. Properly restore/replace damaged items meeting Owner approval.
- D. Where demolition operations create conditions which may result in water and/or weather leaks, provide necessary temporary enclosures which create a weathertight barrier and protect existing structures and facilities from damage due to infiltration of water and/or weather.
- E. Verify routing of existing Fire Alarm, Electrical, Security, Phone, Mechanical, Plumbing, and other systems prior to cutting roof, walls, floor, etc. Maintain these systems in full operating condition during course of the work. Pay repair costs to systems and finishes damaged during the execution of the Work.

#### 1.05 DEMOLITION

- A. Exact extent of demolition as shown on drawings and to be completed shall be verified at the site. Determine the nature and extent of demolition that will be necessary by comparing the drawings with existing site conditions. Operations shall be done in a careful and orderly manner to avoid hazards to persons and property, and interference with the use of adjacent areas, and interruption of free passage to and from such areas.
- B. Where concrete or masonry is to be cut, a straight cut line shall be obtained by using a carborundum masonry saw.
- C. Work shall be demolished in small sections. Provide bracing and shoring necessary to maintain existing building integrity.
- D. Do not remove more of existing construction than is necessary. Do not mar, damage, or deface construction which is to remain.
- E. Verify routing of existing Fire Alarm, Electrical, Security, Phone, Mechanical, Plumbing, and other systems prior to cutting roof, walls, floor, etc. Maintain these systems in full operating condition during course of the work. Pay repair costs to systems and finishes damaged during the execution of the Work.
- F. Access routes to and from the site shall be kept clean of debris resulting from the Work.

#### 1.06 SALVAGEABLE ITEMS

- A. Verify with the Owner the items to be salvaged and turned over to the Owner.

END 02 41 19

DIVISION 3 – CONCRETE

Section 03 30 00 - Cast In Place Concrete

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 QUALITY ASSURANCE

A. Qualifications of Concrete Contractor

- 1. Installation shall be by a company continuously and regularly employed in the installation of Concrete Cast In Place work for a period of at least 5 consecutive years; and which can show evidence of these materials being satisfactorily installed on at least 6 projects of similar size, scope and type within such a period. At least 3 of the projects shall have been in successful use for 3 years or longer.

B. Interior Floor Slab Moisture Content Requirements, Testing, and Moisture Sealer

- 1. Schedule work as necessary to install slab with enough time prior to finish flooring, to allow for complete drying of concrete, minimum of 180 days, as per the recommendations of the concrete contractor and the finish floor manufacturer.
- 2. Provide appropriate scheduling, curing, & drying time, and other related conditions to insure moisture content as acceptable by the finish floor manufacturer. (The proper installation of the vapor retarder, the low water cement ratio specified, installation 180 days prior, protection from weather & rain, and moist curing can contribute significantly to accomplishing a timely drying date.) Repair and prepare concrete surfaces to meet the finish floor moisture content requirements. Moisture content shall not exceed 5 pounds, or 3 pounds if finish floor manufacturer recommends 3 pounds, per 1000 sq. ft. for a 24 hour period, as per calcium chloride test ASTM F1869-98, measured 45 days prior to scheduled Substantial Completion. Testing shall take place in the building envelope conditioned to the temperature and humidity levels as recommended by the finish floor manufacturer. Testing density is required to equal 3 tests in the first 1,000 square feet, with one additional test per each additional 1,000 square feet of concrete slab surface. Provide Architect with written test reports including pertinent data, locations as per a key plan, temperature, humidity, time & date, and moisture readings.

C. Pre-Installation-Concrete Meeting

- 1. Meeting with Architect and Contractor; Contractor shall submit procedures to provide quality installation of the work, and protection of work after placement, including: curing, testing, protection of fresh concrete from rain and water infiltration, flatness, minimize curling of slabs, minimize high spots at construction joints, provision (location, construction, and timing) of control joints, cold or hot weather placement & protection, special concrete finishes, meeting interior slab moisture

requirements, installation of Moisture Sealer, coordination with finish flooring substrate prerequisites, other coordination, and other requirements of this section.

### 1.03 REFERENCE STANDARDS

- A. Work shall conform to the following except as superseded by this Section, American Concrete Institute (ACI) and ASTM Publications:
  - 1. ACI 117 - Specifications for Tolerances for Concrete Construction.
  - 2. ACI 301 - Specifications of Structural Concrete for Buildings.
  - 3. ACI 302.1R-15 – Guide to Concrete Floor and Slab Construction.
  - 4. ACI 305 - Hot Weather Concreting.
  - 5. ACI 306 - Cold Weather Concreting.
  - 6. ACI 308 - Recommended Practice for Curing Concrete.
  - 7. ACI 309 - Standard Practice for Consolidation of Concrete.
  - 8. ACI 347 - Recommended Practice for Concrete Formwork. ( Includes tolerances.)
  - 9. ASTM C 494 - Standard Specification for Chemical Admixtures.
  - 10. ASTM C 260 - Standard Specification for Air-entraining Admixtures.
  - 11. ASTM C 94/C 94M - Ready-Mixed Concrete.

### 1.04 COORDINATION

- A. Coordinate Concrete Flatwork with Requirements of Finish Floors
  - 1. Coordinate the installation and components of concrete flatwork with the scheduled finish floor selections, such that concrete flatwork, including but not limited to mix design, admixtures, flatness, levelness, curing compounds, evaporative retarder, curing covers, surface treatments, moisture, moisture sealers, alkalinity, hardeners, sealers, fillers, underlayments, fiber reinforcing, joint design, joint location, joint fillers, elevation, recesses, inserts, and finishing are compatible with the final concrete finish and final finish flooring.

### 1.05 SUBMITTALS

- A. Concrete supplier's test reports indicating mix design specification compliance.
- B. Mix design components.
- C. Shop drawings indicating floor slab control joints.
- D. Proposed cold and hot weather placement & protection procedures.
- E. Product literature for Moisture Sealer.
- F. Product literature for products listed below.

### 1.06 FIELD-CONSTRUCTED MOCK-UP(S)

- A. Prior to installation of vapor barrier, assemble mock-up(s) to comply with the following requirements.

1. Assemble mock-up(s) of vapor barrier at typical edge, penetrations, thickened slabs, column piers, and standard lap joint conditions. Mock-ups may be part of the actual construction.
2. Protect the mock-up(s) from damage. The approved mock-up(s) conditions shall be used to review the quality of the installation of the vapor barrier throughout the project.
3. Approved mock-up(s) does not constitute approval to deviate from specifications.

#### 1.07 DELIVERY, STORAGE, AND HANDLING

- A. Store cementitious materials in a dry, weather tight location. Maintain accurate records of shipment and use.
- B. Store aggregates to permit free drainage and to avoid contamination with deleterious matter or other aggregates. When stockpiled on ground, discard bottom 6 inches of pile.
- C. Handle aggregates to avoid segregation.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Cementitious Materials: Portland cement meeting requirements of ASTM Specification C 150-81 Type I.
- B. Cementitious Materials: Fly Ash: ASTM C 618, Type C. Limit Fly Ash content to a maximum of 20% total cement content.
- C. Cementitious Materials: Ground Granulated Blast-Furnace Slag (GGBS): ASTM C 989, Grade 100 or Grade 120. Limit GGBS content to a maximum of 50% total cement content. Due to color variations between GGBS concrete and non-GGBS concrete, if GGBS concrete is used, it shall be used at all locations of exposed concrete.
- D. Fine aggregate: Sand, clean and sound grains, free of injurious amounts of dust and other deleterious matter and conform to ASTM C 33.
- E. Coarse aggregate: Clean, sound un-coated crushed stone or gravel (do not use gravel at vehicular pavements, walks, retaining wall, exterior stairs or curbs, unless material is approved by Illinois Department of Transportation, IDOT, for use in highway construction in portland cement concrete surfaces) free from injurious amounts of soft, thin or laminated pieces or other deleterious matter and conform to ASTM C 33. Aggregate shall pass a 3/4" ring except that used for footings which may be one inch (1").
- F. Water: Clean, fresh, potable, and free from injurious amounts of mineral or organic matter.
- G. Admixtures
  1. Contractor shall submit for review any proposed admixtures to improve workability of the mix without having detrimental effect on the strength, durability, permeability, curing, finishing, sealing, adhesion of final finish flooring, or other desirable attributes of the concrete.

2. The Contractor shall submit the name of the admixtures proposed and admixture manufacturer's certification that the selected admixtures meet the requirements herein. Admixture manufacturer's product literature shall specify when in the batching/mixing operation the admixture must be added, how the mixing shall be accomplished, and dosage rate range. Where multiple admixtures for a single design mix are proposed, Contractor shall submit a letter or notation from their concrete supplier certifying that such joint use of multiple admixtures are compatible with the design mix, such that the desirable effects of each admixture will be realized. Where the multiple admixtures which are proposed are not of the same brand, Contractor shall specifically address that issue within such letter or notation.
  3. Liquid admixtures shall be considered part of the total water. Admixtures which result in more than 0.1 percent of soluble chloride ions by weight of cement are prohibited.
  4. When admixtures are used with a mix containing cementitious materials other than Portland cement, such as fly ash or slag, Contractor shall verify with the admixture manufacturer whether the amount of the admixture shall be based on the amount of Portland cement only or the total amount of cementitious materials.
  5. Where concrete contains a Water Reducing, High Range Admixture or an Accelerating Admixture, the admixture manufacturer's representative shall attend the pre-installation-concrete meeting, observe project start-up of concrete placements, and offer recommendations.
  6. Admixtures:
    - a. Air-entraining Admixture: Comply with ASTM C 260. Air entraining is required as per Design of Concrete Mixes, listed above.
    - b. Accelerating Admixture: Accelerating admixture complying with ASTM C 494, Type C. Non-chloride admixture.
    - c. Water Reducing Admixture: Water reducing admixture complying with ASTM C 494, Type A.
    - d. Water Reducing and Retarding Admixture: Water reducing and retarding admixture complying with ASTM C 494, Type D.
    - e. Water Reducing, High Range Admixture: Water reducing, high range admixture (superplasticizer) complying with ASTM C 494, Type F or G, ASTM C 1017, Type 1 or 2.
    - f. Other: as complying with applicable ASTM requirements and approved by the Architect.
- H. Cure and Seal for interior slabs: Water based, non-yellowing, 20% solids, single coat or two coat application as specified herein. Confirm compatibility with finish flooring manufacturer for acceptable methods; if cure and seal is not acceptable provide 7 day moisture cured method in accordance with ACI-308 and as required by the finish flooring manufacturer:
1. BASF Master Builders, MasterKure CC 200WB

2. WR Meadows, VOCOMP 20
  3. Tamms-Euclid, Luster Seal WB 150
- I. Curing Cover for exterior slabs: Meet or exceed ASTM C171- 03, ASTM C171-97a, and AASHTO M171-00, single-use (not reusable), water retaining, waterproof, UV protective curing cover:
1. Sika Corporation, UltraCure NCF
  2. Mctech Group, UltraCure NCF
  3. PNA Construction Technologies, HydraCure S16.
- J. Interior Expansion Joint Filler, wood/cellulose fiber, thickness ½” unless as called out otherwise:
1. Knight-Celotex, "Flexcell"
  2. W.R. Meadows, Inc., "Fibre Expansion Joint"
  3. Right Pointe, "Right Joint Expansion Joint"
- K. Exterior Expansion Joint Fillers: Conform to applicable articles of the "Standard Specifications for Road and Bridge Construction, State of Illinois, Division of Transportation", current adopted edition.
- L. Vapor Barrier: Provide vapor retarder/barrier over prepared granular base material directly below slabs on grade. Vapor retarder/barrier membrane must have the following qualities:
1. Permeance: ASTM E 96; no greater than 0.01 Perms, as tested in accordance with mandatory conditioning test per ASTM E 1745 Section 7.1 (7.1.1-7.1.5)
  2. Strength: ASTM E 1745; exceeds Class A for tensile strength and puncture resistance.
  3. Thickness: ACI 302.1R-96; Not less than 15 mils
  4. Materials: polyethylene or polyolefin, manufactured for use as under slab vapor retarder/barrier; ordinary or generic polyethylene are not acceptable. No use of recycled or post consumer resins.
  5. Use only materials that are resistant to decay when tested in accordance with ASTM E 154 – Sections 8, 11, 12 and 13.
  6. Provided in continuous sheets of not less than 10 foot wide.
  7. Sealing Materials: Provided with vapor retarder/barrier manufacturer's recommended seam tape, mastics, and edge seal products.
  8. Provided with vapor retarder/barrier manufacturer's recommended prefabricated penetration boots, collars, etc.
  9. Provided with vapor retarder/barrier manufacturer's installation instructions.
  10. Products: Subject to compliance with requirements, provide from one of the following approved manufacturers:
    - a. Stego Industries, Inc., Stego-Wrap, 15 mil.

- b. WR Meadows, Perminator, 15 mil.
- M. Underlayment Compound: Free-flowing, self-leveling, cement-based compound, for interior applications as applicable, leveling from 1 inch thick to feathered edges. Must be compatible with finish flooring products and adhesives. Gypsum containing products are not permitted. Install with primer as per manufacturer's recommendations. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109M. Flexural Strength: Not less than 1000 psi at 28 days when tested according to ASTM C 78.
  - 1. Subject to compliance with requirements and recommendations of manufacturer for thickness required and substrate condition, provide one of the following:
    - a. Conspec Mfg. Co. Spec Topping ESL
    - b. Euclid-Tamms, Super Flo-Top
    - c. Ardex, K-15
    - d. Mapei, Ultraplan Easy
  - 2. If required for exterior applications manufacturer must provide their product as applicable for exterior and moist environments.
- N. Waterstops: Manufactured flexible waterstops shall be PVC, dumb-bell style, minimum 9" wide, with pre-fabricated corners.
  - 1. Manufacturer's
    - a. Greenstreak
    - b. Vinylex Corporation,
    - c. Tamms
- O. Self-Expanding Strip Waterstops: Manufactured rectangular or trapezoidal strip, active sodium bentonite or other similar hydrophylic material for adhesive bonding to concrete with manufacturer's adhesives.
  - 1. Products: Subject to compliance with requirements, provide manufacturers proper shape for each condition:
    - a. CETCO, Waterstop RX
    - b. Concrete Sealants Inc., Conseal CS-231
    - c. Greenstreak, Hydrotite
    - d. Mirafi Moisture Protection, Mirastop
- P. Perimeter Insulation: 2 inches thick, extruded polystyrene board insulation (XPS), Type IV, 1.6 pcf minimum density, 25 psi minimum compressive strength, square edge rigid cellular polystyrene with closed-cells and integral high density skin, for below grade installation. Comply with ASTM C 578, ASTM E 84 maximum flame-spread of 10 and smoke-developed indexes of 175; 5 year aged R-values of 10.8 at 40 degrees F and 10.0 at 75 degrees F:
  - 1. Dow Chemical Company - "Styrofoam XPS"
  - 2. Owens Corning - "Foamular 250 XPS"

3. DiversiFoam Products Co. - "CertiFoam 25"

2.02 DESIGN OF CONCRETE MIXES

- A. The Contractor shall have prepared, the design mixes of the Portland cement (including other cementitious materials), aggregates, and water for each class of concrete to be used. Each mix shall be based upon a mix with the approved materials and admixtures, and the concrete supplier's testing laboratory results meeting the requirements herein. (Tested design mixes do not need to contain hot or cold weather conditioning admixtures such as accelerators.)
1. Design Mixes in accordance with ACI 211.1-81 to provide normal weight concrete with properties as indicated on drawings and schedule, but shall at a minimum meet the requirements set herein.
    - a. Provide two design mixes; one for flatwork, one for concrete other than flatwork. Design mix for interior and exterior flatwork shall produce 4,500 lb. per sq. in. compressive strength at the end of 28 days, and water/cement (water/cementitious materials) ratio is not to exceed 0.45. Design mix for other than flatwork shall produce 3,500 lb. per sq. in. compressive strength at the end of 28 days, and water-cement ratio shall not exceed 0.55.
    - b. Provide slump of 3 inches plus or minus 1 inch for flatwork and 4 inches plus or minus 1 inch for other concrete work.
    - c. Concrete exposed to the exterior, excluding building foundations; add an air entraining agent in accordance with air entraining manufacturer's recommendation; Air content; 6 percent plus or minus 1 percent.
    - d. Concrete exposed to the exterior, excluding building foundations; use GGBS cementitious materials in accordance with GGBS manufacturer's recommendation.

2.03 FORM-FACING MATERIALS

- A. Formed Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
1. Rust-free metal.
  2. Exterior-grade undamaged, unpatched plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
    - a. Medium-density overlay, Class 1, or better, mill-release agent treated and edge sealed.
    - b. Structural 1, B-B, or better, mill oiled and edge sealed.
    - c. B-B (Concrete Form), Class 1, or better, mill oiled and edge sealed.
  3. Architecturally Exposed Concrete: Medium-density overlay, class 1 or better, mill-release agent treated and edge sealed
- B. Chamfer Strips: Wood, metal, PVC, or rubber strips, 3/4 by 3/4 inch (19 by 19 mm), minimum.

- C. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
  - 1. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- D. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
  - 1. Furnish units that will leave no corrodible metal closer than 1 inch (25 mm) to the plane of the exposed concrete surface.
  - 2. Furnish ties that, when removed, will leave holes not larger than 1 inch (25 mm) in diameter in concrete surface.
  - 3. Furnish ties with integral water-barrier plates to walls indicated to receive dampproofing or waterproofing.
  - 4. Furnish stainless steel ties where drawings indicate to be exposed.

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Install products as per the manufacturer's written recommendations, except as superseded herein.

### 3.02 FORMS

- A. Construct forms true to lines, shapes and dimensions as shown. Erect plumb, straight and sufficiently tight to prevent leakage. Brace and shore to adequately and safely support construction loads and prevent displacement. The design and engineering of the formwork and shores as well as its construction and removal shall be the responsibility of the Contractor and shall conform to "Recommended Practice for Concrete Formwork", ACI 347 and Section 6.2 of ACI 318.
  - 1. Accurately form structural forms as per ACI 347-78. Brace, tie and shore as required to prevent movement in any direction during the placement of concrete.
  - 2. Side forms may be omitted at footings where soil conditions will permit excavation to accurate size without cave-in.
- B. Coat contact surfaces of forms with non-staining, rust preventative form-release agent, according to manufacturer's written instructions, before placing reinforcement. Rust stained steel formwork is not acceptable.
- C. Forms for exposed concrete:
  - 1. Drill forms to suit ties used and to prevent leakage of concrete mortar around tie holes.
  - 2. Do not use metal cover plates for patching holes or defects in forms.
  - 3. Provide sharp, clean corners at intersecting planes, without visible edges or offsets. Back joints with extra studs or girts to maintain true, square intersection.

4. Use extra studs, walers and bracing to prevent bowing of forms between studs and to avoid bowed appearance of concrete. Do not use narrow strips of form material that will produce bow.
5. Assemble forms so they may be readily removed without damage to exposed concrete surfaces.

### 3.03 PREPARATION FOR PLACING CONCRETE

- A. Clean earth surface upon which concrete footings are to be placed and interiors of forms free from frost, ice, mud, water and other foreign matter.
- B. Moisten wood forms, except in freezing weather, so joints will tighten to prevent cement grout seepage. The Contractor shall inspect reinforcement for secure fastening and accurate position.
- C. Level floor areas on grade to true planes with gravel as a bed for concrete, prior to applying mesh.
- D. Prior to the placing of concrete, the Contractor shall notify the Architect in due time to allow for the Architect's review of the work.

### 3.04 DELIVERING CONCRETE

- A. Batch, mix and deliver concrete in accordance with the requirements set forth in ASTM C 94; subject to provisions specified herein relative to materials, strength, proportioning, consistency and delivery timing.
- B. The rate of delivery of the mixed concrete shall be such that the interval between placing of successive batches shall not exceed 30 minutes. The elapsed time between the introduction of mixing water to the cement and aggregate and completion of discharge shall not exceed 90 minutes.
- C. Delivery tickets shall record the mix design and the batch time. Keep legible copies of these available for examination by the Architect.

### 3.05 ENTRANCE PLATFORM FOUNDATIONS

- A. Provide solid concrete foundation/frost protection wall around entire perimeter of entrance platforms, stoops, landings, etc. Depth of wall minimum of 4 feet below grade. Tie platform to foundation with minimum #5 bars 12" o.c.

### 3.06 INSTALLATION OF EMBEDDED ITEMS

- A. General: Set anchorage devices, including but not limited to anchorage devices for precast concrete panel or slabs, curtainwall, elevator, masonry, mechanical/electrical equipment, and other items required for other work connected to or supported by cast-in-place concrete, using templates, setting drawings, and instructions from suppliers of items to be embedded.
  1. Install reglets to receive flashings and other membrane materials at locations indicated, in accordance with manufacturer's recommendations.
  2. Edge Forms and Screeds: Set edge forms and intermediate screeds as necessary to achieve final elevations indicated for finished slab surfaces.
  3. Install anchor rods and dowels, accurately located, to required elevations.
  4. Install dovetail masonry anchor slots per manufacturer's requirements to receive specified masonry ties.

- B. Waterstops: Install waterstops according to manufacturer's written instructions.
  - 1. PVC Waterstops: Install in construction joints as indicated to form a continuous diaphragm. Install in longest lengths practicable. Support and protect exposed waterstops during progress of Work. Field-fabricate, weld and seal joints in waterstops watertight according to manufacturer's written instructions.
  - 2. Self-Expanding Strip Waterstops: Install in construction joints and at other locations as indicated, according to manufacturer's written instructions, bonding with manufacturers adhesives, or mechanically fastening if conditions require, firmly pressing into place. Install in longest lengths practicable. Allow for expansion without damage or blow-out of concrete.

### 3.07 INSTALLATION OF VAPOR BARRIER

- A. Following leveling and tamping of granular base for slabs on grade, place vapor retarder/barrier sheeting with longest dimension parallel with direction of pour.
- B. Install as per ASTM E-1643, unless exceeded herein. Comply with manufacturer's recommendations, except as herein exceeded.
- C. Protect from damage, place vapor retarder/barrier just ahead of concrete placement, not to exceed extent of day's pour.
- D. Lap joints 6-12" and seal with vapor retarder/barrier manufacturer's appropriate tape. At foundation perimeter walls and vertical wall interruptions, provide manufacturer recommended double sided seal tape 1" below the installed slab elevation. Install vapor retarder/barrier up the perimeter walls and vertical wall interruptions so that the edges are showing 1" above the installed slab elevation. After installation of floor slab, trim flush with slab. Extend vapor retarder/barrier 6" out from construction joints for access for seam taping. Install manufacturer's recommended pipe boots fully sealed, or similar manufacturers approved sealing methods at pipe penetrations. Installation shall be water tight and vapor tight. Use extreme care to ensure that the integrity of the vapor retarder/barrier is not violated.
- E. Notify Architect by email and provide the opportunity for observation of the fully installed, taped and sealed vapor retarder/barrier by the Architect no less than 24 hours prior to installation of the concrete slab.

### 3.08 PERIMETER INSULATION:

- A. Install perimeter insulation around the entire perimeter of the foundation wall. Apply insulation complying with manufacturer's recommendations. Butt boards closely together. Apply board insulation to clean surfaces. On vertical surfaces, use appropriate spot adhesive to secure in place.
- B. Insulation shall extend vertically to top of footing, or 4'-0" where footing is lower than 4'-0", except where shown to exceed this. Where shown on horizontal surfaces, level fill below slab so that boards are well seated.

### 3.09 CONCRETE SLAB FINISH FLOORING SUBSTRATE REQUIREMENTS

- A. Concrete slab flatness, fiber exposure, final finish, recess or elevation, admixtures, curing methods/materials, sealers, sealants, alkalinity, and moisture

content shall meet the requirements of finish flooring in this project. Contractor shall verify the requirements with the finish floor suppliers prior to installation of this concrete work.

### 3.10 PLACING CONCRETE

- A. Place concrete immediately after mixing. Tamp, spade or vibrate to force out air pockets and work concrete into corners of forms and around reinforcement to ensure a dense homogeneous mass.
  - 1. Pouring shall be continuous from working joint to working joint.

### 3.11 JOBSITE ADDITION OF WATER TO CONCRETE

- A. Water shall not be permitted to be added at the jobsite unless all of the following are met:
  - 1. Design mix was batched to allow for added water, clearly states so on the batch ticket delivered to the site, and clearly states how many gallons per cubic yard may be added on site without exceeding the water/cement ratio.
  - 2. Batched water plus site added water shall not exceed the specified water/cement ratio.
  - 3. The slump, properly tested as per ASTM C143, is less than the specified requirement.
  - 4. The time from leaving the plant does not exceed 90 minutes.
  - 5. Water may be added only to a full batch (full truckload).
  - 6. Maximum amount of water permitted shall be 2 gallons of water per cubic yard of concrete.
  - 7. Truck drum shall make 35 revolutions after water added.
  - 8. The slump as originally tested and the amount of water added shall be recorded on copies of the batch ticket, and shall be signed by the Contractor.

### 3.12 COLD & HOT WEATHER PROCEDURES

- A. ACI cold & hot procedures are minimum requirements. Contractor must protect concrete from freezing, from frost below concrete slabs or footings, from excessive or fast evaporation or drying and provide for proper curing in all types of weather.
- B. Cold weather concreting: Do not mix or place concrete when the temperature is expected to fall below 40 deg. F. during the 24 hour period after placing concrete or below 30 deg. F. during the succeeding 6 days unless proper provision has been made for heating and protecting the concrete. In such cases provide heated concrete in accordance with ASTM C-94 and follow procedures outlined in ACI 306 or the "Manual of Concrete Practice".
- C. Hot weather concreting: During hot weather and periods of low humidity, take adequate precautions to reduce the detrimental effects of these conditions on concrete. When applicable, apply an evaporation retarder which is fully compatible with other materials, methods, and final finish flooring. The approved

practice for hot weather concreting are those approved by ACI 305. Conduct hot weather concreting in accordance with these practices as outlined.

### 3.13 FINISHING CONCRETE

- A. Exposed concrete wall areas, interior and exterior: Wet grind to a smooth finish, and to the approval of the Architect.
- B. Concrete paving, walks, stoops, ramps, and curbs shall receive a broom finish.
- C. Interior floor slabs: One course concrete, steel troweled to a smooth finish, without the use of drier. Screed concrete floor slabs with an approved vibrating screed or other approved methods to ensure a dense concrete.
- D. Interior floor slabs shall be level, and flat within a tolerance of 3/16" in 10 feet, or 1/8" in 10 feet where required by the finish floor manufacturer. Make corrections required to meet flatness levels before installation of flooring materials.
- E. Slope floors to pitch ¼ inch at a 1 foot radius from the edge of floor drains, except where shown with a larger slope or radius on the drawings.

### 3.14 CONCRETE JOINT CONSTRUCTION

- A. Construction Joints: Locate and install construction joints as indicated on drawings. If construction joints are not indicated, locate in manner which will not impair strength and will have least impact on appearance.
  - 1. Keyways: Provide keyways not less than 1-1/2 inches deep.
  - 2. Reinforcement: Continue reinforcement across and perpendicular to construction joints, unless details specifically indicate otherwise.
- B. Expansion Joints: Construct expansion joints where indicated. Install expansion joint filler to full depth of concrete.
- C. Control Joints: Construct control joints in slabs poured on grade to form panels of sizes indicated on drawings, but not more than 10 feet apart in either direction. Panels shall be nearly square and the length shall not exceed 1.5 times the width. L-shaped panels are not acceptable. Provide control joints at column centerlines. Provide additional control joints as necessary to comply with these guidelines. Provide control joints at elevated slabs. In addition, control joints at elevated slabs shall be centered on beam lines and as required to meet the above spacing requirements.
  - 1. Interior: Form control joints by means of saw cuts one-fourth the depth of the slab, performed as soon as possible after slab finishing without dislodging aggregate.
  - 2. Exterior: Form control joints by means of neatly tooling one-fourth the depth of the slab, performed as soon as possible after slab finishing without dislodging aggregate. Sawcut exterior control joints are not acceptable.

### 3.15 CURING CONCRETE

- A. Protect concrete from damage due to premature drying or exposure to rain.
  - 1. At interior concrete flatwork, apply one coat of cure and seal per manufacturer requirements.

- a. Locations which are to have exposed concrete floors without finish flooring, and areas indicated to have Sealed Concrete Floors, shall have two coats total. After initial coat, areas are to be thoroughly cleaned and prepared for the application of one additional coat of cure and seal. The additional coat of cure and seal should be applied after the end of the 28 day concrete cure time.
  - b. Where floors are ground down, reapply cure and seal.
2. At exterior concrete flatwork, cure by placing curing cover over finish surface within two (2) hours after final troweling and leave in place for 7 days.
- a. Follow curing cover manufacturer's requirements, if necessary keep concrete thoroughly wet for a period of seven (7) days when subjected to excessive heat, sun, wind or other elements producing a drying effect.
- B. Make provisions necessary to maintain temperature of concrete at a minimum of 50 deg. F. for at least five (5) days after placement.

### 3.16 QUALITY CONTROL DURING CONSTRUCTION

- A. Contractor shall fully prepare substrate, vapor retarder, reinforcing, formwork, etc, prior to concrete placement. Contractor shall notify Architect by email no less than 24 hours prior to installation of concrete, and provide the Architect the opportunity for observation of the full preparation (including reinforcing, vapor barrier, etc.) prior to the concrete placement. Should the Architect determine that the preparation is improper, incomplete, or otherwise fails to meet the requirements of the specifications, he shall notify Contractor, in writing or by email, stating observed shortcomings. Contractor shall take immediate steps to remedy the stated deficiencies and send a second 24 hour notice by email to Architect, certifying that preparation is now proper & complete & those deficiencies remedied, and again provide the Architect the opportunity for observation of the full preparation prior to the concrete placement.
- B. Should the Contractor fail to give the Architect proper notice prior to installation of any concrete work that concrete work shall be subject to additional testing, including core samples, and other testing methods. Contractor shall properly fill test holes and reimburse the Owner for the additional testing expenses, even if the concrete tests indicate general compliance with the specifications.
- C. Contractor shall take precautions as necessary to prevent curling of flatwork including but not limited to use of curing sheets, misting, and other ACI approved procedures.
- D. Contractor shall take precautions as necessary to provide a consistent appearance in the exposed concrete including but not limited to the use of consistent materials, installation, finishing, jointing, curing, patching, sealing, and other procedures, as well as avoiding "checker board" flatwork installation.

### 3.17 TESTING CONCRETE

- A. The Owner will engage one or more Materials & Geotech Testing agencies to conduct tests for concrete. Refer to Section 01 41 00 - Materials & Geotech

Testing for additional requirements.

### 3.18 ALLOWABLE TOLERANCES OF CONSTRUCTION:

- A. Provide at a minimum concrete tolerances to meet ACI 347 and ACI 117, except as superseded herein:
  - 1. Provide at a minimum the following formed concrete tolerances, except as superseded herein: Provide Class A tolerances for concrete surfaces exposed to view. Provide Class C tolerances for other concrete surfaces.
  - 2. Maximum Variation from Plumb: In lines and surfaces of columns, walls, piers, etc.:
    - a. 1/4 inch in 10 feet.
    - b. 3/8 inch in any story or 20 feet maximum.
    - c. 1/2 inch in 40 feet.
  - 3. Maximum variation from level or grades for exposed foundation wall tops, sills, horizontal grooves, and other conspicuous lines.
    - a. 1/4 inch in any bay or 20 feet maximum.
    - b. 1/2 inch in 40 feet.
  - 4. Maximum variation of linear building line from an established position in plans and related portions of columns, walls and partitions.
    - a. 1/2 inch in any bay or 20 feet maximum.
    - b. 3/4 inch in 40 feet.
    - c. Maximum variation in cross sectional dimensions of thickness of walls: Not less than 1/4 inch smaller or more than 1/2 inch larger.

### 3.19 CONCRETE SURFACE REPAIRS

- A. Patching Defective Areas: Repair and patch defective areas with cement mortar after removing forms.
- B. Mix dry-pack mortar, consisting of one part Portland cement to 2-1/2 parts fine aggregate passing a No. 16 mesh sieve, using only enough water as required for handling and placing.
  - 1. Cut out honeycombs, rock pockets, void over 1/4 inch in any dimension, and holes left by tie rods and bolts down to solid concrete but in no case to a depth less than 1 inch. Make edges of cuts perpendicular to the concrete surface. Thoroughly clean, dampen with water, and brush-coat the area to be patched with bonding agent. Place patching mortar before bonding agent has dried.
  - 2. For surfaces exposed to view, blend white Portland cement and standard Portland cement so that, when dry, patching mortar will match surround color. Provide test areas at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
- C. Repairing Formed Surfaces: Remove and replace concrete having defective surfaces if defects cannot be repaired to satisfaction of Architect. Surface

deflects include but are not limited to honeycomb, cracks, spalls, color or texture irregularities, air bubbles, rock pockets, fins, other projections on the surface, stains, and discolorations that cannot be removed by cleaning. Flush out form tie holes and fill with dry-pack mortar or precast cement cone plugs secured in place with bonding agent.

1. Repair concealed formed surfaces, where possible, containing defects that affect the concrete's durability. If defects cannot be repaired, remove and replace the concrete.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as monolithic slabs, for smoothness and verify surface tolerances specified for each surface and finish. Correct low and high areas as specified. Test unformed surfaces sloped to drain for trueness of slope and smoothness by using a template having the required slope.
1. Repair finished unformed surfaces containing defects that affect the concrete's durability. Surface defects include crazing and cracks in excess of 0.01 inch wide or that penetrate to the reinforcement or completely through non-reinforced sections regardless of width, spalling, pop-outs, honeycombs, rock pockets, and other objectionable conditions.
  2. Correct high areas in unformed surfaces by grinding after concrete has cured at least 14 days. Pay particular attention to slab construction joints, these high areas shall be ground down to minimize the thickness of any filling compound.
  3. Correct low areas in unformed surfaces during or immediately after completing surface finishing operations by cutting out low areas and replacing. Finish repaired areas to blend into adjacent concrete. Proprietary cementitious underlayment compounds may be used when installed as per manufacturer's written recommendations. Substrates shall be cleaned & primed as required and underlayment compound installed as per manufacturer's recommendations. No gypsum underlayment fillers may be used as underlayment compounds.
  4. Repair defective areas, except random cracks and single holes under 1 inch in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose reinforcing steel with at least 3/4 inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials to provide concrete of same type or class as original concrete. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
- E. Repair isolated random cracks and single holes less than 1 inch in diameter with pressure injected repair epoxy in accordance with the repair epoxy manufacturer's recommendations.
- F. Perform structural repairs with prior approval of Architect for method and procedure.
- G. Repair methods not specified above may be used, subject to acceptance of Architect.

END 03 30 00

DIVISION 4 – MASONRY

Section 04 10 00 – Mortar and Grout

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

A. Mortar and Grout

1. Product data.
2. Mortar mix designs. Must clearly state Portland cement, lime, proportional mix, of proper type.
3. Grout mix design.
4. Mortar test reports, ASTM C270 (Lab mixed) & ASTM C780 (Field mixed).
5. Integral Water Repellent (IWR) Admixture, which is the same as the water repellent admixture products used in provided masonry products.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Mortar Mix: Prepackaged or silo mix, must clearly state Portland cement lime mortar mix. Masonry cement or mortar cement mortars are not acceptable.
- B. Masonry: Type N Portland cement lime mortar, complying with ASTM C270, Table 1 (Proportional design), with average compressive strength of 750 psi (800 psi max.).
- C. Grout Mix (for masonry & hollow metal frames): Comply with ASTM C476. Aggregate ASTM C404. Grout shall comply with proportion requirements of ASTM C476. 1 part Portland cement 1/10 part hydrated lime 3 parts sand 2 parts coarse aggregate (for coarse grout only, omit for fine grout). Fine or coarse grout mix as per ACI 530.1. Slump for masonry shall be 8-11 inches. Slump for hollow metal frames shall be 4 inches. Gypsum grout components are not allowed. Mortar is not an acceptable substitution for grout.
- D. Components for field mixed mortar and grout:
1. Cement: Portland cement meeting the requirements of ASTM Specification C 150-81 Type I.
  2. Lime: Hydrated lime meeting standard specifications ASTM C 207 for hydrated lime, Type S.
  3. Sand: Well graded, clean, sharp mason sand meeting ASTM C 144-527.
  4. Water: Clean, fresh and free from salt, dirt and sewage and potable.
  5. Aggregate for Mortar: ASTM C 144.

- 6. Aggregate for Grout: ASTM C 404.
- E. Water Repellent Admixture: Provide water repellent admixture in mortar, which is the same as the water repellent admixture products used in provided masonry products to assure bonding of mortar to masonry products. Use at masonry which has integral water repellent.
- F. Provide mortar, products and accessories compatible with specified masonry products for a complete and proper installation and to assure bonding of mortar to masonry products.
- G. Other Admixtures: The use of calcium chloride or other agents for lowering freezing temperature, or for accelerating, or any other admixtures not listed herein, are not allowed.

### PART 3 - EXECUTION

#### 3.01 MIXING

- A. Mix mortar in such quantities that it will be used within a reasonable time. Re-tempering of mortar is not allowed.

#### 3.02 TESTING MORTAR

- A. The Owner will engage one or more Materials & Geotech Testing agencies to conduct tests for mortar. Refer to Section 01 41 00 - Materials & Geotech Testing for additional requirements.

END 04 10 00

DIVISION 4 – MASONRY  
Section 04 20 00 - Unit Masonry

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

- A. Product data for each of the following.
1. CMU
  2. Split Faced CMU
  3. Burnished Block
  4. Smooth Face masonry
  5. Texture Face masonry
  6. Rough Face masonry
  7. Diffuser CMU (including Burnished if applicable)
  8. Slotted Acoustical CMU
  9. Face Brick including IRA
  10. Water Repellent Admixture
  11. Masonry Cleaning Products
  12. Built-in members, flashings, reinforcing, and accessories
- B. Samples for each of the following.
1. Split Faced CMU
  2. Burnished Block
  3. Smooth Face masonry
  4. Texture Face masonry
  5. Rough Face masonry
  6. Diffuser CMU (including Burnished if applicable)
  7. Slotted Acoustical CMU
  8. Face Brick with cost per thousand as described in the allowance below, for each masonry type and size. Final selection of face brick shall not be approved without written allowance costs.
- C. Control joint layout plans and details.
- D. Final Itemized Cost Accounting for adjustment of masonry allowance

1.03 QUALITY ASSURANCE

- A. Pre-Installation Masonry Meeting: Meeting with Architect and Contractor; Contractor shall review procedures to provide quality installation of the work,

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including: mockup sketch and installation, material selections, accessories, detailing, protection of masonry materials and walls from weather, control joints, cold weather construction and protection, special masonry materials or units or finishes, special or unusual details or conditions, and other requirements of this section.

B. Materials:

1. Do not change source or brands of masonry materials during the Work.
2. Obtain masonry units from one manufacturer, cured (if applicable) by one process and of uniform texture and color, for each type required for each continuous area and visually related areas.
3. Fire-Resistive ratings: Provide materials and construction identical to those of assemblies with fire-resistive ratings determined per ASTM E 119 by a testing and inspection agency, by equivalent concrete masonry thickness, or other means, as acceptable to authorities having jurisdiction.
4. Regulatory Requirements: Comply with the applicable requirements of governing authorities and codes.
5. Unit Masonry Standard: Comply with TMS602/ACI530.1/ASCE6 current edition "Specifications for Masonry Structures," except as otherwise specified.
6. Coordination: Review installation procedures and coordinate with other Work that must be integrated with masonry.

1.04 FIELD-CONSTRUCTED MOCK-UP

A. Prior to installation of masonry, erect mock-up to comply with the following requirements, using preliminary masonry unit selections:

1. Submit a shop drawing sketch of the proposed mock-up panel, prior to mock-up panel construction, showing front and rear elevations.
2. Build Mock-Up approximately 8 feet long by 6 feet high, with a 1 foot 4 inch corner return, full wall thickness, including face and backup wythes as well as masonry accessories. Mockup shall be constructed upon a stable concrete foundation.
3. Include each and every masonry type used on the building, both interior and exterior.
4. Install full range of color, texture, etc. of masonry units in the mock up.
5. Wall construction shall include typical wall vocabulary including flashing and drip edge, drainage mesh, insulation, weep holes, reinforcing, brick and CMU control joints, etc. Leave base of wall flashing partially exposed for viewing flashing installation.
6. Include masonry details such as: special banding, bonding, mortar joint profiles, etc. Foreshorten typical wall construction as required to fully include top of wall cornice, wall banding, etc.
7. Window opening: 16" x 16" opening including jamb, sill, head with lintel, jamb closure wood blocking, weep holes, flashing, and drip edge. Leave flashed lintel partially exposed for viewing flashing and end dam installation. Leave window sill flashing partially exposed for viewing

flashing, flashing support, and end dam installation.

8. Protect the mock-up wall cavity from the elements, with a typical top of masonry wall with wood blocking, flashing, and cap installation at the top of the mock-up wall. Leave one end of the top of wall partially exposed for viewing flashing, flashing support, and blocking installation.
9. Construct the mock-up 21 days prior to the date selections are to be finalized. Approved mockup does not constitute approval to deviate from specifications.
10. Retain and maintain mock-up during construction in undisturbed condition until directed to remove the mock-up. When directed, demolish and remove mock-up from project site.

#### 1.05 MASONRY WARRANTY

- A. The Contractor accepts the responsibility of providing proper workmanship, including completely filling head and bed joints with mortar, proper installing of flashings, and the assumption that leaks through the walls, cracks in the mortar, and improper bonding to masonry units will be due to the Contractor's improper workmanship. Contractor further warrants that the walls will not leak, cracks will not occur in the mortar, and the mortar will be properly bonded to masonry units, and flashing will be properly installed. Contractor agrees to cut out mortar joints to 3/4" depth in areas with either leaks, cracks, or poorly bonding, to point them with mortar, and to replace improperly installed flashings, until such conditions have been stopped. This warranty covers a period of 2 years from the date of Substantial Completion.

#### 1.06 PROJECT CONDITIONS

- A. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602, and as indicated herein.
- B. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
- C. Masonry Protections:
  1. During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
    - a. Where one wythe of multi wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches down face next to unconstructed wythe and hold cover in place.
  2. Do not apply uniform floor or roof loads or concentrated loads for at least 7 days after constructing masonry walls or columns which support these loads.
  3. Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Remove immediately any grout, mortar, and soil that comes in contact with such masonry.

4. Protect base of walls from rain-splashed mud and mortar splatter.
5. Protect sills, ledges, and projections from grout and mortar droppings.
6. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes from grout and mortar droppings.

## PART 2 - PRODUCTS

### 2.01 MASONRY UNITS

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work; if units are installed exposed they will be subject to rejection and replacement.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction, and as specified within.

### 2.02 CONCRETE MASONRY

- A. Concrete block: Standard medium weight concrete block, ASTM C-90, Grade N, Type I, for concrete masonry units.
  1. Interior partitions and exterior back-up medium weight except as otherwise called for on drawings of Haydite, Arcalite, or Solite Plus Limestone. Metallic admixtures not allowed.
  2. Maximum weight of thoroughly cured 8" x 16" medium weight block: 34 lbs. Density, 105-125 lbs. per cu. ft. Blocks shall be of true height so courses and joints line up and be uniform. Interior exposed block shall have a fine to dense uniform surface texture free from superficial defects, to be supplied from one manufacturer.
  3. Minimum net area compressive strength of concrete masonry units shall be 3,000 psi or net area compressive strength of masonry, f'm shall be 1775 by the prism strength test method.
  4. The block, other than those which are autoclave cured, shall be a minimum of 90 days old. Furnish a certification that blocks furnished for this project are a minimum of 90 days when delivered.
  5. Fire Rating:
    - a. 4" and 6" concrete block: Certified classification C-1 (1-hour rating).
    - b. 8" and 12" concrete block: Certified classification C-2 (2-hour rating).
  6. Earlier delivery may be approved when the manufacturer utilizes special curing, or drying processes, or both, which insure the delivery of cured units with a moisture content of less than 30% of total absorption.
  7. Special shapes: At interior block, exposed outside vertical corners shall be bull nosed except door and window jambs, unless shown otherwise. Provide bull nosed units for window sills, unless shown otherwise. Bull nose units shall be manufactured, not field fabricated. Lintel & bond

beam block with "U" shape for use at block lintels and bond beams as called for by the Drawings. Special "control joint" slotted sash units to be provided at masonry control joints. Use solid concrete brick of load bearing grade, where required to adjust steel bearing elevation.

- B. Burnished Block: Burnished block to be factory ground face at exposed surfaces, cast-in integral color, with factory applied clear sealer. Block shall have integral waterproofing, equal to W.R. Grace Dry-Block, with a compatible mortar waterproofing product available from the same waterproofing manufacturer. Approved manufacturers, subject to the requirements herein:
1. Northfield Block Co./Trendstone; Ground Faced Masonry; Provide manufacturer's full color options for selection.
  2. Provide 4", 8", 12" and bond beam units as indicated and required to complete the Work.
  3. Special shapes: At interior block, exposed outside vertical corners shall be factory manufactured bull nose units, except at door and window jambs. Provide special 135° corner units at angled outside corners. Provide special units with multiple ground surfaces as required or indicated to maintain uniform, consistent finish throughout area.
  4. Special finishes: At exterior and interior block, seal walls with one coat of Trencat low VOC 20% solids acrylic sealer (or comparable product, products must be approved by masonry unit manufacturer) clear acrylic sealer. Apply sealer per manufacturer's recommendations. Seal units after properly removing mortar drippings, smears, etc., and proper approved cleaning methods have been accomplished. Protect adjacent dissimilar surfaces, including but not limited to wood, glass, aluminum, prefinished metal, etc.
- C. Split Faced CMU: Standard medium weight split faced concrete block, ASTM C-90, Grade N, Type I, for concrete masonry units. Cast-in integral color, with integral waterproofing, equal to W.R. Grace Dry-Block, with a compatible mortar waterproofing product available from the same waterproofing manufacturer. Approved manufacturer, subject to the requirements herein:
1. Trenwyth Industries, Split Face Concrete Masonry Units; Provide manufacturer's full color options for selection.
  2. Sizes: 8" x 16" x 8"w. Provide factory finished special shapes for corner units (edge returns to have factory texture matching face), door jambs (smooth returns), and as shown or otherwise necessary to accomplish the work.
  3. Maximum weight of thoroughly cured 8" x 16" medium weight block: 34 lbs. Density, 105-125 lbs. per cu. ft. Blocks shall be of true height so courses and joints line up and be uniform.
  4. Minimum net area compressive strength of concrete masonry units shall be 3,000 psi or net area compressive strength of masonry, f'm shall be 1775 by the prism strength test method.
  5. The block, other than those which are autoclave cured, shall be a minimum of 90 days old. Furnish a certification that blocks furnished for this project are a minimum of 90 days when delivered.

6. Earlier delivery may be approved when the manufacturer utilizes special curing, or drying processes, or both, which insure the delivery of cured units with a moisture content of less than 30% of total absorption.
- D. Smooth Face Masonry, Texture Face Masonry, and Rough Face Masonry: Units shall have a fine grain textured appearance similar to natural Indiana Limestone, with no surface crazing or pin holes. Units shall meet the requirements of the Cast Stone Institute, except where listed here otherwise. Units shall have a minimum compressive strength of 5000 PSI and a maximum moisture absorption ASTM C1195 of 6%. Units shall have cast-in integral color or natural aggregate color as selected. Block shall have integral waterproofing, equal to W.R. Grace Dry-Block, with a compatible mortar waterproofing product available from the same waterproofing manufacturer. Units shall be delivered to the job site packaged in a manner to minimize damage to the faces in shipment. The face of masonry units shall be of uniform color, exposure and texture. Surfaces are to be factory coated with a clear, unpigmented sealer.
1. Trenwyth Industries, Cordova Stone
    - a. Smooth; Ground face.
    - b. Texture; Texture face
    - c. Rough; Chisel face.
  2. Sizes: 4" x 24" x 4"w, 8" x 24" x 4"w, and as indicated or required. Provide factory finished special shapes for corner units (edge returns to have factory texture matching face), jambs (smooth returns as indicated), sills, and copings as shown or otherwise necessary to accomplish the work.
- E. Diffuser CMU and Burnished diffuser CMU to be 8" and 12" "Diffuser Blox" without acoustical slots and filler by RPG Diffuser Systems, Inc. Provide necessary components to provide a complete and proper installation. Diffuser CMU to be laid in stack bond and reinforced with vertical and horizontal reinforcing bars grouted in solid as indicated and per manufacturer's requirements. Units at Auditorium and Stage areas to have cast-in integral color matching adjacent burnished CMU units. After installation, seal burnished units after properly removing mortar drippings, smears, etc., and proper approved cleaning methods have been performed. Seal interior walls with one coat of TK Sealer, "Bright Seal" (or comparable product, products must be approved by masonry unit manufacturer) clear acrylic sealer. Apply sealers per manufacturer's recommendations. Protect adjacent dissimilar surfaces, including but not limited to glass, aluminum, prefinished metal, etc.
- F. Slotted Acoustical buCMU: Slotted Acoustical CMU in walls as indicated to be 8" "Soundblox", Type RSC, by Proudfoot Company, Inc. Provide incombustible fibrous filler in each cavity. Provide right and left hand half slot face units at ends to allow running bond to be maintained with straight vertical end slot patterns. Provide RSC-RF units at vertical reinforced locations.

## 2.03 FACE BRICK

- A. General: Provide shapes indicated and as follows:
1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.

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2. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
  3. Provide special shapes as detailed or required, including corner brick (other than 90 degree corners) angle units, solid units, etc. Use solid brick at recessed or projected courses, and at corbelling.
  4. Initial Rate of Absorption (IRA): Provide test data of Initial Rate of Absorption to verify less than 30g / 30sq. in. per minute when tested per ASTM C 67.
  5. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
- B. Face brick to be the same color, manufactured by the same manufacturer, and produced on the same run to assure color match. Face brick to be in sizes and textures as selected.

Specifier Note: Must be edited and allowances updated for each project

1. Face brick Type 'A' shall be furnished where indicated or required. Face brick shall meet A.S.T.M. C-216, Grade SW, Type FBX, velour finish.
  - a. Utility size (3-5/8" x 3-5/8" x 11-5/8")
    1. Typical U.O.N.
    2. Material cost allowance of \$1,500 per thousand F.O.B. jobsite.
  - b. Closure size (3-5/8" x 3-5/8" x 7-5/8")
    1. Material cost allowance of \$1,200 per thousand F.O.B. jobsite.
  - c. Modular size (2-1/4" x 3-5/8" x 7-5/8")
    1. Material cost allowance of \$900 per thousand F.O.B. jobsite.
2. Face Brick Type 'B' shall be furnished where indicated or required. Face brick shall meet A.S.T.M. C-216, Grade SW, Type FBX, vertically struck wire cut finish.
  - a. Utility size (3-5/8" x 3-5/8" x 11-5/8")
    1. Typical U.O.N.
    2. Material cost allowance of \$1,600 per thousand F.O.B. jobsite.
  - b. Closure size (3-5/8" x 3-5/8" x 7-5/8")
    1. Material cost allowance of \$1,300 per thousand F.O.B. jobsite.
  - c. Modular size (2-1/4" x 3-5/8" x 7-5/8")
    1. Material cost allowance of \$950 per thousand F.O.B. jobsite.
3. Face Brick Type 'C' shall be furnished where indicated or required. Face brick shall meet A.S.T.M. C-216, Grade SW, Type FBX, smooth finish.

- a. Utility size (3-5/8" x 3-5/8" x 11-5/8")
    - 1. Typical U.O.N.
    - 2. Material cost allowance of \$1,600 per thousand F.O.B. jobsite.
  - b. Closure size (3-5/8" x 3-5/8" x 7-5/8")
    - 1. Material cost allowance of \$1,300 per thousand F.O.B. jobsite.
  - c. Modular size (2-1/4" x 3-5/8" x 7-5/8")
    - 1. Material cost allowance of \$950 per thousand F.O.B. jobsite.
- C. Allowance: Provide material cost allowance noted above for each masonry type, F.O.B. jobsite, unloaded in a location as directed by Contractor.
- 1. Submit substantiating paperwork for review prior to final approval of the brick selections.
  - 2. Final Itemized Cost Accounting will be reviewed for adjustment of masonry allowance.

#### 2.04 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: Billet steel deformed bars complying with ASTM A 615/A 615M, Grade 60.
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
  - 1. Interior Walls: Class 1 Mill galvanized, carbon steel (ASTM A641).
  - 2. Exterior Walls: Class B-2 Hot-dip galvanized, carbon steel (ASTM A153).
  - 3. Wire Size for Side Rods: 9 gauge.
  - 4. Wire Size for Veneer Ties: 9 gauge.
  - 5. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
  - 6. Masonry Veneer Horizontal Joint Reinforcement at Wood or Metal Stud Walls: 9 gauge wire.
  - 7. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.
- C. Horizontal Joint Reinforcement: Welded-wire units prefabricated with prefabricated corner and tee units. Width of reinforcing shall be not less than two inches (2") less than total width of wall. Provide prefabricated corners and/or tees at intersecting masonry walls.
  - 1. For multi-wythe masonry, provide type as follows: Ladder Design with cross rods spaced not more than 16 inches o.c. and number of side rods as follows: Number of side rods for multi-wythe concrete masonry: One side rod for each face shell of hollow masonry units more than 4 inches in nominal width plus one side rod for each wythe of masonry 4 inches or less in nominal width. Provide drip at cross rod between wythes.
  - 2. For single-wythe masonry, provide type as follows with single pair of side

rods: Truss Design with continuous diagonal cross rods spaced not more than 16" o.c.

3. For multi-wythe masonry, where construction of the concrete block precedes the installation of the exterior veneer, or alignment or horizontal masonry joints do not align between wythes, provide: Ladder Design with cross rods spaced not more than 16 inches o.c., with side rods & accessories as follows: Two side rods at the interior concrete block masonry. One rod at 4" thick exterior masonry wythe, or two ladder type rods at exterior 6" or thicker masonry veneer. 3/16" diameter wire U anchor fabricated to secure a similar wire bent tie. Provide an interlock system (Holmann & Barnard, Inc. "Seismicclip" or comparable), such that the exterior masonry wire reinforcing is tied back to the interior reinforcing.
4. Manufacturers:
  - a. Holmann & Barnard, Inc.
  - b. Heckmann Building Products, Inc.

## 2.05 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
  1. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
  2. Steel Sheet, Galvanized after Fabrication: ASTM A 1008/A 1008M, Commercial Steel, with ASTM A 153/A 153M, Class B coating.
  3. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8" cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Masonry anchors at poured in place concrete wall back up with 3/4" minimum joint depth shall be hot dipped galvanized 3/16" dia. triangular wire tie of the proper length for embed depth required with dovetail clip (corresponding cast in 12 ga. galv. metal dovetail slot by installing contractor from same manufacturer, verify and coordinate exact requirements), and premolded horizontal wire reinforcing seismic clip. Items to be hot dipped galvanized. Provides for continuous horizontal wall reinforcement to be secured to ties.
  1. Hohmann & Barnard, Inc.; #315-BT S.I.S.
  2. Heckman Building Products, Inc.; comparable to (1)
- D. Interior masonry wall anchors at poured in place concrete wall back up with 3/4" minimum joint depth shall be mill galvanized 3/16" dia. triangular wire tie of the proper length for embed depth required with channel clip, premolded horizontal wire reinforcing seismic clip, and surface mounted mill galvanized 12 ga. metal channel slot receiver strips. Provides for continuous horizontal wall reinforcement to be secured to ties.
  1. Hohmann & Barnard, Inc.; #363-BT S.I.S. and #362-C channel
  2. Heckman Building Products Inc.; comparable to (1)

- E. Intersecting Masonry Wall Anchors: Wire Mesh Wall Tie: 1/2" sq. x 16 gauge hot dipped galvanized wire, 16" long panel x 2" width less than wall. Use as tie between intersecting masonry walls.
  - 1. Hohmann & Barnard; MWT
  - 2. Heckman Building Products; No. 269
- F. Masonry wall anchors at embedded steel columns and beams shall be mill galvanized, hot dipped galvanized at exterior walls, 3/16" dia. triangular wire ties of the proper length for embed depth required with proper end clip or strap (corresponding surface anchored 12 ga. channel slot or wire tie receiver strips from same manufacturer as ties, provided by structural steel manufacturer, verify and coordinate exact requirements). Provides for continuous horizontal wall reinforcement to be secured to ties.
  - 1. Hohmann & Barnard, Inc.; #315-BT S.I.S.
  - 2. Heckman Building Products, Inc.; comparable to (1)
- G. Masonry veneer wall anchors at concrete or masonry back up, and embedded steel columns, with 3/8" joint depth, shall be 3/16" dia. wire tie of the proper length for embed depth required with surface mounted 12 ga. metal anchorage strap. Items to be hot dipped galvanized. Provides for continuous horizontal wall reinforcement to be secured to ties.
  - 1. Hohmann & Barnard, Inc.; #345-BL S.I.S.
  - 2. Heckman Building Products Inc.; comparable to (1)
- H. Masonry veneer wall anchors at wood or metal frame wall construction shall be 3/16" dia. triangular wire tie of the proper length for embed depth required with channel clip, pre-molded horizontal wire reinforcing seismic clip, and surface mounted 12 ga. metal channel slot receiver strips of required type for the specified rigid cavity wall insulation thickness. Items to be hot dipped galvanized. Provides for continuous horizontal 9 gauge wire wall reinforcement to be secured to ties.
  - 1. Hohmann & Barnard, Inc.; #363-BT S.I.S. and #362-CX channel
  - 2. Heckman Building Products Inc.; comparable to (1)
- I. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM A 325M, Property Class 4.6); with comparable hex nuts and, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.

## 2.06 EMBEDDED FLASHING MATERIALS

- A. Flexible Flashing: Use the following unless otherwise indicated, for damp course and through wall flashing:
  - 1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040" (40 mil.).
    - a. Products: Subject to compliance with requirements, provide one of the following available products:
      - 1. Grace Construction Products, W. R. Grace & Co. - Conn.;

Perm-A-Barrier Wall Flashing.

2. IPCO; Self Adhesive Rubberized Asphalt Flashing.
3. W.R. Meadows, Inc., Air-Shield Thru-Wall Flashing

b. Associated Flashing Accessories:

1. Mastic: Mastic compatible with flashing materials, supplied by flashing manufacturer.
2. Termination bar: Stainless steel, type 304, Size: 1/8" thick x 1" wide with holes pre-drilled 6" or 8" o.c.
3. Primer: Primer compatible with flashing materials, supplied by flashing manufacturer.
4. Drip Edge Flashing: Shall be stainless steel, type 304, 26 gauge, 1 5/8" min. depth with 2B finish, shall be installed in accordance with manufacturer's recommendation. Provide preformed corners where available from manufacturer. Approved manufacturers subject to requirements as listed:
  - a. Hohmann & Barnard, Inc.
  - b. Sandell Manufacturing.
  - c. IPCO.
5. Flashing Support within wall cavity: IPCO stainless steel (type 304 minimum 28ga) cavity bridge, type F, L, Z, as applicable.
6. Preformed Door Jamb End Dam: IPCO stainless steel (type 304 minimum 28ga) with diagonal end dam. Use at unsupported end dam conditions.

## 2.07 MISCELLANEOUS MASONRY ACCESSORIES

- A. Control joint shear key to be premolded joint filler for use with CMU sash block.
  1. Hohmann & Barnard; RS Series
  2. Heckman Building Products, Inc.; comparable to (1)
  3. Dur-O-Wall; DA 2000 Series
- B. Expansion Joint Filler, Non-metallic (for use at exterior wythe of exterior masonry walls at Expansion Joint): Pre-molded filler strips complying with ASTM D 1056, Type 2, (closed cell), Class A (cellular rubber and rubber-like materials with resistance to petroleum base oils), Grade 1 (compression-deflection range of 2 to 5 psi), compressible up to 35 percent, of width indicated, formulated from the following material:
  1. Neoprene.
  2. Urethane.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep Hole Rope: Sash cord, cotton, 3/8" diameter, 12" minimum length.
- E. Cavity Drainage Mesh: Free-draining mesh, made from polymer strands that will

not degrade within the wall cavity; 1" thick by approximately 10 inches high, polyethylene, polyester, or nylon mesh, 90% open weave, with a top surface in a trapezoidal (dovetail) configuration designed to allow moisture to flow downward in the cavity to masonry flashing and weeps. Drainage system shall be continuous at base of wall and above flashed installations where the cavity extends at least 24" above. Match clear cavity width to drainage mesh thickness. Clear cavity width should be no more than 1/4" wider than the drainage mesh thickness. Make adjustments to the clear cavity width, by installing an additional 12" high piece of rigid cavity wall insulation, thickness as required, in back of the drainage mesh, such that there remains no more than 1/4" of clear cavity space. Approved manufacturers, subject to compliance with these requirements:

1. Mortar Net USA, Ltd.; Mortar Net.
2. Hohmann & Barnard, Inc.; Mortar Trap.
3. CavClear; Mortar Drop Stop.

## 2.08 MASONRY CLEANERS

- A. Proprietary Masonry Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
  1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. Diedrich Technologies, Inc.
    - b. ProSoCo, Inc.

## PART 3 - EXECUTION

### 3.01 INSTALLATION, GENERAL

- A. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- B. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
- C. Wetting of Brick: Wet brick before laying if initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested per ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.
- D. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond with vertical joint in each course centered on units in courses above and below.
  1. Match existing bond unless noted otherwise

### 3.02 TOLERANCES

- A. Dimensions and Locations of Elements:
  1. For dimensions in cross section or elevation do not vary by more than

plus 1/2" or minus 1/4".

2. For location of elements in plan do not vary from that indicated by more than plus or minus 1/2".
3. For location of elements in elevation do not vary from that indicated by more than plus or minus 1/4" in a story height or 1/2" total.

B. Lines and Levels:

1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4" in 10 feet, or 1/2" maximum.
2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8" in 10 feet, 1/4" in 20 feet, or 1/2" maximum.
3. For vertical lines and surfaces do not vary from plumb by more than 1/4" in 10 feet, 3/8" in 20 feet, or 1/2" maximum.
4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8" in 10 feet, 1/4" in 20 feet, or 1/2" maximum.
5. For lines and surfaces do not vary from straight by more than 1/4" in 10 feet, 3/8" in 20 feet, or 1/2" maximum.

C. Joints:

1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8", with a maximum thickness limited to 1/2".
2. For head and collar joints, do not vary from thickness indicated by more than plus 3/8" or minus 1/4".
3. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8".

### 3.03 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond pattern for exposed masonry as indicated in paragraph 3.01. Do not use units with less than nominal 4" horizontal face dimensions at corners or jambs.
  1. Lay concealed masonry with all units in a wythe bonded by lapping not less than 2 inches. Bond and interlock each course of each wythe at corners.
- C. Discard units with cracked faces, chipped edges, or corners or other defects that affect appearance or performance.
- D. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
  1. Install steel lintels, bearing plates, etc. plumb and level.
- E. Fill cores in hollow CMU's with grout 24 inches each way under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.

- F. Chases. Ascertain from each trade subcontractor where chases or openings for pipes, wires, ducts, etc., are to go and do not wait for such information to be given. Construct such chases as shown or required.
- G. Build in anchors, bolts, flashings, wall plugs, nailing strips, frames, etc., as may be required. Place these materials according to directions of those manufacturers who furnish them, except as exceeded herein.
- H. Provide openings as shown or required for windows, doors, as well as mechanical, electrical, plumbing, and other items."
- I. Grout hollow metal frames in masonry or concrete partitions, filling with concrete grout vertical frame members, except for the bottom 8". Do not grout hollow metal frames at gypsum walls. Grout shall comply with ASTM C 476, mixed to provide a 4" maximum slump, and hand troweled into place. Do not use grout mixed to a thin/pumpable consistency, or with an accelerant, or with antifreeze, or with a chloride, or a gypsum grout, any of which may cause premature rusting of frames.
- J. Rake and caulk exposed sill and coping head joints; rake joints 1/2" deep, install backer rod and sealant.

### 3.04 CONTROL JOINTS

- A. Exterior wall control joints shall be provided where indicated on the drawings.
- B. Interior wall control joints shall be provided at the following applications:
  - 1. At non-vertically reinforced wall runs where the length (L) to height (H) ratio (L/H) exceeds 2. Where practicable, place required joint near corners, near intersecting walls and at edges of large openings.
  - 2. At changes in wall height or thickness including at pilasters.
  - 3. At locations where structural columns are fully encased within masonry.

### 3.05 MORTAR BEDDING AND JOINTING

- A. Lay hollow brick and CMU's as follows:
  - 1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
  - 2. With webs fully bedded in mortar in courses of piers, columns, and pilasters.
  - 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
  - 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated. Joints 16" above ceilings, and that will not be exposed shall be struck flush.

### 3.06 CAVITY WALLS

- A. Bond wythes of cavity walls together using the following methods:
  - 1. Individual Metal Ties: Provide ties as shown installed in horizontal joints, but not less than one metal tie for 2.67 sq. ft. of wall area spaced not to exceed 24 inches o.c. horizontally and 16 inches o.c. vertically. Stagger ties in alternate courses. Provide additional ties within 12 inches of openings and space not more than 36 inches apart around perimeter of openings. At intersecting and abutting walls, provide ties at no more than 16 inches o.c. vertically.
  - 2. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
    - a. Where bed joints of both wythes align, use ladder-type reinforcement extending across both wythes or adjustable two-piece tab-type reinforcement if veneer is installed later.
    - b. Where bed joints of wythes do not align, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties.
    - c. Where one wythe is of clay masonry and the other of concrete masonry, use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.
- C. Installing Cavity-Wall Insulation: Place small dabs of adhesive, spaced approximately 12 inches o.c. both ways, on inside face of insulation boards, or attach with plastic fasteners designed for this purpose. Fit courses of insulation between wall ties and other confining obstructions in cavity, with edges butted tightly both ways. Press units firmly against inside wythe of masonry or other construction as shown. Tape joints and around penetrations with manufacturer's approved tape.

### 3.07 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8" on exterior side of walls, 1/2" elsewhere. Lap reinforcement a minimum of 6 inches.
  - 1. Space reinforcement not more than 16 inches o.c.
  - 2. Space reinforcement not more than 8 inches o.c. in foundation walls and parapet walls.
  - 3. Provide reinforcement not more than 8 inches above and below wall openings and extending 12 inches beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.
- D. Provide continuity at corners by using prefabricated L-shaped units.

### 3.08 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

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- A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
  - 1. Provide an open space not less than 1/2" wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
  - 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
  - 3. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally.

### 3.09 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to concrete, and masonry backup with seismic masonry-veneer anchors to comply with the following requirements:
  - 1. Fasten screw-attached and seismic anchors to concrete and masonry backup with metal fasteners of type recommended by manufacturer. Use two fasteners unless anchor design only uses one fastener.
  - 2. Embed tie sections connector sections and continuous wire in masonry joints. Provide not less than indicated air space between back of masonry veneer and face of concrete, or masonry backup.
  - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
  - 4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

### 3.10 ANCHORING MASONRY VENEERS TO STUD FRAMING

- A. Anchor masonry veneers to wood or metal stud framing backup with seismic masonry-veneer anchors to comply with the following requirements:
  - 1. Place seismic anchor channels on face of rigid cavity wall insulation, fasten by screw-attached method with metal spacer clips through rigid insulation and wall sheathing to wall framing with metal fasteners of type recommended by manufacturer.
  - 2. Insert wire tie section into channel, embed tie section connector sections and continuous horizontal reinforcement wire (set in tie section seismic clip) in masonry joints. Provide not less than indicated air space between back of masonry veneer and face of sheathing backup. Allow for rigid wall insulation clearance and installation requirements.
  - 3. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
  - 4. Space anchors as indicated, but not more than 16 inches o.c. vertically and 24 inches o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. of wall area. Install additional anchors within 12 inches of openings and at intervals, not exceeding 36 inches, around perimeter.

### 3.11 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles,  
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lintels, ledges, other obstructions to downward flow of water in wall, and where indicated.

- B. Install flashing as follows unless otherwise indicated:
1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
  2. At lintels and shelf angles, extend flashing a minimum of 6 inches above drainage mat. At heads and sills, extend flashing 6 inches at ends and turn up not less than 2 inches to form end dams.
  3. Install stainless steel metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2" back from outside face of wall and adhere flexible flashing to top of stainless steel metal drip edge.
  4. Install stainless steel metal flashing termination beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2" back from outside face of wall and adhere flexible flashing to top of stainless steel metal flashing termination.
- C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep rope products to form weep holes.
  2. Provide rope and weeps in head joints in first course at base of wall as well as every location immediately above flashing. Provide at the bottom of head joints, spaced as follows: minimum of 16" o.c. at masonry units which are equal to or less than 8" long; 24" o.c. at masonry units which are 12" long; 16" o.c. at masonry units which are 16" long; 24" o.c. at masonry units which are 24" long.
  3. Lay rope on flashing and properly extend rope into cavity and run horizontally behind veneer masonry, below cavity drainage mat.
- D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

### 3.12 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
  2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has

attained enough strength to resist grout pressure.

1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
2. Limit height of vertical grout pours to not more than 60 inches.

### 3.13 PROTECTION OF WORK AND MATERIAL

- A. Refer to Project Conditions paragraph 1.06 for further requirements.
- B. Keep wall surfaces and projections free of droppings and mortar smears.
- C. Corners of entrances and jambs and external corners that could be damaged shall be protected by wood and boxing.
- D. Cover masonry units stored on the site, and keep dry until after placed in the wall. Cover tops of walls, projections, openings, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress. Extend cover a minimum of 24 inches down both sides and secure cover in place against high winds, rain, snow, and ice. Concrete masonry shall be thoroughly cured and dry before placement. Keep stored masonry away from contact with the ground.
- E. Do not perform work when the temperature might drop below freezing before initial set without proper protection and procedures as herein described.

### 3.14 COLD WEATHER CONSTRUCTION/PROTECTION

- A. Cold Weather Construction: Perform the following construction procedures while masonry work is progressing. Temperature ranges indicated below apply to air temperatures existing at time of installation. In heating mortar and grout materials, maintain mixing temperature selected within 10° F. Do not heat water for mortar and grout to above 160° F.
  1. 40° F to 32° F.:

Mortar: Heat sand or mixing water to produce mortar temperature between 40° F. and 120° F.

Grout: Follow normal masonry procedures.
  2. 32° F. to 25° F.:

Mortar: Heat mixing water and sand to produce mortar temperatures between 40° F. and 120° F.; maintain temperature of mortar until used above freezing.

Grout: Heat grout materials to 90° F. to produce in-place grout temperature of 70° F.
  3. 25° F. to 20° F.:

Mortar: Heat mixing water and sand to produce mortar temperatures between 40° F. and 120° F.; maintain temperature of mortar until used above freezing.

Grout: Heat grout materials between 70° F. and 120° F to produce in-place grout temperature of 70° F.
  4. Provide enclosure and auxiliary heat to maintain an air temperature of at

least 40° F.

5. 20° F. and below:

Mortar: Heat mixing water and sand to produce mortar temperatures between 40° F. and 120° F.

Grout: Heat grout materials to 90° F. to produce in-place grout temperature of 70° F.

Masonry Units: Heat masonry units so that they are above 40° F. at time of laying.

Provide enclosure and auxiliary heat to maintain an air temperature of at least 40° F. for 24 hours after laying units.

- B. Cold Weather Protection: These requirements apply after masonry is placed and are based on anticipated minimum daily temperature for grouted masonry and anticipated mean daily temperature for ungrouted masonry. Protect completed masonry in the following manner.

1. 40° F. to 25° F.:

Completely cover masonry with weather-resistive membrane for at least 24 hours.

2. 25° F. to 20° F.:

Completely cover masonry with weather-resistive insulating blankets or similar protection for at least 24 hours, 48 hours for grouted masonry.

3. 20° F. and below:

Except as otherwise indicated, maintain masonry temperature above 32° F. for 24 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps or other methods proven to be satisfactory. For grouted masonry maintain heated enclosure to 40° F. for 48 hours.

### 3.15 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.

- B. Inspections: Level 1 special inspections according to the "International Building Code" where the height (H) of masonry or length of masonry (L) to thickness (T) of masonry ratio (H/T or L/T) exceeds 18.

1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
3. Place grout only after inspectors have verified proportions of site-prepared grout.

- C. Testing Prior to Construction: One set of tests.

- D. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion

thereof.

- E. Clay Masonry Unit Test: For each type of unit provided, according to ASTM C 67 for compressive strength.
- F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- G. During progress of work, mortar tests shall be made by an approved testing laboratory in accordance with "Standard Test Method for Preconstruction and Construction Evaluation of Mortars for Plain and Reinforced Unit Masonry", A.S.T.M. C 780. Include the cost of tests in contract price.
  - 1. Perform one series of mortar tests for each 10,000 square feet of gross building area.
- H. If the test results indicate that the mortar does not meet specified requirements, Architect shall have the right to request additional tests to be made on portions of the building affected at the Contractor's expense. Should the results of the additional testing fail to meet specified requirements, it is the Contractor's responsibility to remove and replace such faulty masonry work as determined by the Architect.

### 3.16 REPAIRING, POINTING, AND CLEANING

- A. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- B. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
  - 1. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes.
  - 2. Clean brick by bucket-and-brush hand-cleaning method described in BIA Technical Notes 20.
  - 3. Clean masonry with a proprietary commercial cleaner applied according to manufacturer's written instructions only if above methods do not achieve approved results.
  - 4. Protect surfaces from contact with cleaner.
  - 5. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
  - 6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

END 04 20 00

DIVISION 6 - WOOD & PLASTICS  
Section 06 10 00 – Rough Carpentry

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified in this section.

1.02 REFERENCE

- A. Framing Standard: American Forest & Paper Association's WCD 1, "Details for Conventional Wood Frame Construction".

1.03 SUBMITTALS

- A. Product Data
- B. Wood Treatment Data:
  - 1. Rot-Resistant Treatment: Submit Certification by treating plant stating type of preservative solution and pressure process used, net amount of preservative retained and conformance with applicable standards.
  - 2. Fire-Retardant Treatment: Submit Certification by treating plant that treatment material complies with specified standard and other requirements.
    - a. Include certified classification from manufacturer's testing agency, either Underwriters Laboratories, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction, including meeting or exceeding the requirements of the specified rated assembly testing agency.
- C. Certification: Modification of Engineered Wood Product (LVL) components.

1.04 PRODUCT HANDLING

- A. Keep materials under cover and dry. Protect against exposure to weather and contact with damp or wet surfaces. Provide for air circulation within and around stacks and under temporary coverings including polyethylene and similar material.

1.05 PROJECT CONDITIONS

- A. Fit carpentry work to other work; scribe and cope as required for accurate fit. Correlate location of nailers and similar supports to allow attachment of other work.

PART 2 - PRODUCTS

2.01 LUMBER

- A. Rough lumber for plates, blocking, nailers, etc., without large knots or splits shall be a minimum of No. 2 & better Doug-Fir Larch, Southern Yellow Pine, or SPF's (Spruce-Pine-Fir South) with fiber stress (fb) = 1,100 psi minimum. Provide continuous and intermediate lengths as required.
  - 1. Utility, standard, stud and No. 3 grade of any lumber species are not permitted.

2. Rough lumber in contact with concrete or earth, to be pressure treated for rot resistance as specified herein.

## 2.02 PLYWOOD

- A. Plywood floor decking to be 3/4" nominal thickness, T & G edge, Group 1 species.
  1. 23/32 PERF CAT APA Rated STURD-I-FLOOR 16" oc Exposure 1.
- B. Plywood wall sheathing to be 5/8" nominal thickness, square edge, Group 1 species.
  1. 19/32 PERF CAT APA Rated Sheathing 24/16 Exposure 1.
- C. Plywood roof sheathing to be 5/8" nominal thickness, square edge, Group 1 species.
  1. 19/32 PERF CAT APA Rated Sheathing 40/20 Exposure 1.
- D. Plywood as indicated for roofing nailer assemblies, blocking, etc. to be 3/4" thickness, square edge, Group 1 species.
  1. 3/4 PERF CAT APA C-C Exposure 1.
- E. Plywood as indicated for use at stainless steel countertops and sills to be 3/4" nominal thickness, square edge, Group 1 species.
  1. 23/32 PERF CAT APA C-C Plugged Exterior.
- F. Miscellaneous plywood indicated within walls and/or roof areas to match the specified plywood wall or roof sheathing for the application condition.
- G. Interior wall sheathing, to receive surface applied FRP panels, to be 1/2" nominal thickness sanded plywood panels, square edge, Group 1 species.
  1. 15/32 PERF CAT APA A-D Exposure 1.
- H. Plywood as indicated for use as an interior exposed mounting board for low voltage equipment such as FACP, TTB, etc. to be at a minimum 5/8" nominal thickness, square edge, Group 1 species.
  1. 19/32 PERF CAT APA A-D Exposure 1
- I. Miscellaneous plywood for temporary use such as enclosures and protection boards to be at a minimum 5/8" thickness, square edge, Group 1 species.
  1. 19/32 PERF CAT APA C-C Exposure 1.
  2. 19/32 PERF CAT APA C-C Plugged Exterior; provide if subject to prolonged exposure to weather affecting the weather tightness of the installation.

## 2.03 TREATED WOOD PRODUCTS

- A. Meet requirements specified in 2.01 for Lumber and 2.02 Plywood.
- B. Rot Resistant Treated: Rough lumber indicated to be treated, in contact with concrete, gravel, earth, and where indicated, exposed to all weather cycles, to be pressure treated for rot resistance, AWPA Category UC4a for exterior items with ground contact, Kiln dried after treatment to a maximum moisture content of 19 percent. Products containing arsenic, chromium, or inorganic boron are not acceptable. Warped material is not acceptable.
  1. Exterior construction, exposed to elements

- C. Rot Resistant Treated: Rough lumber indicated to be treated, above grade, protected from weather, to be pressure treated for rot resistance, AWPA Category UC2 for interior items without ground contact, Kiln dried after treatment to a maximum moisture content of 19 percent. Products containing arsenic, chromium, or inorganic boron are not acceptable. Warped material is not acceptable.
  - 1. Interior construction, concealed
- D. Fire Retardant Treated (FRT): Rough lumber indicated to be fire-retardant-treated (FRT), to be pressure impregnated with fire-retardant chemicals, AWPA Category UCFA for interior items without ground contact and protected from exterior exposure; identify lumber with appropriate classification marking of Underwriters Laboratories, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction. Maximum moisture content of 19 percent. Warped material is not acceptable.
  - 1. Interior construction, concealed
- E. Fire Retardant Treated (FRT) Plywood Roof Sheathing: Plywood roof sheathing indicated to be fire-retardant-treated, to be 5/8" nominal thickness, square edge, Group 1 species, fire-retardant-treated (FRT) plywood pressure impregnated with fire-retardant chemicals in accordance with AWPA C27, Category UCFA for interior items without ground contact and protected from exterior exposure.
  - 1. FRT plywood sheathing must meet the performance category requirements and load capacities of the specified plywood roof sheathing.
  - 2. Flame spread rating of 25 or less in accordance with ASTM E 84, Class I.
  - 3. Identify with appropriate classification marking of Underwriters Laboratories, Inc. or other testing and inspecting agency acceptable to authorities having jurisdiction.

#### 2.04 FLEXIBLE WALL FLASHING

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - 1. Grace Construction Products, Perm-A-Barrier Wall Flashing
  - 2. W.R. Meadows, Inc., Air-Shield Thru-Wall Flashing
- B. Flexible wall flashing to be 40 mil. self-adhesive membrane, rubberized asphalt, self-healing, integrally bonded to cross-laminated, high-density polyethylene film. Membrane shall be interleaved with disposable coated release paper until installed.
- C. Primer for Flexible Membrane Wall Flashing:
  - 1. Grace Construction Products, Perm-A-Barrier WB Primer
  - 2. W.R. Meadows, Inc., MEL-Prime W/B

#### 2.05 ENGINEERED WOOD PRODUCTS - LAMINATED VENEER LUMBER (LVL)

- A. Laminated Veneer Lumber of series called for on the drawings, shall be structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559.

- B. Subject to compliance with requirements, provide products by one of the following.
  - 1. Trusjoist MacMillan
  - 2. Alpine Engineered Products, Inc.
  - 3. Gang-Nail Systems, Inc.
- C. Include extended ends and accessories for the complete and proper installation.
- D. Minimum modulus of elasticity shall be 2,000,000 psi.

#### 2.06 MISCELLANEOUS METAL FRAMING ANCHORS

- A. Manufacturers: Subject to compliance with requirements, provide products by:
  - 1. Simpson Strong-Tie Co., Inc.
- B. Allowable Design Loads: Provide products with allowable design loads, as published by manufacturer, that meet or exceed those indicated. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency.
  - 1. Provide proper number and size fasteners to comply with required loads.
- C. Hot-Dip, Heavy-Galvanized Steel Sheet: ASTM A 653/A653M; Structural steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
  - 1. Provide stainless steel framing anchors where use with fire retardant treated (FRT) lumber.

#### 2.07 MISCELLANEOUS MATERIALS

- A. Rough hardware. Bolts, screws, nails, expansion anchors, hangers, clips, etc., necessary for connection of carpentry, framing, and lumber members shall be of proper size, configuration and strength and shall be hot dipped heavy galvanized.
  - 1. Rough hardware for use with treated members shall be stainless steel.
  - 2. Rough hardware for use with fire retardant treated (FRT) plywood shall be stainless steel unless FRT panel manufacturer allows hot dipped galvanized for the intended application.
  - 3. Rough hardware for exterior gypsum wall sheathing to be hot dipped galvanized drilled fasteners of the proper type for each condition meeting sheathing manufacturers requirements.
- B. Anchor Bolts: L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM A 325M, Property Class 4.6); with comparable hex nuts and, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.
  - 1. Anchor bolts for use with treated members shall be stainless steel.
- C. Plywood roof sheathing metal H-clips shall be prefabricated units of the proper size, configuration and strength, and shall be 20 gauge minimum hot dipped galvanized steel. Clips must be the proper type for the thickness of the panels being supported, and allow for APA recommended 1/8" gap between panels.

1. Clips for use with fire retardant treated (FRT) plywood shall be stainless steel unless FRT panel manufacturer allows hot dipped galvanized for the intended application.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Sill-Sealer Gaskets: ASTM D 1056-91, high density closed-cell neoprene foam strip sill sealer with pressure sensitive adhesive on one side, 1/4 inch thick, match width of sill plate members.
  1. Hohmann & Barnard, Inc., Neoprene Sill Sealer

## PART 3 - EXECUTION

### 3.01 GENERAL

- A. Do not use lumber of material which are unsound, warped, bowed, twisted, improperly treated, not adequately seasoned or too small to fabricate the Work with a minimum of joints or the optimum jointing arrangement.
- B. Treated lumber and wood products, apply minimum 1/16" coating of bituminous paint to the contact surface of steel, galvanized steel, and aluminum to ensure separation from contact with the treated products.
- C. Frame and bolt framing as detailed or as required in straight lines, securely anchored.
- D. Plates and sills resting on masonry or steel shall be secured with bolts of required size and length with suitable washers and nuts spaced not more than 4'-0" o.c. or as detailed.
- E. Install grounds for application of wood trim, etc., where required and of proper thickness and securely fastened.
- F. Frame soffits, install furring, blocking, etc., as shown or required.
- G. Fit carpentry work to other Work. Scribe and cope as required for accurate fit.
- H. Set carpentry work accurately to required levels and lines with members plumb and true.
- I. Securely attach carpentry work to substrates by anchoring and fastening as shown and as required by recognized standards.
- J. Provide washers under bolt heads and nuts in contact with wood.
- K. Select fasteners of size that will not penetrate members where opposite side will be exposed to view or will receive finish materials. Make tight connections between members. Install fasteners without splitting of wood; predrill as required.
- L. Do not drive threaded friction-type fasteners; turn into place. Tighten bolts and lag screws at installation and retighten as required for tight connections prior to closing in or at completion of Work.
- M. Set wood framing accurately to required lines and levels. Provide framing members of sizes and on spacings shown, and frame openings as shown or, if not shown, comply with the recommendations of the NFPA (National Forest Products Association). Cut, join and tightly fit framing around other Work. Do not splice structural members between supports unless otherwise detailed.
- N. Anchor and nail as shown or, if not shown, to comply with the Recommended Nailing Schedule and other recommendations of NFPA.

- O. Grounds, Nailers and Blocking:
  - 1. Provide wherever shown and where required for screeding or attachment of other Work. Form to shapes and cut as required for true line and level of Work to be attached or screeded.
  - 2. Provide solid wood blocking built into gypsum board partitions and walls where shelving, cabinets, toilet partitions, accessories and similar are secured.
  - 3. Coordinate location with other Work. Refer to Shop Drawings of such Work, if any.
  - 4. Attach to substrates securely with anchor bolts or other attachment devices as shown and as required to support applied loading.
  - 5. Countersink bolts and nuts flush with surfaces, unless otherwise indicated.
  - 6. Build into masonry as Work progresses, cutting to fit masonry unit size involved.
  - 7. Anchor to formwork before concrete placement.
- P. Temporary closers shall be of substantial construction with appropriate security measures provided as required.

### 3.02 TREATED LUMBER

- A. Install rot resistant treated lumber where indicated and required including necessary incidentals, components, etc.
  - 1. Rough hardware for use with treated members shall be stainless steel.
- B. Install fire retardant treated (FRT) lumber where indicated and required including necessary incidentals, components, etc. meeting the requirements of the specified assembly testing agency, and the authority having jurisdiction to provide at a minimum the required fire rated assembly.
  - 1. Rough hardware for use with treated members shall be stainless steel.

### 3.03 STRUCTURAL FRAMING

- A. Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Sill plates to be continuous, in longest lengths possible. At exterior walls set on concrete foundations with continuous sill-sealer neoprene gaskets of width matching sill plate, and securely anchor to foundation wall with cast-in anchor bolts as indicated. At existing concrete foundation walls and at interior wall locations securely anchor to concrete with drilled epoxy expansion anchors. Sill-sealer gaskets are not required at interior walls.
- C. Stud System Erection. Attach sill plates at floor with suitable fasteners located 2" from each end and spaced 16" o.c. engaging floor joists. Position studs vertically, engaging floor and ceiling plates and spaced 16" o.c. Studs shall run full height from sill plates at floor to height as indicated. Place studs in direct contact with door frame jambs, abutting partitions and partition corners.
- D. Anchor studs for shelf-walls, counter, vanity, and those adjacent to door frames, partition intersections, and corners to ceiling and floor sill plates with mechanical

fasteners. Securely anchor studs to jamb and head anchor clips of door frames by screw attachment.

- E. Framing components shall be cut squarely for attachment to perpendicular members, or as required for an angular fit against abutting members. Members shall be held positively in place until properly fastened.
- F. Construct corners using minimum 3 studs, double stud at wall opening, door and windows jambs.
- G. Erect studs 1 piece full length; splicing of studs not permitted.
- H. Provide necessary stud bracing, etc. as detailed and/or required to support design and anticipated loads.
- I. Install intermediate studs above and below openings to match wall stud spacing.
- J. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- K. Provide substantial intermediate wood blocking properly anchored to studs for secure attachment of wall mounted items including but not limited to door stops, toilet accessories, wall mounted equipment, casework, etc.
- L. Install Engineered Wood Products per manufacturers requirements. Modifications to these products require review and approval by the manufacturer.

#### 3.04 GENERAL DECKING AND SHEATHING INSTALLATION

- A. Do not use materials with defects that impair quality of sheathing or pieces that are too small to use with minimum number of joints or optimum joint arrangement. Arrange joints so that pieces do not span between fewer than three support members.
- B. Cut panels at penetrations, edges, and other obstructions of work; fit tightly against abutting construction unless otherwise indicated.
- C. Securely attach to substrate and supports by fastening as indicated, complying with the more stringent of the following:
  - 1. NES NER-272 for power-driven fasteners
  - 2. IBC 2015 Table 2304.10 Fastening Schedule

#### 3.05 FLOOR DECKING

- A. Plywood floor decking to be installed continuous over two or more spans, strength axis perpendicular to supports. Ends shall be centered over supports. Secure to supports with continuous bead of adhesive, and with mechanical fasteners spaced at a minimum of 6" o.c. at panel edges and 12" o.c. at intermediate supports. Top layer of decking to be adhered over base layer decking with joints staggered from base layer and secured in the same manner.
  - 1. Wood framing, secure with non-corrosive ring or screw shank 8d nails.
  - 2. Metal framing, secure with non-corrosive hardened screw shank or self-tapping fasteners of the proper size and type. Pneumatically-driven steel pins are not acceptable.

#### 3.06 WALL SHEATHING

- A. Plywood wall sheathing to be installed continuous over two or more spans, strength axis perpendicular to supports, with ends staggered between panels and

centered over supports. Secure to supports with continuous bead of adhesive, and with mechanical fasteners spaced at a minimum of 6" o.c. at panel edges and 12" o.c. at intermediate supports.

1. Wood framing, secure with non-corrosive deformed shank 8d nails.
2. Metal framing, secure with non-corrosive hardened screw shank or self-tapping fasteners of the proper size and type. Pneumatically-driven steel pins are not acceptable.

### 3.07 FLEXIBLE WALL FLASHING

- A. Install membrane flashing, and auxiliary materials according to manufacturer's written instructions to form a seal with adjacent construction and maintain a weathertight barrier.
- B. Apply primer to substrates to receive membrane flashing at required rate and allow to dry. Limit priming to areas that will be covered in same day. Re-prime areas exposed for more than 24 hours.
  1. Prime glass-fiber-surfaced gypsum sheathing and/or roof underlayment board not covered with an air membrane material with number of prime coats needed to achieve required bond, with adequate drying time between coats.
- C. Fill gaps in perimeter framed wall opening surfaces and miscellaneous sheathing penetrations with foam insulation sealant prior to flashing installation.
- D. Connect and seal membrane flashing continuously to roofing membrane air barrier.
- E. Repair punctures, voids, and deficient lapped seams in membrane per manufacturers requirements. Slit and flatten fish-mouths and blisters. Patch with membrane extending 6 inches beyond repaired areas.

### 3.08 ROOF SHEATHING

- A. Plywood roof sheathing to be installed continuous over two or more spans, strength axis perpendicular to supports, with ends centered over supports. Space nails no less than 6" o.c. at panel edges and 12" o.c. at intermediate supports using non-corrosive deformed shank 8d nails.
  1. Provide proper metal H-clips between adjacent panels and at any unavoidable unsupported edges. Clip spacing at a minimum to be one per span of supporting framing member and as required by the loads.
  2. Roof sheathing to be covered and protected from moisture with the specified roofing felts as appropriate sized areas are completed and in a manner to avoid interference between tradesmen.
- B. Fire retardant treated (FRT) plywood roof sheathing panels to be kept dry and protected from moisture, wetting, and condensation during shipping, storage, and installation. Install sheathing continuous over two or more spans, strength axis perpendicular to supports, with ends centered over supports. Space nails no less than 6" o.c. at panel edges and 12" o.c. at intermediate supports using stainless steel deformed shank 8d nails.
  1. Install FRT panels meeting the requirements of the specified assembly testing agency, and the authority having jurisdiction to provide at a minimum the required fire rated assembly.

2. Provide proper metal H-clips between adjacent panels and at any unavoidable unsupported edges. Clip spacing at a minimum to be one per span of supporting framing member and as required by the loads.
3. FRT roof sheathing to be covered and protected from moisture with the specified roofing felts as appropriate sized areas are completed and in a manner to avoid interference between tradesmen.

### 3.09 ROOF NAILERS AND EDGE ASSEMBLIES

- A. Roofing nailers and blocking, to be installed as indicated and called for in specified roofing sections.
  1. Install grounds for application of wood roofing nailers and blocking, etc., where required and of proper thickness and securely fastened.
  2. Fabricate roof edge assemblies with nailers, plywood, blocking, etc. as indicated to provide a secure, stable substrate properly anchored to wall construction to meet applicable codes and standards, and meet roofing system requirements.
    - a. At curved wall locations provide additional layers of specified plywood cut to indicated radius in lieu of multiple 2x nailers. Bottom exterior and interior edges of assembly to be 2x3 nailers cut to meet indicated radius from 2x10 specified material in longest lengths possible to minimize joints.

END 06 10 00

DIVISION 6 - WOOD & PLASTICS  
Section 06 20 00 - Finish Carpentry

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

- A. Shop Drawings
  - 1. Countertops
  - 2. Wood Trim indicating component profiles, locations, and fastening methods.
- B. Product Data
- C. Samples
  - 1. Plastic Laminate and PVC edge banding for color selection
  - 2. Solid Surface for color selection
  - 3. Wood Trim
    - a. Solid wood for transparent finish, set of 3 samples, minimum one foot long, for each required configuration, showing extremes in color and grain.
    - b. Solid wood for opaque finish, 1 sample, minimum one foot long, for each required configuration.
- D. Solid Surface Warranty

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Manufacturer producing products in an ISO 9001, ISO 14001, and OHSAS 18001 certified facility.
- B. Fabricator/Installer: A firm which has successfully produced work similar to the quality specified and in the quantity shown for a period of not less than 5 years.
- C. Reference Standards: Comply with the applicable provisions for grading and workmanship of the "Architectural Woodwork Quality Standards", Current Version, published by the Architectural Woodwork Institute (AWI) (herein referred to as Standards), except as otherwise specified.

1.04 DELIVERY, STORAGE AND HANDLING

- A. Protect woodwork during transit, delivery, storage and handling to prevent damage, soiling and deterioration.
- B. Store plastic laminate and solid surface materials protected from exposure to harmful weather conditions, at temperature and humidity conditions recommended by manufacturer. Store sheet materials flat on pallets or similar rack-type storage to preclude damage.

- C. Store woodwork materials and completed woodwork only in a dry, ventilated place, protected from the weather.
- D. Protect woodwork from soiling and damage during handling and installation. Keep covered with polyethylene film or other protective covering.
- E. Do not deliver woodwork until painting, wet work, grinding and similar operations which could damage, soil or deteriorate woodwork have been completed in installation areas. If, due to unforeseen circumstances, woodwork must be stored in other than installation areas, store only in areas which meet the requirements specified for installation areas.

#### 1.05 JOB CONDITIONS

- A. Environmental Requirements: Do not start Work until room or space is at normal use temperature and humidity and wood has tempered to the room or space.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
  - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before on Shop Drawings.

#### 1.06 COORDINATION

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

#### 1.07 SOLID SURFACE MATERIAL WARRANTY

- A. Manufacturer's 10 year commercial limited warranty against defects in solid surface sheet materials.

### PART 2 - PRODUCTS

#### 2.01 PLASTIC LAMINATE TOPS

- A. Continuous, 3/4" min. thickness with 1 1/4" edge thickness, 3/4" x 4" backsplash where indicated. Exposed end corners to have 2" radius corners.
- B. Description:
  - 1. Self edge plastic laminate edge for countertop and top of backsplash.
- C. Material:
  - 1. Horizontal surfaces; .048" high pressure plastic laminate (HPL) horizontal grade, unless otherwise noted.
  - 2. Countertops, associated backsplash/top edge, transaction counter work surfaces; .048" high pressure high wear (HW) grade plastic laminate. Exceed NEMA LD-3 2005 for wear resistance.
  - 3. Edges of countertops, and transaction counter work surfaces; As described in B. above.

4. Vertical surfaces; .030" high pressure plastic laminate (HPL) vertical grade.
  5. Substrate for plastic laminate tops, panels, shelves, etc., to be 3/4" min. thickness water resistant M-2 industrial grade 45# density particle board substrate. All boards to be balanced.
- D. Plastic laminate (HPL): Colors to be as selected by Architect from manufacturer's full line of non-metallic, non-solid depth colors regardless of quantity. Matte or similar finish.
1. Formica Corp.
  2. Wilsonart, LLC
  3. Panolam Surface Systems, Nevamar/Pionite
- E. PVC edge banding: Colors to be as selected by Architect from manufacturer's full line of non-metallic colors regardless of quantity, matching HPL finish.
1. Richelieu
  2. Dollken
  3. HPL Manufacturer

## 2.02 SOLID SURFACE COUNTERTOPS

- A. Solid surface material countertop and backsplash shall be 1/2" thick with eased profile edges:
1. Dupont, Corian
  2. Formica Corp, Solid Surfacing
  3. Wilsonart LLC, Solid Surfacing
  4. LG, Hi-Macs
  5. Meganite, Solid Surfacing
- B. Color as selected by Architect from Corian color Group 4 and 5 or manufacturer's equivalent color group.

## 2.03 INTERIOR WOOD

- A. Finished wood trim, base, mouldings, handrails, frames, etc., to be premium grade, solid, clear select, smooth sanded for transparent finish. Consecutive members shall match one to the other in color and grain.
1. AWI Premium Grade 1, Red Oak, plain sawn.
- B. Finished wood trim, base, mouldings, handrails, frames, etc., to be premium grade, solid, clear select, smooth sanded for painted finish.
1. AWI Premium Grade 1, Yellow Poplar, plain sawn

## 2.04 EXTERIOR WOOD TRIM

- A. Exterior wood trim, fascias, soffits, etc., shall be smooth sanded Western Red Cedar, clear select, sizes indicated, maximum moisture content of 15% (MC15).

## PART 3 - EXECUTION

IMEG #21002885.00

Rockford PS ESSER HVAC Upgrades

06 20 00-3

### 3.01 FINISH CARPENTRY

- A. Finish carpentry work shall be neatly and substantially constructed in a workmanlike manner according to details. Joints shall be neatly made, coping interior angle joints wherever possible and mitering exterior corners.
- B. Woodwork, trim, etc. to be as detailed. Trim to be backed out to permit tight fit against wall. Items shall be applied in a neat and workmanlike manner by experienced mechanics and left free from hammer marks or other defects.
  - 1. Install in single, unjointed lengths for openings and for runs less than maximum length of lumber available. For longer runs, use only one piece less than maximum length available in any straight run. Stagger joints in adjacent members.
  - 2. Distribute defects allowed in the quality grade specified to the best overall advantage, when installing job assembled woodwork items.
  - 3. Cope moldings at returns and miter at corners.
  - 4. Attach woodwork securely in place with uniform joints providing for thermal and building movements.
  - 5. Blind nail where possible. Use fine finishing nails where exposed. Set exposed nail heads.
  - 6. Screw to wall studs behind finish at each crossing. Countersink and plug with matching wood plugs glued and set flush
  - 7. Hand dressed, cleaned free of tool marks with nails set and holes filled and sand papered smooth. Fastening to be concealed.
- C. Solid surface materials to be installed in strict accord with manufacturer's requirements. Solid surfacing material to be fused together to provide a uniform, watertight, monolithic appearance.

END 06 20 00

DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 10 00 - Building Waterproofing

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified in this section.
- B. Section Includes: Restoration System used in combination with waterproofing system including surface preparation and cement based coating application.
  - 1. Substrate applications of system include:
    - a. Concrete Foundation - vertical surfaces (positive side/ exterior).
    - b. Concrete Foundation - horizontal surfaces (positive side/ exterior).

1.02 REFERENCES

- A. American Society for Testing and Materials (ASTM):
  - 1. ASTM D 4258-83- Practice for Surface Cleaning Concrete for Coating.
  - 2. ASTM D 4262-83- Test Method for pH of Chemically Cleaned Concrete.
  - 3. ASTM D 4259-83- Practice for Abrading Concrete.
  - 4. ASTM C 666-92 - Resistance of Concrete to Rapid Freezing and Thawing.
  - 5. American Concrete Institute: ACI 546R-90 - Guide to Concrete Repairs.

1.03 SYSTEM PERFORMANCE REQUIREMENTS

- A. Provide a concrete coating system utilizing a long term waterproofing restoration system in conjunction with a drainage system, which will comply with performance requirements and environmental regulations when tested by methods indicated.

1.04 QUALITY ASSURANCE

- A. Qualifications:
  - 1. Installer Qualifications: Minimum of Five (5) Years experience in the successful application of waterproofing restoration products and cement/acrylic coating systems. Installer trained and certified System Manufacturer for the products specified.
  - 2. Manufacturer Qualifications: Provide installer training and certification. Manufacturer with a minimum of Five (5) Years experience in the production of specified waterproofing materials and systems.
  - 3. Field Service: Manufacturer shall provide field service representation before, during and after installation. Field Service must be technical representative authorized to make decisions on behalf of the system manufacturer.

1.05 SUBMITTALS

- A. Product Data: Submit manufacturer's current technical product data indicating product test results and compliance as indicated. Submit project specific details. Details shall bear manufacturer's approval prior to submissions to Owner's Representative.
- B. Quality Control Submittals:
  - 1. Pre-Installation Conference: Submit report verifying project site conditions, approval of Mock-Up panels, manufacturer's instructions and requirements.
  - 2. Provide listed Installer's certification and acceptance by system Manufacturer. Include protection plan of surrounding areas and non-masonry surfaces.
  - 3. V.O.C. Certification: Submit certification of compliance that materials furnished comply with regulations controlling the use of Volatile Organic Compounds (VOC).
- C. Contract Closeout Submittals:
  - 1. Warranty: Manufacturer's executed system warranty form with authorized signatures and endorsements.
  - 2. Warranty in final form must be submitted prior to receiving final payment.
  - 3. Warranty proposed for this project: 10 year Below Grade Waterproofing for Concrete Warranty for materials and workmanship.

#### 1.06 DELIVERY, STORAGE AND HANDLING

- A. Deliver, store, handle and protect products in accordance with the manufacturer recommendations.
- B. Ordering: Comply with manufacturer's ordering instructions and lead time requirements to avoid construction delays.
- C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- D. Storage and Protection: Store and protect materials from harmful weather conditions and at temperatures conditions recommended by manufacturer. Do not allow freezing to occur in storage or shipping. Protect from damage during construction and while stored onsite.

#### 1.07 PROJECT CONDITIONS

- A. Environmental Requirements: In accordance with manufacturer's recommendations, substrates and ambient air temperature shall be 40 degrees F (4 degrees C) or greater and rising at installation time and remain above 40 degrees F for at least 12 hours after installation.
  - 1. Weather Conditions: In accordance with manufacturer's instructions, do not apply material(s) in snow, rain, fog, or mist, or when such conditions are expected. Do not apply when relative humidity exceeds 85%, or at temperatures less than 5 degrees F (3 degrees C) above the dew point.

Allow surfaces to attain temperature ranges and conditions recommended by manufacturer before proceeding with installation.

2. Compliance: Follow manufacturer's instructions with regard to safety, health, and other related environmental precautions. Comply with applicable Federal, State, and Local Environmental Regulations.

#### 1.08 WARRANTY

- A. Contractor shall warrant the product and the application from the time of Substantial Completion of the project for two years.

### PART 2 - PRODUCTS

#### 2.01 MANUFACTURERS/MATERIALS

- A. Factory-made composite product with a minimum thickness of 60 mils consisting of rubberized asphalt and cross-laminated, high density polyethylene film and with release paper which is to be removed during installation.
  1. W.R. Grace & Co.; Bituthene 3000 Waterproofing Membrane.
  2. Carlisle; Mirafi Waterproofing Membrane comparable to 1 above.
- B. Manufacturer recommended Mutli-Composite Drainage and Protection Board.

### PART 3 - EXECUTION

#### 3.01 MANUFACTURER'S INSTRUCTIONS

- A. Compliance: Comply with manufacturer's most recently published product technical bulletins including, installation instructions, substrate testing, surface preparation and cleaning, and post installation testing.

#### 3.02 EXAMINATION

- A. Verify substrate conditions are acceptable for Restoration & Waterproofing Coating material system. Installation shall be in accordance with manufacturer's instructions.
- B. Following excavation of existing soil material from existing foundation walls, determine acceptable removal techniques for contaminants harmful to coating system performance, such as dust, dirt, grease, oils, curing compounds, form release agents, laitance, efflorescence, existing paint films and other existing coatings. Remove, collect, sort, and legally dispose of chemical contaminants.
- C. Thoroughly inspect existing concrete substrate. Identify contaminants and remove and dispose of contaminated materials. Remove fins, edges and sharp protrusions. Fill voids and honeycombed areas.
- D. Slope of Horizontal Foundation Footing: Ensure that the footing at the base of the vertical foundation wall has a grade (slopes) away from the building and angles down towards the drain tile. Install additional bonded cementitious materials as to provide a minimum 1:12 slope for proper pitch/drainage away from foundation and to new drain tile collector.

#### 3.03 PREPARATION - CONCRETE RESTORATION - SUBSTRATES:

- A. Following excavation of existing soil material from existing foundation walls, remove loose or unsound concrete.
- B. Where existing concrete is sound and therefore removal of loose or concrete is not required:
  - 1. Remove laitance, contamination, plaster, oil, paint, grease, corrosion deposits, algae, and other materials detrimental to adhesion of mortar using mechanical means.
  - 2. Where breaking out is not required, roughen substrate by mechanical means or abrasive blasting.
  - 3. Substrate shall be clean and free from dust, plaster, oil, paint, grease, corrosion deposits, algae and unsound or contaminated material that may interfere with bonding
  - 4. Ensure previous product systems including damproofing, and bentonite are fully removed from the substrate prior to applying the waterproofing system.
  - 5. Perform sandblasting without free compressed air to remove dust and dirt.
- C. Protect adjacent work areas and finish surfaces from damage during cement coating system installation. Prior to installation, clean substrates of substances that could impair adhesion and/or bonding. Coordinate cleaning and application to avoid contamination of newly treated surfaces.
- D. Test and clean substrates in accordance with manufacturer's printed recommendations and the following National standards;
  - 1. ASTM D 4261, Practice for Cleaning Unit Masonry for Coating.
  - 2. ASTM D 4258, Practice for Surface Cleaning Concrete for Coating.
  - 3. ASTM D 4262, Test Method for pH of Chemically Cleaned Concrete.
  - 4. ASTM D 4259, Practice for Abrading Concrete.
- E. For Application of waterproofing membrane, continue keeping surfaces clean and free from contaminants as mentioned above. Consult technical bulletins for additional information. Continue to protect adjacent work areas and finish surfaces from damage during coating system installation. Prior to installation, clean substrates of substances that could impair adhesion, and or bonding. Coordinate cleaning and application to avoid contamination of newly treated surfaces. Surfaces must be dry before applying membrane. Test for moisture must be performed.
- F. For application of drainage/protection board, apply drainage/protection board materials on both horizontal and vertical surfaces where waterproofing membrane has been applied. Ensure proper mounting as per technical data sheet.

### 3.04 APPLICATION

- A. Waterproofing Membrane and Drainage/Protection Board.
  - 1. Apply in strict accordance with manufacturer's literature and recommendations.

3.05 FIELD QUALITY CONTROL

- A. Provide manufacturer's field service consisting of periodic site visits by Manufacturer's technical representative for observation of waterproofing coating system installation.

3.06 CLEANING AND PROTECTION

- A. Remove temporary coverings and protection of adjacent work areas. Remove over-spray coating from windows or areas not intended to be coated.
- B. Remove construction debris resulting from work in this section.

END 07 10 00

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DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 54 24 – TPO Membrane Roofing

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified under this section.
- B. Be responsible for the condition of the building and site, and provide necessary provisions to protect the building, adjacent work and contents, and site. Replace/restore items and surfaces damaged in carrying out the work.
- C. It is the intent of this specification to assure weathertight and watertight conditions, during and after completion of the Work. The Contractor performing the work is expected to advise the Architect of any unusual or unforeseen conditions arising during the project.

1.02 SCOPE OF WORK

- A. Demolition
- B. Thermoplastic Polyolefin (TPO) Single-Ply Roof System
  - 1. Furnish and install a TPO Single-Ply Roofing System, Class "A" rated, including incidental and accessory items, including, but not limited to the following:
    - a. Vapor Barrier
    - b. Insulation
    - c. Fasteners
    - d. Adhesives
    - e. Roofing Membrane
    - f. Flashings and Metal Edge
    - g. Expansion Joint
    - h. Accessories
    - i. Slip Sheet
    - j. Wood Nailers
    - k. Warranty

1.03 SUBMITTALS

- A. Shop Drawings: Roof Plan with details to indicate roof edge, flashing, penetrations, and miscellaneous items.
- B. Product Data:
  - 1. Roofing membrane, flashing, adhesive, accessories.
  - 2. Vapor Barrier

3. Protective Membrane
  4. Expansion Joint
  5. Walkway Pads
  6. Slip Sheet
  7. Fasteners
- C. Roofing contractor qualifications.
  - D. Roof system manufacturers approval to proceed with installation.
  - E. Roof system manufacturers periodic inspection and mechanical fastener pull out test results as they occur.
  - F. Written warranty.

#### 1.04 QUALITY ASSURANCE

- A. Roofing Contractor must have a minimum of ten (10) years experience installing TPO Single-Ply Roofing Systems specified. Roofing Contractor must be roofing system manufacturers' current approved premium installers in good standing with corporate office located within 50-mile radius of Rockford Public Schools. Owner reserves the right to reject any contractor with past history with the District of: failure to perform the work meeting specifications; excessive call backs for leaks; ongoing issues not corrected; etc.
- B. Pre-Roofing Conference: A pre-roofing conference shall be held at the project site in advance of the time scheduled for roofing work. The purpose of this conference is to review requirements for the work and conditions which could possibly interfere with successful performance of the work. This conference shall review deck surfaces, roof insulation, roofing, flashing, and any other item related to the roof system. A record of all decisions and agreements made at this meeting, as well as a list of attendees, shall be submitted to the Architect in writing for record.
- C. Roofing system manufacturer: Roofing system mechanical fastener pull out tests on components including but not limited to roof system edge securement, nailers, blocking, underlayment board, insulation, etc. to be performed by the roofing system manufacturer, and meet the requirements of the specified full system warranty.

#### 1.05 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
  1. Materials shall be delivered to the site in an undamaged and dry condition.
  2. Material received which is not dry or is otherwise damaged shall be rejected.
- B. Storage under polyethylene or similar non-breathing film stock shall not be permitted, and materials are never to be in contact with the ground.
  1. Proper storage on or off the site shall be the responsibility of the contractor.
- C. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer.

- D. Handle and store roofing materials and place equipment in a manner to avoid permanent deflection of deck.

#### 1.06 WARRANTY

- A. The Contractor shall furnish to the Owner, the Manufacturer's Full System No Dollar Limit Warranty of watertightness. This warranty shall be fully paid for by the Roofing Contractor.
  - 1. Warranty Period: 30 years from date of Substantial Completion.
  - 2. Warranty shall provide at a minimum, manufacturer's wind speed coverage of maximum 100 mph, 3-second peak gusts, measured at 10 meters (33ft) above ground level.
- B. This Warranty shall cover both labor and materials necessary to effect watertightness, including that required to repair conditions caused by structural movement or standing water on the roof membrane, without limit as to amount required to effect repairs.

### PART 2 - PART 2 - PRODUCTS

#### 2.01 ROOFING MEMBRANE

- A. Thermoplastic polyolefin (TPO) sheet, internally fabric reinforced, meet or exceed ASTM D6878 Requirements, with an initial solar reflectance index (SRI) of not less than 99 and three year aged SRI of not less than 85.
  - 1. Thickness: 80 mils
  - 2. Exposed Face Color: Gray
  - 3. System Type: Fully Adhered
- B. Subject to compliance with requirements, provide products by one of the following:
  - 1. Firestone Building Products, Ultraply Platinum.
  - 2. Carlisle Corp., Sure-Weld EXTRA.
  - 3. Johns-Manville, TPO ST8RA-S.
- C. Provide necessary flashing and accessories as required or recommended by roofing system manufacturer. Flashing shall be 80 mil uncured TPO.
- D. Provide materials, incidentals, and installation procedures required for the manufacturer's specified full system warranty.

#### 2.02 VAPOR BARRIER

- A. Vapor Barrier to be roofing system manufacturers self-adhering, polypropylene reinforced rubberized asphalt air and vapor barrier membrane system, meet or exceed ASTM D1970, E96 and E2178 requirements.
  - 1. Firestone Building Products, V- Force
  - 2. Carlisle Corp., VapAir Seal 725TR
  - 3. Johns-Manville, JM Vapor Barrier SA

#### 2.03 ACCESSORIES

- A. Provide manufacturers accessories as necessary and required to provide a full systems approach, including but not limited to:
  - 1. Pre-molded accessories such as inside corners, outside corners, curb wrap corners, pipe flashing, pipe seals, sealant pockets, etc.
  - 2. Adhesives, sealants, pre-molded and field fabricated flashings, fasteners, and other related components manufactured or recommended by the selected roofing system manufacturer.

#### 2.04 WALKWAY PADS

- A. Manufacturers factory formed, non-porous, heavy duty, slip resistant, surface textured TPO walkway pads, heat weldable, 5/32" min. thickness; standard sizes 24" x 24" or 30" x 30" as indicated.
  - 1. Manufacturers roll type system meeting specified criteria is acceptable.

#### 2.05 NAILERS

- A. Wood nailers and nailer assemblies shall be installed where required and indicated. Height of nailers and assemblies shall be matched to that of the insulation being used and as indicated.
- B. Nailers and nailer assemblies are as specified in Section 061050 – Miscellaneous Rough Carpentry.

### PART 3 - EXECUTION

#### 3.01 GENERAL REROOF

- A. roofing, flashings, metal fascia, metal coping, etc. and rigid insulation down to existing roof deck.
  - 1. Remove an area no larger than can be re-roofed in one day.
- B. Repair existing roof deck and nailers deteriorated or damaged during tear off.
- C. Remove existing soil stack leads and replace with new 4# leads.
- D. Remove existing roof drain leads and provide new 4' x 4' - 4# leads at each drain.
- E. Remove existing dome strainers, clamping rings, lugs, and clamping devices at roof heads and clean prior to installation of new roofing system. After new roof system is installed clean and rod roof drain lines serving reroof area for proper operation from roof to point of discharge onto grade or into storm sewer to provide a complete and proper functioning system to insure positive drainage. Provide new metal dome strainers, clamping rings, lugs, etc. at existing roof drain locations to provide a complete and proper functioning system to insure positive drainage. Provide necessary components and incidentals to provide a complete and proper weathertight installation.
- F. Curb flashing at existing exhaust fans, mechanical units, etc. shall be removed to allow proper flashing installation and then replaced on curbs in proper operating condition and in a manner insuring weather tight installation as recommended by manufacturer.
  - 1. Raise mechanical items, roof hatches, etc. and extend curbs as required to provide 8" minimum height above roof surface to top of exposed flashing

- membrane. Disconnect and extend services by licensed tradesman as required to provide a complete and proper operating condition.
2. Secure flashing and install new metal counterflashing prior to re-installation of unit.
  3. Perimeter nailers must be added to match elevation of new roof insulation.
- G. Remove abandoned mechanical items, roof curbs, piping, conduit, etc. Infill roof deck openings as required to provide a stable, secure, load bearing structural roof deck surface to receive the new roof system as indicated on the Drawings.
1. At mechanical items to be removed with associated roof curb to remain abandoned in place:
    - a. After removal of existing mechanical equipment, conduit, piping, ductwork, etc. by licensed tradesman, repair any damage to the existing roof curb to provide a stable, sound weathertight condition.
    - b. Extend top of curb as required by the new top of roof surface elevation to provide 8" minimum exposed height of vertical roof flashing after cap is set in place.
    - c. Cap top of curb with weathertight, insulated, one piece galvanized metal cap.
- H. Immediately remove debris from roof surface. Demolished roof system may not be stored on the roof surface.

### 3.02 INSPECTION

- A. Examine surfaces for inadequate anchorage, foreign material, moisture, unevenness, or other conditions which could prevent the best quality and longevity of roofing, flashing, and accessory components. Notify the architect of deficiencies.
1. Verify installation conditions as satisfactory to receive work.
  2. Verify that work of other trades penetrating roof deck or requiring workers and equipment to transverse roof deck has been approved by roofing system manufacturer, and contractor.
  3. Check projections, curbs, and deck for inadequate anchorage, foreign material, moisture, or unevenness that would prevent quality and execution of new roofing system. Determine it is free from defects, nails, and other irregularities. Decks to be dry prior to starting roof work.
  4. Do not install new roofing until unsatisfactory conditions are corrected.
  5. Beginning work constitutes acceptance of conditions by the contractor and roofing system manufacturer, and shall imply approval of deck surfaces and site conditions; and no claim in this respect will be considered valid in case of failure of the roofing components within the warranty period.

### 3.03 FIELD QUALITY CONTROL

- A. Contractor to make arrangement for the roofing system manufacturer to perform the required fastener pull out tests, provide initial inspection and periodic inspections of the roofing system as appropriate and as required for warranty inspections, including whenever called upon by the Architect for the duration of the installation.

1. Upon completion of the installation, final inspection shall be made by the roofing system manufacturer to ascertain that the roofing system has been installed according to the manufacturer's published specifications and details, and meets the specified full system warranty requirements. The written warranty is to be issued upon final approval of the installation.
- B. Contractor to accompany the manufacturer's technical inspector and assist with equipment and workmen if necessary to provide access to the roof.
  1. Correct defects noted during the inspections.

#### 3.04 PREPARATION

- A. Ensure that surfaces are clean and dry before starting and during performance of work.
- B. Verify that work of other contractors and subcontractors which penetrates the roof deck or requires men and equipment to traverse the roof deck has been completed.
- C. Provide written confirmation that the roof system manufacturer's fastener pull out test results and initial inspection has indicated the work can proceed meeting the requirements of the specified full system warranty.

#### 3.05 GENERAL

- A. Install Roof System following current manufacturer's written instructions, recommendations, and details. Provide materials, incidentals, and installation procedures required for the manufacturer's specified full system warranty.
  1. Install roofing system only in dry weather.
  2. Comply with manufacturer's climatic restrictions.
  3. Roofing membrane to be installed over manufacturer's slip sheet if required.
- B. Material shall be one-piece roof membrane adhered to roof insulation with roofing manufacturers low VOC bonding adhesive, formed by heat welding meeting manufacturer's requirements for the specified full system warranty. At a minimum seams shall be made by lapping the membrane a minimum of two inches (2") over itself or over flashing, making a continuous seam two inches (2") wide allowing for a minimum 1½" wide continuous weld. This seam shall then be checked for continuity and integrity, and as required for the specified full system warranty sealed with 8" wide membrane joint covers, and sealant. Seams are to be welded and sealed the same day.
  1. Follow manufacturer's requirements for seam lap direction relative to slope, which varies depending on degree of slope.
  2. Provide manufacturers additional membrane securement at areas exceeding 2" slope in 12" horizontal.
- C. Once work is started on a roof or section, it shall continue without undue delay until that section is completed before starting another. The installation of flashings shall follow application of the roofing without delay.
- D. Nailers and nailer assemblies shall be firmly anchored to the structure, perimeter walls, etc. with non-corrosive fasteners to resist a force of 200 pounds per lineal foot in any direction. Masonry walls to have embedded anchor bolts as indicated.

2" vent spaces shall be left between lengths of nailers and assemblies.

1. Anchors in double row conditions to have each row staggered equally from the other.
  2. Provide a minimum of 5 anchors (per row) for each 8' length of nailer and assembly, shorter sections provide a minimum of 3 anchors (per row).
- E. Install insulation as called for in Section 07200 - Insulation. Insulation to be installed over roofing system manufacturers vapor barrier using adhered methods without mechanical fasteners.
1. Mechanical fastener penetrations through the vapor barrier are not acceptable.
- F. Flashing shall be installed at vertical surfaces, roof interruptions and penetrations as detailed, and in accordance with roofing membrane manufacturer's current published details consistent with job conditions. Where details appear to be in conflict with those published, then the details shall govern and control. Flashings and terminations shall be securely fastened in place to the roof deck with suitable fasteners to provide holding force of not less than two hundred (200) pounds per lineal foot in any direction for the expected life of the roof.
1. Fasteners shall be installed at intervals not to exceed eight inches (8"), except where otherwise specified or recommended by the manufacturer.
- G. Water cut-offs shall be made by extending the membrane beyond the insulation and setting the end of the membrane in 4" of roofing system manufacturer's approved roofing cement overlapped to existing membrane. Temporary water cut-offs shall be removed prior to proceeding with the next work period by cutting off that portion of the membrane that has been in contact with the roofing cement.
- H. Expansion joint concealed components to be installed in maximum lengths possible, properly tape and seal tubing and vapor retarder joints. Install roofing system flashing cover over tubing as required to provide a sealed, weathertight condition meeting manufacturer's requirements.
- I. Walkway pads to be installed in accordance with manufacturer's recommendations for an adhered installation to the roofing membrane.

### 3.06 PROTECTION

- A. Roof Traffic: After work on roof is started, no traffic will be permitted on the roof other than that necessary for the roofing application and inspection. Materials shall not be piled on the roof to the extent that the original structural design live and dead loads are exceeded. Roofing materials shall not be transported over unfinished or finished roofing unless adequate protection is provided. Any damage to previously installed roofs shall be repaired at no expense to Owner.
- B. Protection against damage: Surfaces shall be protected as necessary to prevent damage resulting from the application of roofing, or transporting of materials. If surfaces are damaged in any way they shall be repaired, restored, or replaced by the contractor, at no cost to the Owner, in a manner acceptable to the Architect and Owner.

### PART 4 - ADJUST AND CLEAN

- A. Adjustment and Repair: Any roofing damaged or misapplication shall be repaired or replaced as required at no expense to Owner.
- B. Remove debris from the roofing areas and job site. Legally dispose of debris.
- C. Remove tools, equipment, and construction aids.
- D. Prevent storage of materials and equipment on the completed roof. Any damage to previously installed roofs shall be repaired at no expense to Owner.

END 07 54 24

DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 71 00 - Prefabricated Roof Specialties

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified under this section.

1.02 SCOPE OF WORK

- A. Work under this section shall include, but not necessarily be limited to the following:
  - 1. Metal fascia, copings, counterflashing, gutters, downspouts, curb mounted expansion joints.
  - 2. Pipe supports, pipe boots, roof curbs.
  - 3. Roof hatches.
  - 4. Walkway pads.
  - 5. Roof curb metal caps.

1.03 SUBMITTALS

- A. Product data
- B. Shop drawings
- C. Samples of finish color on metal.
- D. Letter from NRCA stating that manufacturer and/or shop fabricator is a NRCA Authorized Fabricator of ANSI/SPRI ES-1 components and systems.
- E. Prior to fabrication, submit certification that edge securement components meet requirements of ANSI/SPRI ES-1, and Roofing System Manufacturer's requirements for the specified full system warranty.
- F. Warranty

1.04 QUALITY ASSURANCE

- A. Materials, components and installation procedures shall be in accordance with Roofing System Manufacturer's requirements for the specified full system warranty.
- B. Edge securement components shall meet requirements of ANSI/SPRI ES-1, and Roofing System Manufacturer's requirements for the specified full system warranty.
- C. Manufacturer and/or shop fabricator shall be a NRCA Authorized Fabricator of ANSI/SPRI ES-1 components and systems meeting Roofing System Manufacturer's requirements for the specified full system warranty.
- D. Installing contractor must have proven experience record on projects of similar scope, and requirements including but not limited to water tightness, aesthetics, adherence to design intent, coordination of components, provide and maintain

manufacturers warranties, etc.

#### 1.05 PROJECT CONDITIONS

- A. Coordinate Work with adjacent Work, including installation of roofing system to prevent roofing terminations being left unprotected.

#### 1.06 PRODUCT DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storage.
  - 1. Materials shall be delivered to the site in an undamaged and dry condition.
  - 2. Material received which is not dry or is otherwise damaged shall be rejected.

#### 1.07 WARRANTY

- A. Prefinished Metal: Furnish a written 20 year non-prorated manufacturer's warranty on finish and material for pre-finished metal items.
  - 1. Metal Roof Edge and Copings: Products as specified and required by Roofing System Manufacturer to provide the specified full system warranty.
- B. Roof Hatch: Provide manufacturer's standard written warranty. Materials shall be free of defects in material and workmanship for a period of five years. Should a part fail to function in normal use within this period, manufacturer shall furnish a new part at no charge.
- C.

### PART 2 - PRODUCTS

#### 2.01 METAL COPING AND FASCIA SYSTEM

- A. Two piece pre-manufactured system:
  - 1. Edge securement components meet requirements of ANSI/SPRI ES-1.
  - 2. Materials and components as required by Roofing System Manufacturer to provide the specified full system warranty.
- B. Coping:
  - 1. Material: 24-gauge galvanized steel; Sizes and shapes as indicated on drawings.
  - 2. Concealed cleat attachment on the outside, exposed fasteners with neoprene gaskets on the inside
  - 3. Finish: Kynar 500. Color as selected by Architect from manufacturer's full range of non-metallic colors.
  - 4. Provide pre-manufactured accessories, concealed splice plates, corner assemblies, miters, etc.
  - 5. Provide manufacturers factory curved sections at curved wall areas

conforming to indicated radius. Lengths to be as long as possible to minimize joints. Short flat segments are not acceptable.

6. Manufacturers:
  - a. Petersen Aluminum Corp.: PAC-TITE
  - b. OMG Roofing Products: Permasnap
  - c. Metal ERA: Perma-Tite
  - d. Manville: Presto Lock
  - e. Roofing System Manufacturers comparable products as required by the specified full system warranty. Above products may be used only if approved in writing by the Roofing System Manufacturer.
7. If approved in writing by the Roofing System Manufacturer as meeting the specified full system warranty requirements, Contractor may use shop-fabricated sheet metal for certain specific components in lieu of specified pre-manufactured system components only due to reasons generated by the Roofing System Manufacturer. In addition to the specified full system warranty requirements, the Contractor certifies in writing prior to fabrication the following:
  - a. Shop-fabricated components meet minimum thickness required by NRCA recommended details which comply with ANSI/SPRI ES-1 requirements or the specified thicknesses, whichever is more.
  - b. Shop-fabricated components were installed in strict accordance with NRCA recommended details which comply with ANSI/SPRI ES-1 requirements.
  - c. Shop-fabricated components are watertight and weathertight.
8. Field-fabricated metal components are not acceptable.

C. Fascia:

1. Material: 24-gauge prefinished galvanized steel; Sizes and shapes as indicated on drawings.
2. Factory-made, 2-piece with water dam and snap-on cover, designed for specified roofing system.
3. Finish: Kynar 500. Color as selected by Architect from manufacturer's full range of non-metallic colors.
4. Provide pre-manufactured accessories, concealed splice plates, corner assemblies, miters, scuppers, etc.
5. Manufacturers:
  - a. Petersen Aluminum Corp.: PAC-LOC 2000
  - b. OMG Roofing Products: Econosnap
  - c. Metal ERA: Perma-Tite System 200

- d. Manville: Comparable to above
  - e. Roofing System Manufacturers comparable products as required by the specified full system warranty
6. If approved in writing by the Roofing System Manufacturer as meeting the specified full system warranty requirements, Contractor may use shop-fabricated sheet metal for certain specific components in lieu of specified pre-manufactured system components only due to reasons generated by the Roofing System Manufacturer. In addition to the specified full system warranty requirements, the Contractor certifies in writing prior to fabrication the following:
- a. Shop-fabricated components meet minimum thickness required by NRCA recommended details which comply with ANSI/SPRI ES-1 requirements or the specified thicknesses, whichever is more.
  - b. Shop-fabricated components were installed in strict accordance with NRCA recommended details which comply with ANSI/SPRI ES-1 requirements.
  - c. Shop-fabricated components are watertight and weathertight.
7. Field-fabricated metal components are not acceptable.

## 2.02 MISCELLANIOUS PREFINISHED METAL ITEMS

- A. Shop fabricated metal counterflashing, gutters, scuppers, downspouts, valley flashings, mechanical equipment flashings, roof edge flashings, fascias and copings on projects without a full system warranty.
  - 1. Edge securement components meet requirements of ANSI/SPRI ES-1.
  - 2. Contractor shall certify in writing the following:
    - a. Shop-fabricated components meet minimum thickness required by NRCA recommended details which comply with ANSI/SPRI ES-1 requirements or the specified thicknesses, whichever is more.
    - b. Shop-fabricated components were installed in strict accordance with NRCA recommended details which comply with ANSI/SPRI ES-1 requirements.
    - c. Shop-fabricated components are watertight and weathertight.
  - 3. Field-fabricated metal components are not acceptable.
- B. 24-gauge prefinished galvanized steel by:
  - 1. Petersen Aluminum Corp.: Pac-Clad
  - 2. Firestone: Una-Clad
- C. Shop fabricated, shapes and sizes as indicated.
- D. Finish: Kynar 500, color as selected by Architect from manufacturer's full range of non-metallic colors.
  - 1. Valley flashings and mechanical equipment flashings to match shingles and may be different color from other items.

## 2.03 PIPE SUPPORTS

- A. Conduit, gas piping, HVAC piping, etc to be supported above roof surface with prefabricated pipe supports. Non-metallic support base with height adjustable galvanized metal bracket type at single conduit and piping, and adjustable channel strut guide type at multiple adjacent conduit and piping runs. Provide roller guide type accessory at gas lines.
  - 1. Portable Pipe Hangers Inc.
  - 2. Cooper Industries, B-Line
  - 3. Miro Industries, Inc.
  - 4. OMG Roofing Products.
  - 5. Roofing System Manufacturers comparable products as required by the specified full system warranty.

## 2.04 PIPE BOOTS

- A. Prefabricated EPDM pipe boot cover
  - 1. Portals Plus, Inc.
  - 2. OMG Roofing Products.
  - 3. Roofing System Manufacturers comparable products as required by the specified full system warranty.
- B. Provide proper single boot or multiple boot cap system as required by the conditions.

## 2.05 ROOF EXPANSION JOINT COVER – CURB MOUNTED

- A. Materials must be approved by the roofing system manufacturer to provide specified warranty requirements.
- B. Prefabricated insulated roof expansion joint cover with neoprene bellows of the proper width and 2" x 0.032" aluminum flanges, mounting type indicated, factory insulated core with integrally attached vapor retarder.
  - 1. Manville, Expand-O-Flash.
  - 2. Balco, Inc., Roof Bellows Expansion Joint.
  - 3. Roofing System Manufacturers comparable products as required by the specified full system warranty.
- C. Provide in maximum lengths possible, factory fabricated corners, properly seal lap joints and install per manufacturer's requirements and as required to provide a weathertight condition.

## 2.06 WALKWAY PADS

- A. Walkway Pads: Provide manufacturer standard walkway pads around perimeter of roof mounted equipment requiring access or service including roof hatches, stairs, ladders, mechanical exhaust fans, air handling units, condensing units, etc. Individual walkway pads shall be nominal 30" by 30".

## 2.07 ROOF HATCH

- A. Roof hatch shall be 2'-6" x 3'-0" single-leaf type, thermally broken, preassembled aluminum unit.
  - 1. Bilco, Type GS-50
- B. Performance:
  - 1. Cover and curb shall be thermally broken to prevent heat transfer between interior and exterior surfaces.
  - 2. Cover shall be reinforced to support a minimum live load of 40 psf with a maximum deflection of 1/150th of the span and 20 psf wind uplift.
  - 3. Operation of the cover shall be smooth and easy with controlled operation throughout the entire arc of opening and closing, and shall not be affected by temperature.
  - 4. Entire hatch shall be weather tight with fully welded corner joints on cover and curb.
- C. Cover: 11 gauge minimum aluminum with a 5" beaded flange with formed reinforcing members. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Cover shall have a heavy extruded EPDM rubber gasket bonded to the cover interior to assure a continuous seal when compressed to the top surface of the curb.
- D. Insulation: 3" minimum rigid polyisocyanurate with an LTTR-value of 18.0, fully covered and protected by an 18 gauge minimum aluminum liner.
- E. Curb: 11 gauge minimum aluminum. Interior and exterior surfaces shall be thermally broken to minimize heat transfer and to resist condensation. Curb shall have an integral 11 gauge aluminum capflashing fully welded at the corners. Curb to have 5" minimum mounting flange with height to allow for 12" minimum clearance from final roof surface to bottom of capflashing flange. Top of curb to be level, curb to be tapered as required.
  - 1. Insulation: 3" minimum rigid polyisocyanurate with an LTTR-value of 18.0.
- F. Lifting mechanisms: Compression spring operators enclosed in telescopic tubes.
- G. Hardware
  - 1. Heavy stainless steel pintle hinges.
  - 2. Cover shall be equipped with a spring latch with interior and exterior turn handles
  - 3. Hatch shall be equipped with interior padlock hasps.
  - 4. Latch strike shall be a stamped component bolted to the curb assembly.
  - 5. Cover shall automatically lock in the open position with a rigid hold open arm equipped with a vinyl grip handle to permit easy release for closing.
  - 6. Compression spring tubes shall be an anti-corrosive composite material and all other hardware shall be zinc plated and chromate sealed.
  - 7. Cover hardware shall be bolted into heavy gauge channel reinforcing

welded to the underside of the cover and concealed within the insulation space.

- H. Finishes: Mill finish aluminum.
- I. Ladder safety post for attachment to roof access ladder with safety yellow finish.
  - 1. Bilco, LadderUP Safety Post, Model LU-1.
  - 2. Babcock-Davis, BSP

## 2.08 EQUIPMENT CURBS/RAILS

- A. Prefabricated, load bearing equipment curbs/rails, double wall 18 gauge minimum galvanized steel with continuous welded and mitered corner seams and internal wood blocking with rigid insulation fill. Provide with integral base mounting plate and counterflashing.
  - 1. The Pate Company
  - 2. RPS Accessories
  - 3. Hranec Sheet Metal Inc.

## 2.09 ROOF CURB METAL CAPS

- A. Existing abandoned roof curbs to remain without use are to be capped with a weathertight, insulated, one piece galvanized metal cap as indicated.
- B. Cap to be shop fabricated, 14 gauge minimum galvanized steel with continuous 3" minimum perimeter flange with drip edge, overlapping exterior edges of roof curb on all four sides, with maximum vertical gap of 1/4". Any seams and joints to be fully welded and sealed. Cap to be fully insulated with 5" total thickness polyisocyanurate rigid board insulation, consisting of two layers fully adhered together and to underside of cap, and abutting inside faces of roof curb. Caps with either dimension exceeding 48" to have horizontal surface cross broken for strength, with peak on exterior side. In addition, caps with either dimension exceeding 60" to be reinforced with concealed 3 x 3 x 14 gauge galvanized steel bent angles spanning the short dimension at 24" centers, tack welded to underside of cap. Follow current SMACNA recommendations.
  - 1. Steel to be commercial quality hot-dipped zinc coated steel that complies with ASTM A653, Coating Designation A60 (Galvanealed).
  - 2. Touch-up any seams, welds, and exposed edges with galvanized paint.
  - 3. Rigid insulation to be closed cell polyisocyanurate foam board, foil faced, square edges, maximum flame spread 25 and smoke developed indexes of 450. ASTM C 1289 Type I Class 1 Grade 3, 25 psi minimum compressive strength, ASTM D 1621. Minimum LTTR-R Value of 28.8.

## PART 3 - EXECUTION

### 3.01 INSTALLATION - GENERAL

- A. Comply with manufacturer's instructions and recommendations. Coordinate with installation of roof deck and other substrates to receive roof accessory units, and with roof insulation, roofing and flashing; as required to ensure that each element of the work performs properly, and that combined elements are waterproof and

weathertight. Anchor units securely to supporting structural substrates, adequate to withstand lateral and thermal stresses as well as inward and outward loading pressures.

1. Except as otherwise indicated install roof accessory items in accordance with construction details of "NRCA Roofing and Waterproofing Manual".
  2. Follow NRCA recommended details which comply with ANSI/SPRI ES-1 requirements for edge securement items.
- B. Where metal surfaces of units are to be installed in contact with non-compatible metal or corrosive substrates, including wood, apply bituminous coating on concealed metal surfaces, or provide other permanent separation.
- C. Flange Seals: Except as otherwise indicated, set flanges of accessory units in a thick bed of approved roofing sealant to form a seal.
- D. Operational Units: Test operate units with operable components. Clean and lubricate joints and hardware. Adjust for proper operation.

### 3.02 INSTALLATION – PRE-MANUFACTURED COPING AND FASCIA

- A. Install two-piece pre-manufactured coping and fascia system components per manufacturer's requirements.
- B. Provide necessary components, accessories, trim, etc. to provide a complete and proper finished weathertight condition.
- C. Provide manufacturers concealed interlocking splice plates at section joints, properly sealed to provide a weathertight condition and allow for expansion. Lapped joints or exposed cover plates are not acceptable.

### 3.03 INSTALLATION – SHOP FABRICATED METAL

- A. Counterflashing to be set on continuous bead of caulk and secured to wall construction with neoprene gasketed non-corrosive fasteners of the proper type for the supporting substrate at 12" centers. Provide one piece and two piece as indicated. Top edge at one piece to be caulked continuous.
1. Sections to be lapped 4" and fully sealed.
- B. Gutters to be in maximum available lengths and installed with prefinished metal straps of same material as gutters, including expansion joints, etc. following SMACNA recommendations. Gutters to be properly pitched to downspouts and shall have joints properly lapped and caulked to provide a watertight condition. Do not install joints within 5'-0" of exterior passage doors. Metal straps to be non-exposed from grade.
- C. Downspouts to be secure to masonry with prefinished metal rod type anchors at 4'-0" o.c. min. matching downspout finish. Provide concrete splashblocks at discharge end of each downspout, at roof locations set on roofing manufacturers specified walkway pads, full coverage and a minimum of 6" larger than the splashblock in all directions.
- D. Fascias and copings where approved to be shop fabricated, shall be applied to wood backing as detailed and in accordance with manufacturer's recommendations with continuous 22 ga. minimum galvanized metal cleats.

1. Provide concealed 12" closure at section joints of same material, caulked in to provide a weathertight condition and allow for expansion. Provide 3/8" joint between sections centered on closure.
- E. Provide necessary components, accessories, trim, etc. to provide a complete and proper finished weathertight condition.
- F. Rake ends to be drain lapped 3" minimum.
- G. Miscellaneous metal wall flashings to be installed in longest sections possible to minimize joints. Securely fasten concealed to solid substrate backup with non-corrosive flat head fasteners. Joints to be lapped 3" minimum with vertical/horizontal surfaces set together on beads of sealant to ensure watertight condition.
- H. Concealed non-corrosive fasteners to be utilized wherever possible. Exposed fasteners to be non-corrosive, Kynar 500 finish matching adjacent metal.
- I. Exposed edges and cut edges of prefinished metal to be properly treated, and finished, matching faces to provide a finished, corrosion free appearance.

#### 3.04 INSTALLATION – MISCELLANEOUS ROOF COMPONENTS

- A. Install miscellaneous roof components per manufacturer's recommendations to provide complete and proper weathertight installation.
- B. Skylight roof curbs to be securely anchored to roof structure and properly sealed and flashed to provide a complete and proper finished weathertight condition for the items indicated, meeting manufacturer's requirements.
- C. Install walkway pads in accordance with manufacturer's recommendations.
- D. Roof hatch to be securely anchored to roof structure and associated structural supports. Properly sealed and flashed to provide a complete and proper finished weathertight condition meeting manufacturer's requirements. Install units level, plumb, and in proper alignment with adjacent work.
  1. Test units for proper function and adjust until proper operation is achieved.
  2. Repair finishes damaged during installation.
  3. Restore finishes so no evidence remains of corrective work.
- E. Equipment curbs and rails to be securely anchored to roof structure and associated structural supports. Properly sealed and flashed to provide a complete and proper finished weathertight condition for the roof supported equipment, meeting manufacturer's requirements.

#### 3.05 INSTALLATION - ROOF CURB METAL CAPS

- A. Existing abandoned roof curbs to remain: After removal of existing mechanical equipment, conduit, piping, ductwork, etc. by licensed tradesman, repair any damage to the existing roof curb to provide a stable, sound weathertight condition. Extend top of curb as required by the new top of roof surface elevation to provide 8" minimum exposed height of vertical roof flashing after cap is set in place.

- B. Set cap on existing roof curb with a continuous bead of silicone sealant along top surface of curb. Secure cap at 8" centers through the perimeter cap flange with non-corrosive neoprene gasketed fasteners of the proper type for existing material to be anchored to.
- C. Caulk bottom drip edge of perimeter cap flange to the roof curb with silicone sealant. Include incidentals, etc. as needed to provide a complete and proper, secure, weathertight installation.

### 3.06 CLEANING AND PROTECTION

- A. Remove protective film where applicable. Clean exposed surfaces in accordance with manufacturer's instructions.
- B. Touch up damaged coatings and exposed metal edges with manufacturers Kynar touch up paint.

END 07 71 00

DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 84 13 - Through-Penetration Firestop Systems

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified.

1.02 SUBMITTALS

- A. Product Data

1.03 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed firestop systems similar in material, design, and extent to that indicated for this Project and familiar with the requirements and restrictions/limitations of the Firestop Contractors International Associations (FCIA) manual of practice and factory mutual research approved.
- B. Source Limitations: Obtain through-penetration firestop systems, for each kind of penetration and construction condition indicated, from a single manufacturer.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Subject to compliance with requirements provide products by one of the following:
  - 1. Grace Construction Products
  - 2. Hilti, Inc.
  - 3. Johns Manville
  - 4. 3M Fire Protection Products
  - 5. Tremco, Inc. Tremco Fire Protection Systems Group
  - 6. USG Corporation

2.02 PENETRATION FIRESTOPPING

- A. Provide penetration firestopping that is produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01- inch wg.
  - 1. F-Rating: Not less than the fire-resistance rating of construction penetrated.
- C. Penetrations in Horizontal Assemblies: Ratings determined per ASTM E 814 or UL 1479 based on a positive pressure differential of 0.01-inch wg.

1. F-Rating: At least 1 hour, but not less than the fire-resistance rating of constructions penetrated.
  2. T-Rating: A least 1 hour, but not less than the fire-resistance rating of the constructions penetrated except for floor penetrations within the cavity of a wall.
- D. Exposed Penetration Firestopping: Provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping manufacturer and approved by qualified testing and inspecting agency for firestopping indicated.

### 2.03 SYSTEM FIRE SAFING

- A. Manufacturers, subject to system manufacturer's approval:
1. Certainteed: Thermafiber
  2. Johns Manville: MinWool Safing
  3. Owens Corning: Safing Insulation/MW
  4. Industrial Insulation Group, LLC; MinWool Safing
- B. Description: Unfaced mineral wool fire rated safing, thicknesses as required for the system. Greenguard Indoor Air Quality Certified.
- C. Ratings: Non-combustible, ASTM E136; Three hour fire resistance rating, ASTM E119, UL 263, NFPA 251; Flame spread rating 5 and smoke developed rating 0, ASTM E84, UL 723.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Examine substrates and conditions for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Surface Cleaning: Clean out openings immediately before installing through-penetration firestop systems to comply with written recommendations of firestop system manufacturer and the following requirements:
1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of through-penetration firestop systems.
  2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with through-penetration firestop systems. Remove loose particles remaining from cleaning operation.
  3. Remove laitance and form-release agents from concrete.
- C. Priming: Prime substrates where recommended in writing by through-penetration firestop system manufacturer using that manufacturer's recommended products

and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

- D. Install penetration firestopping to comply with manufacturer's written installation instructions and published drawings for products and applications indicated.
- E. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings indicated.
  - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not indicated as permanent components of firestopping.
- F. Install fill materials for firestopping by proven techniques to produce the following results:
  - 1. Fill voids and cavities formed by openings, forming materials, accessories, and penetrating items as required to achieve fire-resistance ratings indicated.
  - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
  - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

### 3.02 FIRE SAFING

- A. Install fire safing per manufacturer's requirements to obtain required Fire Rating, Flame Spread and Smoke Developed ratings. Fill gaps fully and seal with systems fire caulk.

### 3.03 IDENTIFICATION

- A. Identify through-penetration firestop systems with pressure-sensitive, self-adhesive, preprinted vinyl labels. Attach labels permanently to surfaces of penetrated construction on both sides of each firestop system installation where labels will be visible to anyone seeking to remove penetrating items or firestop systems. Include the following information on labels:
  - 1. The words: "Warning--Through-Penetration Firestop System--Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Contractor's name, address, and phone number.
  - 3. Date of installation.
  - 4. Through-penetration firestop system manufacturer's name.
  - 5. Installer's name.

### 3.04 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not damage materials in which openings occur.

- B. Provide final protection and maintain conditions during and after installation that ensure through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce through-penetration firestop systems complying with specified requirements.

END 07 84 13

DIVISION 7 - THERMAL & MOISTURE PROTECTION  
Section 07 92 00 – Joint Sealants

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 PERFORMANCE REQUIREMENTS

- A. Provide and install elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide and install joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.03 SUBMITTALS

- A. Product Data indicating specific location(s) where submitted material(s) is to be installed.
- B. Color Samples consisting of strips of cured sealants showing the full range of colors available for each product exposed to view and indicating specific location(s) where submitted material(s) is to be installed.
- C. Warranty

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

1.05 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with installation of joint sealants under the following conditions:
  - 1. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer.
  - 2. When joint substrates are wet.
- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

1.06 WARRANTY

- A. Installer's Warranty: Submit written warranty, signed by Installer agreeing to repair or replace work that does not comply with performance and other requirements specified herein within Two (2) years from Substantial Completion date.

## PART 2 - PRODUCTS

### 2.01 MATERIALS

- A. Perimeter caulking, exterior, at louvers, window and door frames, masonry control joints, and other joints between wood and masonry, metal and masonry, metal and wood, metal flashings, metal copings, metal fascias, conduit, piping, and other dissimilar materials shall be silicone building sealant by:
  - 1. Dow Corning, 790 Building Sealant
  - 2. GE, SCS2000 SilPruf
  - 3. Pecora, 864NST
  - 4. Tremco, Spectrem 1
- B. Perimeter caulking, interior, at louvers, window and door frames, and other joints between wood and masonry, metal and masonry, metal and wood, conduit, piping, and other dissimilar materials shall be paintable white acrylic siliconized building sealant:
  - 1. Pecora, AC-20 + Silicone
  - 2. GE, SCS7000 Paintable
  - 3. Tremco, Tremflex 834
- C. Perimeter caulking, interior, along hard surface finish flooring or floor slabs, at metal door and sidelight frames, steel columns, other metal and wood terminations/joints, etc. shall be colored acrylic siliconized building sealant:
  - 1. Pecora, AC-20 + Silicone
  - 2. GE, SCS7000
  - 3. Tremco, Tremflex 834
- D. Sealing of interior concrete floor slab control joints, construction joints, expansion joints (including perimeter expansion joints at walls), cracks, penetrations through the floor slab, and cast in floor devices to be polyurethane building sealant:
  - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. BASF/MasterSeal: NP 2 and SL 2.
    - b. Pecora: Dynatrol II and Dynatrol II SG or NR-200
  - 2. Sealant shall be flush with concrete floor slab. Provide gun grade or pourable as appropriate for the application.
- E. Sealing of exterior concrete slab control joints, expansion joints, penetrations through concrete slab, and cast in items to be high performance, traffic exposure, exterior urethane building sealant:
  - 1. BASF/MasterSeal

2. Pecora
  3. Tremco
  4. Sealant shall be flush with concrete slab. Provide gun grade or pourable as appropriate for the application.
- F. Colors as selected by Architect.
- 2.02 JOINT SEALANT BACKING
- A. Provide sealant backings of material and type which are non-staining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
  - B. Backer Rod: ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
    1. Type C: Closed-cell material with a surface skin, unless open cell is indicated or recommended by sealant manufacturer.
    2. Type O: Open-cell material.
    3. Type B: Bicellular material with a surface skin.
  - C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

### 2.03 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

## PART 3 - EXECUTION

### 3.01 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.02 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
  - 1. Remove foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
  - 2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air. Porous joint surfaces include the following:
    - a. Concrete.
    - b. Masonry.
    - c. GFRC
    - d. Unglazed surfaces of ceramic tile.
  - 3. Remove laitance and form-release agents from concrete.
  - 4. Clean nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
    - a. Metal.
    - b. Glass.
    - c. Porcelain enamel.
    - d. Glazed surfaces of ceramic tile.
- B. Joint Priming: Prime joint substrates where recommended in writing by joint sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.03 INSTALLATION

- A. General: Comply with joint sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.

- C. Install sealant backings of type indicated to support sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
  - 1. Do not leave gaps between ends of sealant backings.
  - 2. Do not stretch, twist, puncture, or tear sealant backings.
  - 3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.
- E. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
  - 1. Place sealants so they directly contact and fully wet joint substrates.
  - 2. Completely fill recesses provided for each joint configuration.
  - 3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Nonsag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.
  - 1. Remove excess sealants from surfaces adjacent to joint.
  - 2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
  - 3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.
- G. Use masking tape to protect adjacent surfaces of recessed tooled joints.

### 3.04 CLEANING

- A. Clean off excess sealants or sealant smears adjacent to joints as the Work progresses by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

### 3.05 PROTECTION

- A. Protect joint sealants during and after curing period from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so installations with repaired areas are indistinguishable from the original work.

END 07 92 00

DIVISION 5 – METALS  
Section 07 95 00 - Expansion Control

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified.

1.02 SUBMITTALS

- A. Product Data
- B. Shop Drawings
  - 1. Indicate joint device profiles, dimensions, locations in the Work, affected adjacent construction, anchorage devices, available colors and finish, and locations of splices.
  - 2. Provide details showing intersection between floor areas, floor-to-wall, wall-to-ceiling, corner conditions, transitions between systems, terminations, etc.
- C. Installation Instructions
  - 1. Manufacturer's installation instructions.
- D. Color Samples
  - 1. Manufacturer standard color and finish options for selection.
- E. Assembly Samples
  - 1. Two assembly samples 6 x 6 in. in size illustrating profile, dimension, color, and finish selected.

PART 2 - PRODUCTS

2.01 EXPANSION JOINTS AT NEW/EXISTING CONSTRUCTION

- A. Interior floor expansion joint at doors shall be surface mounted extruded aluminum saddle type expansion joint cover. Unit shall be pedestrian rated and meet ADA requirements.
  - 1. MM Systems Corp., HSC-C Series / Slab to Slab
  - 2. Architectural Art, comparable to 1 above.
  - 3. Balco, Inc., comparable to 1 above.
- B. Interior floor expansion joint at walls shall be surface mounted extruded aluminum saddle type expansion joint cover.
  - 1. MM Systems Corp., HSC-C Series / Slab to Wall
  - 2. Architectural Art, comparable to 1 above.
  - 3. Balco, Inc., comparable to 1 above.
- C. Interior masonry wall expansion joint shall be flexible cellular polyurethane backer with preformed silicone sealing strip.

1. MM Systems Corp., ESS Series
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- D. Fire rated interior gypsum board wall expansion joint shall be surface applied expansion joint system.
1. MM Systems Corp., FSWL-100 Fire Rated
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- E. Interior gypsum board ceiling/soffit expansion joint shall be concealed securement, flush expansion joint with flexible cover.
1. MM Systems Corp., VSWL-500
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- F. Exterior masonry wall expansion joint shall be flexible cellular polyurethane backer with preformed silicone bellows seal.
1. MM Systems Corp., SIF Series
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- G. Sizes as required by joint widths and application.

## 2.02 METAL EXPANSION JOINTS

- A. Interior floor expansion joint shall be classic curved expansion joint cover with recessed flange to accept floor finish. Unit shall be pedestrian rated and meet ADA requirements.
1. MM Systems Corp., Model HFXR
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- B. Interior wall expansion joint shall be surface applied expansion joint system.
1. MM Systems Corp., Model FXK and FXL
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- C. Interior ceiling expansion joint shall be expansion joint with accordion flexible filler. Color as selected by Architect.
1. MM Systems Corp., Model CX (ACT ceiling) and KX (Gypsum board)
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- D. Exterior wall expansion joint shall be silicone expansion joint system. Provide extruded aluminum cover plate, width to be 2" greater than the maximum joint opening width. Anchor cover plate to one side of joint only.

1. MM Systems Corp., Model HFXR
  2. Architectural Art, comparable to 1 above.
  3. Balco, Inc., comparable to 1 above.
- E. Sizes as required by joint widths and application.

## 2.03 MISCELLANEOUS REQUIREMENTS

### A. Materials:

1. Extruded Aluminum: 6063-T5
2. Threaded Fasteners: Manufacturers standard non-corrosive
3. Silicone Seal and integral Foam Backer: Colored silicone surface seal factory applied to secondary micro-cell self-expanding foam with impregnated acrylic polymer, watertight, UV stable, flame resistant, chemical resistant meeting ASTM 283, ASTM 518, DIN 18542
4. Elastomeric Seals: ASTM E 1783; preformed elastomeric membranes or extrusions to be installed in metal frames.
5. Compression Seals: ASTM E 1612; preformed elastomeric extrusions having an internal baffle system and designed to function under compression.
6. Fire Barriers: Manufacturers standard to meet performance criteria for required fire-resistance rating.
7. Protective Coatings: Isolate dissimilar materials with manufacturers standard protective coatings for the proper application.

### B. Finish

1. Exposed Extruded Sections on Floors: Mill finish.
2. Exposed Extruded Sections on Walls and Ceilings: Clear anodized.
3. Resilient Fillers/Silicone Seals/Elastomeric Seals: Color as selected by Architect from manufacturers full range of non-custom colors.

C. Back paint components in contact with cementitious materials to prevent electrolysis with manufacturers protective coatings.

D. Galvanize concealed ferrous metal anchors and fastening devices.

E. Shop assemble components and package with anchors and fittings.

F. Provide joint components in single lengths wherever practical. Minimize site splicing.

G. At fire rated locations, provide comparable unit or add standard components that meets required fire rating.

## PART 3 - EXECUTION

### 3.01 PREPARATION

A. Provide anchoring devices for installation and embedment. Modify as required to provide secure installation into each substrate.

B. Provide templates or rough-in measurements.

### 3.02 INSTALLATION

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- A. Install components and accessories in accord with manufacturer's instructions. Provide necessary sealants, fasteners, etc. required for each system.
- B. Align work plumb and level, flush with adjacent surfaces.
- C. Rigidly anchor and/or adhere to substrate to prevent movement or misalignment.
- D. Provide items and components necessary for continuous transition between roof, wall, floor, and ceiling (soffit) joint covers and as required to provide a uniform finished appearance, and a complete and proper weathertight installation.

3.03 PROTECTION

- A. Protect finished installation.
- B. Provide removable strippable coating reinforced cloth tape to protect finish joint surface.

END 07 95 00

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 PERFORMANCE REQUIREMENTS

- A. Operation-Cycle Requirements: Design overhead coiling door components and operators to operate for normal use of up to 25 cycle per day maximum, not less than 50,000 cycles lifetime.
- B. Wind Loading at Exterior Door Assemblies: Doors to withstand specified design wind loads. Refer to structural drawings.
- C. Safety Requirements:
  - 1. Chain operated doors shall be designed so that the door immediately stops upward or downward travel and is maintained in a stationary position when the hand chain is released by user.
- D. Fire Rated Doors: Doors to be provided with Underwriters' Laboratories, Inc. label for the fire rating classification specified, including smoke label with Underwriters' Laboratories, Inc. label for "Leakage Rated Assembly" or "S" label demonstrating product tested to UL 1784.
  - 1. Comply with NFPA 105 air leakage requirements
- E. Exterior Doors Thermal Performance:
  - 1. Flame Spread Index of 0 and a Smoke Developed Index of 10 as tested per ASTM E84.
  - 2. Minimum R-Value of 7.7.
  - 3. Polyurethane insulation to be CFC Free with an Ozone Depletion Potential (ODP) rating of zero.
- F. Exterior Doors Air Infiltration Performance:
  - 1. Meet or exceed current ASHRAE Standard 90.1 requirements.
  - 2. Meet or exceed IECC 2015 requirements.

1.03 SUBMITTALS

- A. Shop Drawings: Indicate manufacturer's data, size, construction, arrangement and installation details. Include special components and installation not dimensioned or detailed in manufacturer's data sheets but pertinent to project conditions and design intent.
- B. Product Data: Complete printed data for each type overhead coiling door indicating features to be provided and locations. Provide roughing-in diagrams, operating instructions, maintenance information, and wiring diagrams of related fire detection components. Include the following:
  - 1. Summary of forces and loads on walls and jambs.

2. Motors: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.
- C. Certification: Manufacturer's Thermal Performance and Air Infiltration Test Results.
- D. Color Samples: For selection of each finish product specified, set of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches long, representing actual product, color, and patterns.
- F. Operation and Maintenance Manual.
- G. Demonstration and Training Video Recordings.
- H. Warranty.

#### 1.04 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced installer who is an authorized representative of the overhead coiling door manufacturer for both installation and maintenance of units specified.
- B. Fire-Rated Door Assemblies: Provide assemblies complying with NFPA 80 and NFPA 105 that are identical to door and frame assemblies tested for fire-test-response characteristics per UL 10b, and that are labeled and listed for fire ratings indicated by UL, FM, ITS/Warnock Hersey, or another testing and inspecting agency acceptable to the local authorities having jurisdiction.

#### 1.05 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging with seals and labels intact until ready for installation.
- B. Store materials off the ground in a dry, warm, ventilated weathertight location.

#### 1.06 WARRANTY

- A. Two year warranty against defects in material and workmanship from date of Substantial Completion.
- B. Five year limited warranty on electric motor operators from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.01 INSULATED ROLLING SERVICE DOORS

- A. Subject to compliance with requirements, provide products by one of the following.
  1. Cookson; Thermiser Max ESD30
  2. Cornell; Thermiser Max ESD30
  3. Wayne Dalton; ThermoTite 800C
  4. Clopay Building Products Co.; Model CESD20
- B. Mounting: Face of wall mounting type.
- C. Operation Type: Doors shall be manual chain operated type with governor to regulate downward speed. Gear box to completely enclose operating mechanism and be oil-tight. Location of chain shall be as indicated for each door.

- D. Counterbalance Mechanism: Provide manufacturer's standard by means of adjustable-tension steel torsion spring, mounted around a steel shaft and contained in a spring barrel connected to door curtain with required barrel rings. Use grease-sealed bearings or self-lubricating graphite bearings for rotating members.
- E. Slats: 1" minimum nominal thickness insulated slat with maximum 3" face. 22 gauge minimum G90 galvanized steel exterior skin and 24 gauge minimum G90 galvanized interior skin with foamed in place closed cell polyurethane insulation core, minimum R-Value of 7.7. Provide with continuous end locks, and wind locks.
- F. Hood: Form to entirely enclose coiled curtain and operating mechanism at opening head and act as weatherseal. Contour to suit end brackets to which hood is attached. Roll and reinforce top and bottom edges for stiffness. Provide closed ends for surface mounted hoods and fascia for any portion of between jambs mounting projecting beyond wall face. Provide intermediate support brackets as required to prevent sag.
  - 1. Steel hoods to be minimum 24 gauge, G90 galvanized (Z275 zinc coating), complying with ASTM A 653M.
- G. Guides:
  - 1. Minimum 3/16 inch G90 galvanized structural steel angles. Provide windlock bars of same material to meet specified wind load. Top of inner and outer guide angles to be flared outwards to form bellmouth for smooth entry of curtain into guides. Provide removable guide stoppers to prevent over travel of curtain and bottom bar.
  - 2. Top portion of coil side guide angles to be removable for ease of curtain installation and as needed for future curtain service
- H. Weatherseals: EPDM bulb type compressible bottom bar, severe jamb and head seals, and neoprene/rayon hood baffle to provide a weathertight installation.
  - 1. Replaceable, adjustable, continuous, compressible weather-stripping gaskets, fitted to bottom, top, and jambs of exterior doors. 1/8" minimum thickness. Lintel seal to be nylon brush type fitted at door header. Provide with 2015 IECC air infiltration option.
- I. Locking Device: Adjustable locking bar to engage through slots in tracks.
  - 1. Single-jamb side, operable as follows:
    - a. Unlocking on coil side by slide bolt on bottom bar
- J. Chain Lock Keeper on Manual Doors: Suitable for padlock.
- K. Operator and Bracket Mechanism Cover: Minimum 24 gauge G90 galvanized steel sheet metal trim cover to enclose exposed moving operating components at coil area of unit. Finish to match door hood.
- L. Finishes: Exposed steel items to receive manufacturer's pre-treatment and factory baked on polyester powder coat system.
  - 1. 2.5 mils minimum cured film thickness. ASTM D-3363 pencil hardness, H or better
  - 2. Color as selected by Architect from manufacturers full range of non-custom colors, minimum 32 color selection.

### PART 3 - EXECUTION

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### 3.01 EXAMINATION

- A. Examine substrates upon which work will be installed and verify conditions are in accordance with approved shop drawings, and contract requirements.
- B. Coordinate with contractor to perform corrective work on unsatisfactory substrates.
- C. Commencement of work by installer is acceptance of substrate.

### 3.02 INSTALLATION

- A. Install door and operating equipment complete with necessary hardware, jamb and head mold strips, weatherstripping, hood baffles, seals, anchors, inserts, hangers, and equipment supports according to Shop Drawings, manufacturer's written instructions, and as specified.
  - 1. Rated doors to comply with NFPA 80 and NFPA 105.
- B. Provide concealed hood and motor operators above ceilings where indicated. At gypsum board ceilings and soffits, Contractor to coordinate proper size and location of access doors needed for maintenance, repairs, and replacement of door components.
- C. Insulated exterior coiling doors to be installed properly to not permit air, water, and weather infiltration into building. Provide necessary components and incidentals to provide a complete and proper weathertight installation.

### 3.03 ADJUSTMENT

- A. Test door operations, motor operators, etc. Lubricate bearings and sliding parts; adjust doors to operate easily, free from warp, twist, or distortion and fitting properly for entire perimeter.

### 3.04 FIELD QUALITY CONTROL

- A. Site Test: Test doors for normal operation, and automatic closing at rated doors. Coordinate with authorities having jurisdiction to witness rated doors test, and sign required documentation.

### 3.05 DEMONSTRATION

- A. Startup Services: Engage a factory-authorized service representative to perform startup services and to train Owner's maintenance personnel as specified below:
  - 1. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
  - 2. Test door closing when activated by detector or alarm connected fire-release system. Reset door-closing mechanism after successful test.
  - 3. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, preventive maintenance, and procedures for testing and resetting release devices.
    - a. Review data in the Operation and Maintenance Manuals.
    - b. Video tape each training session per Section 01 77 00 – Closeout Procedures.

END 08 33 00

DIVISION 8 - OPENINGS  
Section 08 80 00 - Glazing

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of work shown on the drawings and/or specified.

1.02 SUBMITTALS

- A. Product data.
- B. Glazing schedule indicating glazing types and locations
- C. Samples of colored and/or tinted glazing units, 12" x 12".

1.03 PERFORMANCE

- A. Insulated Glass
  - 1. Conform to ASTM E 774-88. Visible, permanent IGCC Certification Label for CBA rating level.
  - 2. Dual perimeter seals, silicone and polyisobutylene.
  - 3. Manufacturer's continuous warm edge type spacer with desiccant. Manufacturer listed and dated.
- B. Glazing Requirements: Conform to Consumer Products Safety Commission Part 1201 - Safety Standard For Architectural Glazing Materials.
- C. Fire-Rated Glazing and Tempered Glass shall be furnished with an etched label showing conformance with specified requirements and IBC code requirements.

1.04 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass 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 on Laminated Glass: Manufacturer's standard form in which 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 on Insulating Glass: Manufacturer's standard

form in which 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

### 2.01 MATERIALS

- A. Fire-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
  1. Laminated Ceramic Glazing: Laminated glass made from 2 plies of clear, ceramic flat glass; 5/16-inch total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials.
  2. Manufacturer Size Limitations: Contractor shall coordinate requested glazing sizes with manufacturer production size limitations. Where necessary, Glazing installed in adjacent lites shall be furnished by a single manufacturer in order to produce a consistent appearance.
  3. Products: Subject to compliance with requirements provide one of the following:
    - a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite Plus.
    - b. Schott North America, Inc.; Laminated Pyran Platinum.
    - c. Vetrotech Saint-Gobain; SGG Keralite FR-L.
  4. At door lites, provide manufacturer's Standard grade fire rated glazing. At locations other than door lites, provide manufacturer's Premium grade fire-rated glazing.
- B. Interior Tempered Glass: At interior doors and frames and as indicated, clear 1/4" thick shall be:
  1. Guardian
  2. PPG
  3. Pilkington
  4. Trulite
- C. Exterior Tempered Glass: At exterior doors and as indicated, tinted to match insulated units with hard coat low emissivity coating on the #2 surface, 1/4" thick, shall be:
  1. Guardian
  2. PPG
  3. Pilkington

4. Trulite
- D. Insulated Glass for aluminum windows, exterior aluminum doors and frames, 1" thick insulated glass. Shading Coeff. 0.37; Solar Heat Gain Coeff. 0.32; LSG 1.31.
  1. Provide tempered insulated units as follows:
    - a. Exterior lite 1/4" tempered PPG Solarbronze tinted.
    - b. Airspace.
    - c. Interior lite 1/4" tempered PPG Solarban 60 clear with high performance soft coat low emissivity coating on the #3 surface.
  2. Provide units fabricated by one of the following for all applications:
    - a. Oldcastle
    - b. Trulite
    - c. Traco
    - d. EFCO
- E. Obscure Glass
  1. 1/4" tempered, acid etched in pattern and transparency as selected by Architect.

## PART 3 - EXECUTION

### 3.01 INSTALLATION

- A. Glass shall be new. Each light shall bear manufacturer's label or be delivered in labeled boxes. Labels must remain on until the glass has been set reviewed, and approved by the Architect. When glass is not cut to size by manufacturer and is furnished unlabeled from local stock, the Contractor shall submit an affidavit stating the quality, type, thickness and manufacturer of glass furnished.
- B. Do not set glass until rabbets are prime painted and dry. Glass shall be supported with spring clips or setting blocks. Glazing shall be set in sealants or gaskets. Sealants or gaskets shall engage both sides of glazing.
  1. Where glazing sealant is used, back putty and neatly strike flush with stops.
  2. Where dry gasketing is used, gaskets shall not extend above the stops.
- C. Sizes for glass shall be taken from the actual frames and sash. This work contemplates glass set in place and the Contractor shall assume responsibility in regard to correct sizes. Sizes, if shown on drawings, are approximate, and shall be used for estimate only.
- D. Glass shall be set by skilled workmen in the best possible manner and in such a way that there will be an equal bearing the entire width of each panel. Glass shall be accurately sized to fit the frame and edges shall be smooth, no sharp or ragged edges being left. Contractor shall be held responsible for broken glass due to improper setting. Glazing beads or stops shall be properly reset without marring or injuring the finish.

- E. At interior dual glazed locations provide proper spacers, gaskets, tape, etc. to provide a complete and proper sound isolation installation. Properly clean units prior to installation of glazing.
- F. Wall mirrors shall be installed to minimize distortion.
- G. Security film to be installed on the interior side of exterior units and on the secure side of interior units. Security film shall be installed per manufacturer's requirements with perimeter adhesive attachment type system. New and existing glass must be properly cleaned and prepared prior to installation. Protect as recommended by the manufacturer for the initial 30 days after installation.

### 3.02 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. 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; remove as recommended in writing by glass manufacturer.
- D. Glass provided by the Contractor that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism before Substantial Completion shall be replaced by the Contractor without additional cost to Owner.

END 08 80 00

DIVISION 9 - FINISHES

Section 09 29 00 - Gypsum Board System

PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified under this section.
- B. Provide Level 1 gypsum board level of finish to unexposed gypsum board. At fire rated and/or smoke partitions provide additional requirements meeting codes.
- C. Provide Level 4 gypsum board level of finish to exposed gypsum board to receive paint finish unless otherwise noted.

1.02 SUBMITTALS

- A. Product Data

1.03 QUALITY ASSURANCE

- A. Gypsum Association standards and recommendations
  - 1. GA-214 - Recommended Levels of Gypsum Board Finish.
  - 2. GA-216 - Application and Finishing of Gypsum Panel Products.
  - 3. GA-290 - Area Separation Walls.
  - 4. GA-600 - Fire Resistance Design Manual.
  - 5. GA-801 - Handling and Storage of Gypsum Panel Products.

1.04 DESIGN REQUIREMENTS

- A. Metal Framing: Provide non-load bearing steel stud partitions with deflections conforming to L/240 at 5 psf (239 Pa) typical for gypsum board walls.
- B. Fire-Resistive Rating: Where indicated on Drawings, provide materials and construction that are identical to those assemblies whose fire resistance rating has been determined per ASTM E119 by a testing and inspecting organization acceptable to authorities having jurisdiction.
  - 1. Meet or exceed fire resistance requirements outlined under provisions of the GA-600 Fire Resistance Design Manual for wall and ceiling assemblies.
  - 2. Meet or exceed Class A flame/fuel/smoke requirements of ASTM E84 surface burning characteristics for finish materials.

PART 2 - PRODUCTS

2.01 FRAMING MATERIALS

- A. Steel studs, framing, runners, furring, and associated system components: ASTM C645, 30 mil (20ga) galvanized, sizes indicated. Subject to compliance with requirements, provide products by one of the following.
  - 1. Gypsum Board Manufacturer Products

2. ClarkDietrich
  3. United States Steel
  4. Marinoware
- B. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes due to deflection of structure above. Allow for 1" of movement.
1. Fire Rated Locations: Provide Fire Trak Deflection Trak and Fire Stop System by FireTrak Corp. or comparable fire rated system by metal stud manufacturer.
  2. Non-fire Rated Locations: Provide metal stud manufacturer's slip-type head joint system.

## 2.02 METAL SUSPENSION SYSTEM

- A. Manufacturers:
1. Chicago Metallic Corp./Rockfon, Fire Front 650 System
  2. USG Interiors, Ceiling Suspension Division, Rigid X
  3. Armstrong, Drywall Furring System 8900 Series
- B. Provide proper system and components to support additional loading of multiple layers of gypsum board, light fixtures, etc.
- C. Provide necessary components for a complete and proper installation.
- D. Exterior installations to be galvanized.

## 2.03 GYPSUM BOARD

- A. Gypsum Board: ASTM D3273, 5/8" thick, Type X, Mold Resistant with a score of 10 as rated according to ASTM D 3273 and/or 0 as rated according to ASTM G21.
1. U.S Gypsum; Sheetrock Firecode Core, Mold Tough Board
  2. National Gypsum Co.; Gold Bond XP Fire-Shield, Mold Resistant Board
  3. Georgia-Pacific; ToughRock Fireguard X Mold-Guard Gypsum Board
  4. Continental Building Products; Mold Defense Type X
  5. CertainTeed Corp.; M2Tech Type X

## 2.04 ABUSE RESISTANT GYPSUM BOARD

- A. Abuse Resistant Gypsum Board: ASTM D3273 and C1629 – Level 1, 5/8" thick, Type X, Abuse and Mold Resistant with a score of 10 as rated according to ASTM D 3273 and/or 0 as rated according to ASTM G21.
1. U.S Gypsum; Sheetrock Firecode Core, Mold Tough AR Board
  2. National Gypsum Co.; Gold Bond Hi-Abuse XP Fire-Shield, Mold Resistant Board
  3. Georgia-Pacific; ToughRock Fireguard X Mold-Guard Abuse-Resistant Gypsum Board

4. Continental Building Products; Protecta AR 100 Type X with Mold Defense
5. CertainTeed Corp.; AirRenew Extreme Abuse Type X

## 2.05 EXTERIOR GYPSUM BOARD

- A.
- B. Exterior Gypsum Soffit Board for Protected Horizontal Applications: ASTM C1396 with manufacturer standard edges, 5/8" thick. Firecode C or X core, ASTM E84 flame spread 20 max. and smoke developed 0.
- C.
  1. U.S Gypsum; Sheetrock Exterior Gypsum Ceiling Board
  2. National Gypsum Co.; Gold Bond Exterior Soffit Board
  3. Georgia-Pacific; ToughRock Fireguard C Soffit Board
  4. Continental Building Products; Firecheck Soffitboard
  5. CertainTeed Corp.; Exterior Soffit Type X Board

## 2.06 TRIM

- A. Metal Trim and Finishing Accessories: Manufacturers standard zinc galvanized metal edge trim, corner bead, etc. for use at intended application.
- B. Edge Trim: PVC conforming to ASTM C1047 and D3678 for interior exposure. Include manufacturer's proper intersection and corner trim for continuous monolithic appearance. Mud set type trim with perforated concealed flanges. Provide proper comparable unit rated for exterior exposure at exterior gypsum board soffits.
  1. Corner Bead, at outside corners
  2. J Bead, at exposed board edges not abutting dissimilar materials
  3. L Bead at board edges abutting dissimilar materials; tear away type
  4. L Bead with gasket at board edges abutting exterior window and door frames, plenum walls, and at exterior soffits; tear away type
  5. L Bead at board edges abutting dissimilar materials with 1/4" caulk channel if narrow reveal (uncaulked) or caulk channel is needed; tear away type
  6. Archway Bead at curved surfaces; tear away type
  7. Subject to compliance with requirements, provide products by one of the following:
    - a. Trim-Tex, Inc.
    - b. Plastic Components, Inc.
- C. Control Joint Trim: 1/4" joint, PVC conforming to ASTM C1047 and D3678 for interior exposure. Include manufacturer's proper intersection and corner trim for continuous monolithic appearance. Mud set type trim with perforated concealed flanges. Provide proper comparable unit rated for exterior exposure at exterior gypsum board soffits. Subject to compliance with requirements, provide products

by one of the following:

1. Trim-Tex, Inc., #093V Expansion Joint
  2. Plastic Components, Inc., #2027-16
- D. Reveal Trim: 2" x 2", PVC conforming to ASTM C1047 and D3678 for interior exposure. Include manufacturer's proper intersection and corner trim for continuous monolithic appearance. Mud set type trim with perforated concealed flanges. Provide proper comparable unit rated for exterior exposure at exterior gypsum board soffits. Subject to compliance with requirements, provide products by one of the following:
1. Trim-Tex, Inc., #AS5510 at wall intersection and #AS5110 in field
  2. Plastic Components, Inc., #202 Z Mold Trim at wall intersection and #225 Drywall Reveal in field.

## 2.07 COMPONENTS

- A. Joint compound, tapes, etc.: Gypsum board manufacturer's premium products matching the specified board type and characteristics. Must maintain indicated mold resistance, fire resistance, and abuse resistance. Do not mix manufacturers, provide same manufacturer as board to maintain the integrity of their system.
1. Screws: Type "S" as recommended by gypsum board manufacturer.

## 2.08 CONTINUOUS SOFFIT VENT

- A. Manufacturers:
1. Air Vent, Inc; SV202
  2. Guardian Building Products; 105 Continuous Soffit Vent
  3. Tamlyn; CUV8 Continuous Soffit Vent
- B. Products specified above are intended to be installed against a vertical surface. Provide similar model if vent is to be installed in field of soffit.
- C. Extruded aluminum, 2 inch ventilated width providing nine (9) square inches net free area per lineal foot.
- D. Provide concealed continuous aluminum insect screen sealed to each section.
- E. Provide maximum lengths available.
- F. Factory applied baked enamel finish, color as selected by Architect.

## PART 3 - EXECUTION

### 3.01 METAL STUD FRAMING INSTALLATION

- A. Stud System Erection. Attach metal runners at floor with suitable fasteners located 2" from each end and spaced 16" o.c. Position studs vertically, engaging floor and ceiling runners and spaced 16" o.c. Metal studs shall run full height from floor to height as indicated. When necessary, splice studs with 8" nested lap and one positive attachment per stud flange. Place studs in direct contact with door frame jambs, abutting partitions and partition corners.

- B. Anchor studs for shelf-walls, counter, vanity, and those adjacent to door frames, partition intersections, and corners to ceiling and floor runner flanges with USG Metal Lock Fastener tool. Securely anchor studs to jamb and head anchor clips of door frames by bolt or screw attachment. Over metal door frames, place horizontally a cut-to-length section of runner with a web flange bend at each end, and secure with one positive attachment per flange.
- C. Framing components shall be cut squarely for attachment to perpendicular members, or as required for an angular fit against abutting members. Members shall be held positively in place until properly fastened.
- D. Construct corners using minimum 3 studs, double stud at wall opening, door and windows jambs.
- E. Erect studs 1 piece full length; splicing of studs not permitted.
- F. Attachment of similar materials shall be done by mechanical fasteners. Dissimilar materials may be attached with screws, bolts or properly designed clips. Wire tying of framing components in structural applications shall not be permitted.
- G. Provide necessary stud bracing, etc. as detailed and/or required to support design and anticipated loads.
- H. Install intermediate studs above and below openings to match wall stud spacing.
- I. Provide deflection allowance in stud top track, directly below horizontal building framing for non-load bearing framing. Deflection top track to be installed per manufacturer's requirements to allow for vertical deflection, and fire rating at walls indicated to be fire rated. Provide additional gypsum board layers, etc. required by manufacturer of system.
- J. At locations where the stud top track is not supported on a continuous support, provide misc. items including metal framing, blocking, angles, etc. to properly brace and support the wall.
- K. Install framing between studs for attachment of mechanical and electrical items, and to prevent stud rotation.
- L. Provide substantial intermediate wood blocking properly anchored to metal studs for secure attachment of wall mounted items, toilet accessories, etc.

### 3.02 GYPSUM BOARD INSTALLATION

- A. The suspension system for the suspended gypsum board panels, ceilings and soffits shall consist of necessary components as required and shall be installed as per manufacturer's requirements and/or as detailed to support loads at 1/360 max. deflection. Provide control joints as indicated and required, installed per manufacturer's requirements. Properly glue and screw gypsum board panels to ceiling suspension system.
- B. Suspension system and components to be supported from steel bar joists including but not necessarily limited to framing and hanging wire shall be supported from the top chord of the steel joists unless otherwise specifically indicated.
- C. Gypsum board erection (on studs). Apply gypsum panels vertically. Position edges over studs for vertical application; ends over studs for horizontal application.
- D. Use maximum practical lengths to minimize end joints. Fit ends and edges closely,

but not forced together.

- E. Stagger joints on opposite sides of partition and on laminated sections. Space screws 12" o.c. in field of panels and 8" o.c. staggered along vertical abutting edges.
- F. Gypsum board shall be applied to surfaces where called for the drawings. Joints shall be taped, spackled and neatly sanded to form a smooth even sound surface so as to show no evidence of joints after surfaces have been painted. Provide corner beads at exterior corners and trim at exposed edges of gypsum board surfaces and where gypsum board abuts dissimilar materials, taped flush. Provide indicated level of finish meeting Gypsum Association standards.
- G. Cement board to be provided as the backer board for areas to receive ceramic tile wall finish. Install per manufacturer's requirements.
- H. Exterior gypsum board shall be provided in exterior locations. Install per manufacturer's requirements.
- I. Trim, beads, control joints, reveals, etc. to be taped in flush to provide a uniform monolithic appearance. Installation with mechanical fasteners and adhesives to meet manufacturers requirements.
- J. Work and materials to be per gypsum board manufacturer's requirements to provide and maintain the fire rating, mold resistance, and abuse resistance of their system.
- K. Install continuous soffit vent as required to maintain proper ventilation of soffit systems.

### 3.03 PATCHING

- A. After other trades and contractors have finished their work, damaged areas shall be patched. The Contractor shall accomplish patching and repainting without cost to the Owner.
  - 1. Touch-up, repair or replace damaged products before Substantial Completion.

### 3.04 PROTECTION

- A. Protect adjacent finish surfaces from damage due to operations.
- B. Protect installed products until Substantial Completion.

END 09 29 00

DIVISION 9 – FINISHES  
Section 09 51 00 - Acoustical Ceilings

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

- A. Product Data
- B. Samples
  - 1. Acoustical Tile, 6" square manufacturers sample, one (1) of each tile type
- C. Attic Stock: Written verification of attic stock delivery to Owner's representative.

1.03 STORAGE AND HANDLING

- A. Deliver acoustical ceiling panels, suspension system components, and accessories to Site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, direct sunlight, surface contamination or other causes.
- B. Before installing acoustical ceiling panels, permit them to reach room temperature and stabilized moisture content.
- C. Handle acoustical ceiling panels carefully to avoid chipping edges or damaging units in any way.

1.04 PROJECT CONDITIONS

- A. Space Enclosure: Do not install interior acoustical ceilings until space is enclosed and weatherproof, wet-work (painting, gypsum board, plastering, tiling, and concrete leveling) in space is completed and dry, work above ceilings is complete, and ambient temperature and humidity conditions will be continuously maintained at values indicated for the Project when occupied for its intended use.

PART 2 - PRODUCTS

2.01 ACOUSTICAL TILE

- A. Type 'A', lay-in type white tiles, ASTM E84 Class A rated incombustible mineral tile, 24" x 24" x 5/8" min. with square cut edge design, high temperature and humidity resistant. UL Classified NRC 0.70 min., with CAC 22 min.
  - 1. Armstrong, School Zone Fine Fissured # 1713
  - 2. CertainTeed, Performa Fine Fissured High NRC #HHF-457-HNRC
  - 3. USG Acoustical Products Co., Radar ClimaPlus High-NRC #22111
  - 4. Rockfon, Artic #600
- B. Type 'A', lay-in type white tiles, ASTM E84 Class A rated incombustible tile, 24" x 24" with square cut edge design, high temperature and humidity resistant. UL Classified NRC 0.70 min. and CAC 40 min.

1. Armstrong, School Zone Fine Fissured #1810 (3/4" thickness)
  2. CertainTeed, Performa Adagio High CAC #HCAC-1672-IOF-1 (1-1/2" thickness)
  3. USG Acoustical Products Co., Radar ClimaPlus High-NRC/CAC #22521 (3/4" thickness)
  4. Rockfon, Sonar dB #23100 (2" thickness)
- C. Type 'B', lay-in type white tiles, ASTM E84 Class A rated, incombustible mineral tile, 24" x 24" x 5/8" min., reveal trim edges, high temperature and humidity resistant. UL Classified NRC 0.70 min., with CAC 22 min.
1. Armstrong, School Zone Fine Fissured # 1717
  2. CertainTeed, Performa Fine Fissured High NRC #HHF-454-HNRC
  3. USG Acoustical Products Co., Radar ClimaPlus High-NRC #22121
  4. Rockfon, Artic #660
- D. Type 'B', lay-in type white tiles, ASTM E84 Class A rated incombustible tile, 24" x 24" with reveal cut edge design, factory painted edges, high temperature and humidity resistant. UL Classified NRC 0.70 min. and CAC 40 min.
1. Armstrong, School Zone Fine Fissured #1717 (3/4" thickness)
  2. CertainTeed, Performa Adagio High CAC #HCAC-1672B-IOF-1 (1-1/2" thickness)
  3. USG Acoustical Products Co., Radar ClimaPlus High-NRC/CAC #22523 (3/4" thickness)
  4. Rockfon, Sonar dB #23300 (2" thickness)
- E. Type 'C', lay-in type white tiles, ASTM E84 Class A rated, incombustible fiberglass tile, 24" x 24" x 1" sq. cut edges, high temperature and humidity resistant. UL Classified NRC 0.95 min., with CAC 22 min. and AC 190 min.
1. Armstrong, Optima #3152
  2. CertainTeed, Performa VOC Compliant Symphony #1342-IOF-1
  3. USG Acoustical Products, Halcyon ClimaPlus #98221
  4. Rockfon, Sonar #16100
- F. Touch-Up Edge Paint: Tile manufacturer's touch-up edge paint matching tile color.

## 2.02 METAL SUSPENSION SYSTEMS - GENERAL

- A. Pre-finish exposed members white. Provide hold down clips in vestibules and as required.
- B. Provide additional cross tees, adapter clips, and any necessary components for the proper installation of perimeter and multiple layer gypsum board ceilings and feature areas, and mechanical and electrical items to be secured to this system.
- C. Roll-Formed, Sheet-Metal Edge Moldings and Trim: Provide manufacturer's standard edge moldings that fit acoustical panel edge details and suspension

systems indicated and that match width and configuration of exposed runners, formed from sheet metal of same material, finish, and color as that used for exposed flanges of suspension-system runners; provide in longest standard single piece lengths. For penetrations of ceiling, provide edge moldings fabricated to fit penetration exactly. Provide manufacturer's factory fabricated matching trim, inside and outside corners, including matching radius for outside corner bullnose CMU and/or gypsum board wall locations.

- D. Attachment Devices: Size for five times the design load indicated in ASTM C 635, Table 1, "Direct Hung," unless otherwise indicated or recommended by manufacturer.
1. Anchors in Concrete: Provide one of the following types:
    - a. Postinstalled Expansion Anchors: Suitable for application indicated, fabricated from corrosion resistant materials, with holes or loops for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to five times that imposed by ceiling construction, as determined by testing according to ASTM E 488 or ASTM E 1512 as applicable, conducted by a qualified testing and inspecting agency.
      1. Corrosion Protection: Carbon-steel components zinc plated to comply with ASTM B 633, Class Fe/Zn 5 (0.005 mm) for Class SC 1 service condition.
    - b. Power-Actuated Fasteners: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hangers of type indicated and with capability to sustain, without failure, a load equal to ten times that imposed by ceiling construction, as determined by testing according to ASTM E 1190, conducted by a qualified testing and inspecting agency.
- E. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
1. Zinc-Coated, Carbon-Steel Wire: ASTM A 641, Class 1 zinc coating, soft temper.
  2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter (12 gage) wire.

## 2.03 LAY-IN SUSPENSION SYSTEM

- A. Manufacturers:
1. Chicago Metallic Corp./Rockfon, 200 System
  2. USG., DX System
  3. Armstrong, Prelude XL
  4. CertainTeed, Classic
- B. Standard 15/16" grid.

- C. Provide heavy duty suspension system at precast insulated wood fiber acoustical panels.

#### 2.04 CONCEALED SUSPENSION SYSTEM

- A. Manufacturer's
  - 1. Chicago Metallic Corp./Rockfon, 1200 System
  - 2. Donn Corp., comparable to (1) above
  - 3. Armstrong, Accessible Tile System
  - 4. Certainteed, comparable to (1) above
- B. Provide for full access without sightlines.

#### 2.05 VERTICAL SUSPENSION TRIM

- A. Extruded aluminum, 12" straight nominal vertical face, pre-finished white.
  - 1. Rockfon, Infinity Standard Perimeter Trim
  - 2. USG, Compasso Elite
  - 3. Armstrong, Axiom Classic Trim
  - 4. CertainTeed, Cloud Perimeter Trim
- B. Provide manufacturer's factory mitered corner trim, concealed splice plates, etc. and components required to provide a complete and proper, finished installation.
- C. Provide factory curved sections meeting radius as indicated.

#### 2.06 HORIZONTAL SUSPENSION TRIM

- A. Extruded aluminum, 6" nominal horizontal face, sharp edged perimeter, pre-finished white.
  - 1. Rockfon, Infinity Z Perimeter Trim
  - 2. USG, Compasso Slim
  - 3. Armstrong, Axiom Knife Edge
- B. Provide manufacturer's factory mitered corner trim, concealed splice plates, etc. and components required to provide a complete and proper, finished installation.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Examine acoustical panels before installation. Acoustical panels that are cracked or damaged, wet, moisture damaged, mold damaged, etc. are not acceptable.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.02 INSTALLATION

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- A. Install materials in accordance with ASTM C 636, manufacturer's printed instructions, industry standards applicable to the Work, and requirements of authorities having jurisdiction. Exposed fasteners are not acceptable.
- B. Acoustical ceiling systems and ceiling components to be supported from building structural members. Securely hang ceiling from structural system in an approved manner, capable of supporting a minimum of 25 lbs./sq.ft. Provide additional supports at multiple layer gypsum board areas, mechanical, and electrical items as required.
  - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum, which are not part of supporting structural or ceiling suspension system.
  - 2. Splay hangers only where required to miss obstructions and offset resulting horizontal force by bracing, counters playing or other equally effective means.
  - 3. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with location of hangers at spacings required to support standard suspension-system members, install supplemental suspension members and hangers in form of trapezes or equivalent devices.
  - 4. Do not support ceilings directly from permanent metal forms or composite floor deck. Fasten hangers to cast-in-place hanger inserts, post-installed mechanical or epoxy adhesive anchors, or power-actuated fasteners that extend through forms into concrete.
  - 5. When steel or wood framing does not permit installation of hanger wires at spacing required, install carrying channels or other supplemental support for attachment of hanger wires.
  - 6. Do not attach hangers to steel or wood, roof or floor decking. Attach hangers to structural members or top chord of trusses as designed for the ceiling loads.
  - 7. Space hangers not more than 48 inches o.c. along each member supported directly from hangers, unless otherwise indicated, leveling to tolerance of 1/8 inch per 12 feet. Provide hangers not more than 8-inches from ends of each member. Provide additional hangers and locate hangers as recommended by ceiling manufacturer to support pendant lighting and other similar items.
  - 8. Secure wire hangers by looping and wire-tying, either directly to structures or to inserts, eye-screws, or other devices which are secure and appropriate for substrate, and which will not deteriorate or fail due to age, corrosion, or elevated temperatures. Secure wire hangers with not less than three (3) full, closely spaced turns.
  - 9. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications and as indicated.
- C. Set ceilings level with laser beam in straight lines and paralleled with rectangular walls.

- D. Lay out pattern in coordination with other trades to eliminate off-centering of units in tile pattern.
- E. Lay tile pattern out in order that there shall be no tile less than half.
- F. Certain rooms have grilles, recessed light fixtures recessed into ceilings, access panels and other required openings. Where such occur, furring shall be framed properly to permit the installation of such fixtures, panels and openings. This Contractor shall install frames, panels, etc., as furnished by the other contractors.
- G. System Runners: Install suspension-system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- H. Ceiling Panels: Install acoustical panels with undamaged edges and fit accurately into suspension-system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit with edges matching edge design of panel.
  - 1. Install square-edged panels with edges fully hidden from view by flanges of suspension-system runners and moldings.
  - 2. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces with manufacturers touch-up edge paint.

### 3.03 ADJUST AND CLEAN

- A. Clean exposed surfaces of acoustical panel ceilings, including trim, edge moldings, and suspension-system members. Clean exposed surfaces of acoustical ceilings; comply with manufacturer's instructions for cleaning and touch-up of minor finish damage. Remove and replace work, which cannot be successfully cleaned and repaired to permanently eliminate evidence of damage.

### 3.04 ATTIC STOCK

- A. Provide four (4) full, unopened boxes of each tile type delivered to Owner at site at Substantial Completion. This material shall be in full tiles in unopened cartons with identifying labels.
- B. Store extra stock where directed by the Owner. Provide written verification of attic stock delivery to Owner's representative, submit to Architect.

END 09 51 00

DIVISION 9 – FINISHES

Section 09 65 13 - Resilient Base

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified in this section.

1.02 SUBMITTALS

- A. Samples for color selection
  - 1. Base
- B. Product Data
  - 1. Base
  - 2. Adhesive
- C. Operation and Maintenance Instructions
- D. Attic Stock: Written verification and sign off of attic stock delivery to Owner's representative.

1.03 QUALITY ASSURANCE

- A. Single-Source Responsibility: Obtain each type, color, and pattern of resilient flooring materials from a single source with resources to provide products of consistent quality in appearance and physical properties without delaying progress of the Work.
- B. Fire-Test-Response Characteristics: As determined by testing identical resilient flooring products according to ASTM E 648 or NFPA 253 by a qualified testing agency.
  - 1. Critical Radiant Flux Classification: Class I, not less than 0.45 w/sq. cm.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to site in original packages and containers with seals unbroken and bearing manufacturer's original labels, including manufacturer's name, product name, and directions for storing, handling, and use.
- B. Store resilient flooring materials in clean, dry interior spaces protected from the weather, extreme temperature and humidity range, and freezing, with ambient temperature and humidity maintained within the range of minimum and maximum allowable by each manufacturer.
  - 1. Store on flat surfaces.
  - 2. Limit stacking to five (5) boxes high.
- C. Move materials into spaces where they will be installed at least 48 hours prior to installation.

1.05 PROJECT CONDITIONS

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- A. Maintain temperatures within the range of minimum and maximum allowable by each manufacturer for at least 48 hours before, during, and for not less than 48 hours after installation. Protect materials from the direct flow of heat from hot-air registers, radiators, or other heating fixtures and appliances. After installation period, maintain a temperature of not less than 55 deg F.
- B. Close spaces to traffic during base installation and for not less than 48 hours after base installation.

#### 1.06 RELATED SECTIONS

- A. Section 07 92 00 – Joint Sealants

### PART 2 - PRODUCTS

#### 2.01 WALL BASE

- A. Base: On-top type 4" x 1/8" thermoset rubber, cove type.
  - 1. Roppe, Pinnacle
  - 2. Johnsonite, BaseWorks
  - 3. Burke, BurkeBase Type TS
- B. Adhesive:
  - 1. Manufacturer's contact type on non-porous surfaces.
  - 2. Manufacturer's acrylic type on porous surfaces.
- C. Manufacturer's pre-formed inside and outside corners shall be used.
- D. Colors as selected by Architect.

### PART 3 - EXECUTION

#### 3.01 PREPARATION

- A. Prepare substrates according to manufacturer's written instructions to ensure adhesion of resilient products.
- B. Contractor shall examine substrates prior to installation to determine that surfaces are smooth and free from cracks, holes, ridges, and other defects that might prevent adhesive bond, or impair durability or appearance of the resilient materials.
- C. Remove coatings, including curing compounds, and other substances that are incompatible with adhesives and that contain soap, wax, oil, or silicone.
- D. Broom sweep and vacuum clean substrates to be covered immediately before installation. Ensure substrates are free of moisture, alkaline salts, carbonation, dust, dirt, grease and debris.
- E. Apply primer to substrates if recommended by manufacturer, prior to application of adhesive. Apply primer in accordance with manufacturer's instructions.

#### 3.02 INSTALLATION

- A. The installer shall be competent in the installation of the resilient materials.
- B. Install in strict accordance with the manufacturer's requirements, and as required to meet manufacturer's warranty requirements.

- C. Install rubber base on each wall including casework with manufacturers approved adhesives for the existing substrate to be applied. Provide additional sealing methods as indicated to assure a watertight installation.

### 3.03 CLEANING AND PROTECTION

- A. Perform the following operations immediately after completing resilient materials installation:
  - 1. Remove adhesive and other surface blemishes using clean cloth and cleaner recommended by flooring manufacturer.
  - 2. Sweep and vacuum areas thoroughly.
  - 3. Damp-mop surfaces to remove marks and soil.
- B. Protect resilient materials against mars, marks, indentations, and other damage from construction operations and placement of equipment and fixtures during remainder of construction period. Use protection methods recommended in writing by manufacturer to ensure the resilient materials will be free of damage at Substantial Completion.
- C. Immediately prior to Substantial Completion, remove protective covers and panels, thoroughly clean flooring in accordance with manufacturer's instructions.

### 3.04 ATTIC STOCK

- A. Provide a minimum of 12 linear feet of rubber base in each color selected.
- B. Store extra stock where directed by the Owner. Provide written verification of attic stock delivery to Owner's representative, submit to Architect.

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END 09 65 13

DIVISION 9 – FINISHES  
Section 09 68 13 – Modular Tile Carpeting

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified under this section.

1.02 SCOPE OF WORK

- A. Work shall consist of the furnishing of modular carpet in areas so designated.

1.03 SUBMITTALS

- A. Product Data: Provide data on specified products, describing physical and performance characteristics, sizes, patterns, colors available, and method of installation.
- B. Samples for initial selection.
- C. Shop Drawing showing columns, doorways, enclosing walls or partitions, built-in cabinets, and locations where cutouts are required as well as direction of carpet pile and pattern, location of edge moldings and edge bindings shall be submitted to the Architect for approval prior to installation.
- D. Floor schedule using same room designations indicated on drawings.
- E. Verification Samples: Submit full size samples illustrating color and installation laying pattern for each carpet material specified.
- F. Manufacturer's Installation Instructions: Indicate special procedures and perimeter conditions requiring special attention.
- G. Maintenance Data: Include maintenance procedures, recommendations for maintenance materials and equipment, and suggested schedule for cleaning.
- H. Manufacturer's Product Warranty.
- I. Test Reports: Floor slab moisture content level test reports from an independent agency. Testing procedures, number of test locations, and physical locations shall meet manufacturer=s requirements.
- J. Attic Stock: Verification of delivery of attic stock to Owner.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications
  - 1. Company specializing in manufacturing specified carpet with minimum 10 years documented experience.
  - 2. Upon request, manufacturer to provide representative to assist in project start-up and to inspect installation while in process and upon completion. Representative will notify designated contact if any installation instructions are not followed.
  - 3. Single Source Responsibility: Obtain each type of product from one

source and by a single manufacturer.

B. Installer Qualifications

1. Flooring contractor must be certified by the manufacturer prior to bid.
2. Flooring contractor to be a specialty contractor normally engaged in this type of work and shall have prior experience in the installation of these types of materials.
3. Flooring contractor to provide Owner a written installation warranty that guarantees the completed installation to be free from defects in materials and workmanship for a period of one year after job completion.

1.05 DELIVERY, STORAGE, & HANDLING

- A. Deliver materials to the site in manufacturer's original packaging listing manufacturer's name, product name, identification number, and related information.
- B. The temperature of the interior environment, including the sub floor should be no lower than 65°F and no higher than 90°F at least 72 hours prior to, during and after the tile installation. Flooring products and installation materials should be stored between 65°F and 90°F for at least 48 hours prior to installation. Relative humidity should be no more than 65%.
- C. Make stored materials available for inspection by the Owner's representative.
- D. Store materials in area of installation for minimum period of 48 hours prior to installation.

1.06 PROJECT CONDITIONS

- A. Sub-floor preparation is to include required work to prepare the existing floor for installation of the product as specified in this document and manufacturer's installation instructions.
- B. Material used in sub-floor preparation and repair shall be recommended by the carpet manufacturer and shall be chemically and physically compatible with the carpet system being bid.
- C. Maintain minimum 65 degrees F ambient temperature and 65% relative humidity for 72 hours prior to, during, and 48 hours after installation.
- D. Do not install flooring until space is enclosed and weatherproof, wet-work in space is completed and nominally dry, work above ceilings is complete, and ambient temperature and humidity conditions are and will be continuously maintained at values near those indicated for final occupancy.

1.07 PRODUCT WARRANTY

- A. Provide a non-prorated lifetime limited warranty which shall specifically warrant against the following:
  1. Excessive Surface Wear: More than 15% loss of pile fiber weight
  2. Excessive Static Electricity: More than 3.0 kV per AATCC 134
  3. Resiliency Loss of the Backing: More than 10% loss of backing resiliency

4. Delamination
  5. Edge Ravel
  6. Zippering
    - a. Tuft Bind warranty in lieu of edge ravel and zippering is not acceptable.
- B. Warranty to be sole source responsibility of the manufacturer. Second source warranties and warranties that involve parties other than the carpet manufacturer are unacceptable.
- C. If the product fails to perform as warranted when properly installed and maintained, the affected area will be repaired or replaced at the discretion of the manufacturer.
- D. Chair pads are not required, but are recommended for optimum textural performance. Absent the use of chair pads, more intensive maintenance will be required for areas in direct contact with chair caster traffic, and some degree of appearance change is to be expected.

## PART 2 - PRODUCTS

### 2.01 MODULAR CARPET

- A. Tandus; Accentuate and/or Emphasize Modular
1. Construction: Stratatec Patterned Loop
  2. Gauge: 5/64
  3. Stitch Rate: 9.6 stiches / inch
  4. Pile Height Average: 0.187 inch
  5. Fiber System: Dynex Nylon
  6. Dye Method: 70% Solution Dyed / 30% Yarn Dyed
  7. Static Coefficient of Friction: ASTM C-1028; Passes ADA requirements.
  8. Static Propensity: AATCC 134: less than 3.5 kv
  9. Flooring Radiant Panel: ASTM E-648 or NFPA 253: Class 1
  10. Secondary Backing: Ethos
  11. NSF140: Platinum
- B. Shaw Contract Group; Diffuse and/or Disperse Modular
1. Construction: Multi-level Pattern Loop
  2. Gauge: 1/12
  3. Stitch Rate: 9.0 stiches / inch
  4. Pile Height Average: 0.092 inch
  5. Fiber System: Eco Solution Q Nylon
  6. Dye Method: 100% Solution Dyed

7. Static Coefficient of Friction: ASTM C-1028; Passes ADA requirements.
8. Static Propensity: AATCC 134: less than 3.5 kv
9. Flooring Radiant Panel: ASTM E-648 or NFPA 253: Class 1
10. Secondary Backing: Ecoworx Tile
11. Protective Treatments: SSP Shaw Soil Protection
12. NSF140: Platinum

## 2.02 MISCELLANEOUS MATERIALS AND CARPET ACCESSORIES

- A. Materials recommended by manufacturer for patching, leveling, priming, etc.
- B. Nonmetallic Edge Guard: Rubber of size and profile adequate for location. Color as selected by Architect.
  1. Roppe
  2. Mercer
  3. Johnsonite
- C. Miscellaneous Materials: Adhesives, tapes, thread, nails, staples and similar products of type recommended by manufacturer and installer.
- D. Moisture Sealer: Apply to areas to receive carpet flooring even when the slab meets the moisture content requirements. Provide moisture sealer appropriate for moisture conditions present and approved in writing by the finish floor manufacturer(s) for the conditions present.
  1. Where moisture levels are below manufacturer recommended levels, provide a moisture sealer with a minimum resistance capacity of 3 pounds, per 1000 sq. ft. for a 24 hour period, as per calcium chloride test ASTM F1869-98.
  2. The required pH range is 9.0 or less as tested according to ASTM F-710-05.

## PART 3 - EXECUTION

### 3.01 EXAMINATION / PREPARATION

- A. Prepare sub-floor to comply with criteria established in manufacturer's installation instructions. Use only preparation materials that are acceptable to the manufacturer.
  1. Remove deleterious substances from substrate(s) that would interfere with or be harmful to the installation.
  2. Remove sub-floor ridges and bumps. Fill cracks, joints, holes, and other defects.
- B. Verify that sub-floor is smooth and flat within specified tolerances and ready to receive carpet.
- C. Verify that substrate surface is dust-free and free of substances that would impair bonding of product to the floor.

- D. Verify that concrete surfaces are ready for installation by conducting moisture and pH testing. Results must be within limits recommended by manufacturer.
- E. There will be no exceptions to the provisions stated in the manufacturer's installation instructions.

### 3.02 INSTALLATION – GENERAL

- A. Install product in accordance with manufacturer's installation instructions. Product must have low VOC, factory applied, "dry" adhesive. A peel & stick method applied to the back at the time of manufacture is preferred.
- B. Adhesive must meet the requirements of CRI's Green Label Plus program for adhesive. Provide documentation. Provide documentation showing third-party certification of VOC content.
- C. Product as installed to be securely attached to the floor in compliance with Americans with Disabilities Act (ADA), Section 4.5.3.
- D. Cut and fit carpet tile to butt tightly to vertical surfaces, permanent fixtures, and built-in furniture including cabinets, pipes, outlets, edgings, thresholds, and nosings.
- E. Provide fully adhered installation by trimming and fitting carpet widths into each space prior to application of adhesive. At adhesive backing installation, peel back adhesive backing sheet and lay down meeting manufacturer's requirements.
- F. Extend carpet tile into toe spaces, door reveals, closets, open-bottomed obstructions, removable flanges, alcoves, and similar openings.
- G. Install borders parallel to walls.
- H. Roll with appropriate roller for complete contact of product with adhesive to sub-floor.
- I. Trim carpet neatly at walls and around interruptions. Completed product is to be smooth and free of bubbles, puckers, and other defects.
- J. Install edge guards at exposed edges. Bind edges with cloth tape and thread where not concealable.
- K. Apply vinyl cove base to walls, columns, pilasters, casework, concrete islands, and other permanent fixtures in rooms or areas where base is scheduled. Base is not required on moveable partition walls where metal base is present.
  - 1. Install base in lengths as long as practicable, with job-formed corners.
  - 2. Tightly bond base to backing throughout length of each piece, with continuous contact at horizontal and vertical surfaces.
  - 3. On masonry surfaces, or other similar irregular surfaces, fill voids along top edge of wall base with base manufacturer's recommended adhesive filler material.

### 3.03 PROTECTION & CLEANING

- A. Remove excess adhesive and/or other from floor and wall surfaces without damage. Replace carpet which cannot be cleaned.

- B. Rubbish, wrappings, debris, trimmings, etc. to be removed from site and disposed of properly.
- C. Clean and vacuum surfaces using a beater brush/bar commercial vacuum.
- D. After each area is installed, protect from soiling and damage by other trades.
- E. In order to allow the adhesive to cure properly, hot water extraction cleaning should not be used within the first 30 days after installation, otherwise warranties are null and void.

#### 3.04 RESTORATION

- A. Damage done to paint, walls, woodwork, floors, and/or similar finishes as a result of this work, shall be corrected by the responsible contractor.
- B. Required repairs shall be made by the proper trade contracted on the work of this project, who shall make the necessary repairs and shall be paid by the responsible subcontractor for the repair work.

#### 3.05 CLEANING

- A. Upon completion of the installation, remove waste materials, tools and equipment.
- B. Using commercial vacuums, thoroughly vacuum the entire floor surface.
- C. Remove spots or replace carpet where spots cannot be removed.
- D. Remove debris, sorting pieces to be saved from scraps to be disposed of.
  - 1. Usable pieces of carpet, roll ends of less than nine feet in length, and pieces of more than three square feet in area not more than one foot wide and necessary to complete the work, are to be left on the job site and placed in orderly manner in such area as designated by the Owner.
  - 2. Dispose or smaller pieces as construction waste.
- E. Provide protection methods and materials needed to ensure that carpeting will be without deterioration or damage at time of substantial completion.
- F. In order to allow the adhesive to cure properly, hot water extraction cleaning should not be used within the first 30-45 days after installation, otherwise warranties are null and void.

#### 3.06 ATTIC STOCK

- A. Upon completion of installation, deliver a minimum of 5% of the total area of modular carpet to the Owner.
- B. Package attic stock materials with protective covering with identifying labels.
- C. Store attic stock materials where directed by the Owner.

END 09 68 13

DIVISION 10 – SPECIALTIES  
Section 09 69 00 - Access Flooring

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified.

1.02 SUBMITTALS

- A. Product Data.
- B. Shop drawings indicating understructure plan, panels layout, and air grille locations.
- C. Samples of panel, understructure and finishes.

1.03 MANUFACTURER'S QUALIFICATIONS

- A. Manufacturers of Access Flooring shall have not less than five (5) years experience in the design and fabrication of access flooring systems.
- B. Manufacturers shall have successfully completed not less than five (5) other installations which are similar in size and construction.

1.04 GENERAL REQUIREMENTS

- A. The access floor system shall consist of removable panels supported by adjustable steel pedestal assemblies and shall accommodate electrical conduit, communication and mechanical service lines.
- B. The finished floor height shall be 12"  $\square$  form the slab to the top of removable panels.
- C. The access floor contractor shall be a duly authorized and approved installer of the manufacturer and shall submit shop drawings, sample, literature and certifications of performance for approval.
- D. The access floor contractor shall furnish labor, materials, equipment and services necessary for the installation of the access floor in accordance with the specifications and approved shop drawings.

PART 2 - PRODUCTS

2.01 MANUFACTURERS

- A. Tate Access Floors, Inc.; ConCore SF 1000 access floor system 2'-0" x 2'-0" panels.
- B. Maxcess Technologies, Inc.; Products to match "A." above.
- C. Interface AR; Products to match "A." above.

2.02 MATERIALS

- A. Panels: 2'-0" x 2'-0" x 1", top steel sheet welded to a formed steel bottom pan and painted inside and outside with a baked epoxy paint. Panels shall be filled with a lightweight cementitious product. Panels to have carpet tile factory applied

to allow carpet tile and panel to be removed as one unit.

- B. Understructure: Galvanized steel support system. Pattern to be 2'-0" x 2'-0". System to be adjustable height type to accommodate a height of +/- 1'-0" above concrete floor slab. Provide adjustable pedestals, pedestal bases, and pedestal heads, and accessories for a complete installation. Securely anchor system to concrete floor slab with expansion type anchors, two (2) minimum per base.
1. Type of Understructure: Freestanding, laterally restrained on pedestal without fasteners.
  2. Pedestal Assembly:
    - a. Shall provide a 8000 lb. axial load without permanent deformation.
    - b. Assembly shall provide a range of adjustment from 1" to 2" total.
    - c. Provide a means of leveling and locking the assembly at a selected height which requires deliberate action to change height setting and which prevents vibrating displacement.
  3. Pedestal Bases: Fabricated of a square base with not less than 16 square inches of bearing area and assembled to a stud or tube which is designed to engage the pedestal head assembly; secure subfloor in accordance with manufacturer's instructions.
  4. Pedestal Heads: Fabricated of a head plate with corresponding stud or tube which is designed to engage the pedestal bases assembly. The head must be the proper type to positively locate the floor panel. When specified, the head shall provide a means to fasten the floor panels or stringer directly to the head.
- C. Include miscellaneous items for a complete installation including but not limited to trim edging, access boxes, cable cut-outs, grommets, and panel lifters.

## 2.03 SYSTEM PERFORMANCE

- A. Concentrated Load Performance:
1. Panels shall be capable of supporting a concentrated load of 1000 lbs. placed on a one square inch area at any location on the panel with a maximum top surface permanent set not to exceed 0.010 inches after load is removed.
- B. Uniform Load Performance:
1. Panels shall be capable of supporting a uniform load of 250 lbs. placed on a one square foot area.
- C. Ultimate Load Performance:
1. Panels shall be capable of supporting an ultimate load of 3200 lbs. on one square inch area without failure. Failure is defined as point at which the panel will not longer accept the load.
- D. Rolling Load Performance: Local and overall surface deformation shall not exceed 0.040 inches.

- E. Impact Load Performance: Panels and supporting understructure shall withstand without failure an impact load anywhere on the panel of 100 lbs. dropped from a height of 36" onto a one square inch area.

#### 2.04 FLOOR SURFACE COVERING

- A. Carpet Tiles: Provide modular carpet tiles by Lees Carpets, Durastyle (Antron Legacy yarn with DuraTech Soil Protection. Continuous conductive filament to provide maximum conductivity.) 5/64" gauge, 22 oz. face yarn weight, backing material to be Self Loc. Tiles to be factory applied. Color and pattern as selected by Architect.

#### 2.05 ACCESSORIES

- A. Provide spare parts consisting of at 2% of total plus 1 carton of carpet tile to owner. Deliver to project in manufacturer's standard packages clearly marked with the contents.
- B. Provide two (2) panel lifting devices.
- C. Provide flush mounted data/phone/power outlets as shown on Electrical Drawings.
- D. Provide aluminum air grilles with dampers as shown on Mechanical Drawings. Provide 32 round grommets with sliding cover 1 per panel. Install panels at locations indicated by owner.

### PART 3 - EXECUTION

#### 3.01 SURFACE PREPARATION

- A. Preparation: Before commencing installation examine the substrate and surrounding conditions to insure that there is nothing to prevent proper and timely execution of the installation. Start of work shall indicate acceptance of substrate and surrounding conditions.

#### 3.02 INSTALLATION

- A. Install system in strict accordance with manufacturer's recommendations.
- B. Coordinate work with other trades.

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END 09 69 00

DIVISION 9 - FINISHES  
Section 09 91 00 – Painting

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PART 1 - GENERAL

1.01 DESCRIPTION

- A. Provide labor, materials, equipment and incidentals required for the completion of the work shown on the drawings and/or specified.
- B. The Contractor is directed to read the specification pertaining to the work and materials of other trades in order to understand the extent of various materials used and the provisions regarding their painting. Surfaces that are left unpainted or unfinished shall be finished as part of this work. Complete finished painting is required for every item whether scheduled, noted or not. Work requiring finish but not scheduled or noted shall be finished with products as specified for similar and/or adjacent work.
  - 1. Paint new and existing exposed surfaces unless noted otherwise. If the drawings and/or Schedule of Painting does not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces.
- C. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
  - 1. Prefinished items include, but are not limited to, the following factory-finished components:
    - a. Architectural woodwork.
    - b. Metal lockers.
    - c. Elevator equipment.
    - d. Finished mechanical and electrical equipment.
    - e. Light fixtures and supports.
  - 2. Concealed surfaces refers to surfaces, materials, assemblies, or items that cannot be accessed without moving a building element, such as within a chase, wall, or ceiling cavity; as in the following generally inaccessible spaces:
    - a. Furred areas.
    - b. Ceiling plenums.
    - c. Pipe spaces.
    - d. Duct shafts.
    - e. Elevator shafts.
  - 3. Finished metal surfaces include, but are not limited to, the following:
    - a. Anodized aluminum.
    - b. Stainless steel.
    - c. Chromium plating.
  - 4. Operating parts include moving parts of operating equipment and the following:

- a. Valve and damper operators.
  - b. Linkages.
  - c. Sensing devices.
  - d. Motor and fan shafts.
5. Labels: Do not paint over:
- a. UL, FMG, or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
  - b. Labels designating materials or assemblies as accessible.

## 1.02 QUALITY ASSURANCE

- A. Single Source Responsibility: Provide primers and undercoat paint produced by the same manufacturer as the finish coats. If single source responsibility is not possible, furnish written approval of manufacturer of finish coat indicating acceptance of proposed under coats.
- B. For shop primed materials by others, verify compatibility between primer and finish coats. Notify the Architect in writing of problems anticipated with using the specified finish coat materials. Where finish coats are incompatible with primer coats or existing finishes, provide additional barrier coat or surface preparation as required by the manufacturer of the primer and finish coats.
- C. Verify compatibility between primer and substrate. Notify the Architect in writing of problems anticipated with using the specified primer and finish coat materials. Where primer and finish coats are incompatible with substrates, for issues such as non-acceptable alkalinity levels, moisture levels, or poor adhesion. Provide additional barrier coat or surface preparation as required by the manufacturer of the primer and finish coats.
- D. Preparatory work to be performed as indicated, and at a minimum shall be performed in strict accordance with coating manufacturer's requirements including applicable Society for Protective Coatings (SSPC) and the National Association of Corrosion Engineers International (NACE) standards.

## 1.03 SUBMITTALS

- A. Product data: Include information regarding recommended usage, drying times, preparation and primers, surface compatibility, and application instructions which are to be followed. Material Safety Data (MSD) sheets are not acceptable as product data and if submitted, will be returned without review and comment.
- B. Schedule: Submit schedule showing materials to be used, locations, and number of coats to be applied. See SCHEDULE OF PAINTING for format.
  - 1. Products listed on the SCHEDULE OF PAINTING have been recommended by the paint system manufacturers for the intended use and establish a level of quality. If the Contractor submits and/or uses the specified products, the Contractor agrees that the specified products are proper for the intended use. If the Contractor does not agree with the use of the specified products, and recommends the use of alternative products, the Contractor shall submit written explanation and supporting data from the manufacturer for the proposed products. If accepted, proposed products shall be covered under the provisions of the warranty.

- C. Color Samples: Provide manufacturer's color fans and/or samples for color selection purpose. Provide full line of standard, custom and premium colors. Provide samples on actual stock when requested by the Architect.
- D. Verification Samples: Provide "Draw-Downs" of each paint color for verification purposes. Provide actual samples of each stain or varnish on actual stock. Each sample shall be marked on the backside with the manufacturer, material, and color code.
- E. Adhesion Testing Reports: Provide manufacturer's recommended adhesion testing meeting ASTM D 3359 and/or ASTM D 667 as appropriate for substrate being tested. Perform in a non-conspicuous area for each substrate to receive the specified coatings. Do not proceed further until positive results are achieved. Provide additional preparatory work, primer and/or barrier coats, etc. as necessary for proper adhesion; perform additional adhesion testing to confirm proper conditions have been met.
- F. Alkalinity Testing Reports: Provide manufacturer's recommended alkalinity testing of plaster, concrete, and concrete masonry surfaces scheduled to receive paint in order to confirm that surfaces do not exceed manufacturer's required alkalinity levels.
- G. Moisture Testing Reports: Provide manufacturer's recommended moisture testing of concrete, concrete masonry, gypsum board, plaster, wood, finished woodwork, and other non-metallic surfaces scheduled to receive paint in order to confirm that surfaces do not exceed manufacturer's required moisture levels.
- H. Warranty: Submit a written warranty, executed by the Contractor.
- I. Coating Maintenance Manual: At project closeout for Owners Record Documents, provide a coatings maintenance manual including area summary with finish schedule, area detail designating location where each product/color/finish was used, product data pages, material safety data sheets, care and cleaning instructions, touch-up procedures, and color samples of each color and finish used.
- J. Attic Stock: Verification of delivery of attic stock to Owner.

#### 1.04 DELIVERY, STORAGE AND HANDLING

- A. Materials used on the job shall be stored as recommended by the manufacturer. Storage areas shall be kept neat and clean. Damage to these areas or surrounding areas shall be repaired to original condition by the Contractor. Oily rags, waste, etc., must be removed from the building every night and precautions must be taken to avoid fire or indoor contamination. Paints may not be stored, mixed or applied in rooms which have installed finished flooring without taking necessary methods for protection.

#### 1.05 PROTECTION OF WORK

- A. Contractor shall provide drop cloths for protecting the floors and finishes from damage during the execution of the work. When necessary, the Contractor shall remove temporary coverings in order to execute the work and shall replace same in a proper manner. In case the covering cannot be replaced, the Contractor shall protect the work as necessary.
- B. Before painting, remove hardware, accessories, plates, lighting fixtures and other similar items or provide necessary protection of such items. Upon completion of

the work, remove protections and reinstall above items. Verify proper operation of affected items and replace damaged items as directed by the Architect.

- C. Contractor shall be responsible for staining of floors or other work, and must either entirely remove the stains or replace the stained materials with materials to match original condition as acceptable to the Architect.

#### 1.06 PROJECT CONDITIONS

- A. Conditions must fall within the paint manufacturers requirements, coordinate with below criteria, the more stringent shall apply.
  - 1. Apply water-based paints only when the temperature of surfaces to be painted and surrounding air temperatures are:
    - a. Exterior surfaces between 50 deg F and 90 deg F.
    - b. Interior surfaces between 60 deg F and 90 deg F.
  - 2. Apply solvent-thinned paints only when the temperature of exterior surfaces to be painted and surrounding air temperatures are between 45 deg F and 95 deg F.
  - 3. Interior and exterior painting shall not be performed when satisfactory results cannot be obtained due to high humidity, excessive temperatures or other conditions affecting application and performance.
    - a. Do not apply in snow, rain, fog, or mist.
    - b. Do not apply when the relative humidity exceeds 85 percent.
    - c. Do not apply at temperatures less than 5 deg F above the dew point
    - d. Do not apply to damp or wet surfaces.
- B. Do not apply paint in areas where dust is being generated or will be generated while the applied paint is drying.
- C. In rooms and spaces where paint is being applied, ensure there is adequate ventilation to allow for proper paint drying, as well as to exhaust paint fumes and minimize odors.

#### 1.07 WARRANTY

- A. The Contractor accepts the responsibility of providing proper workmanship, including but not limited to proper cleaning and preparation of surfaces, proper application of product based upon manufacturer's requirements, and acceptance that specified products are proper for the intended use. Contractor agrees that if paint system fails in any manner, it will be due to improper workmanship. Should any failure occur within the specified warranty period, the Contractor agrees to remedy the affected area(s). Work shall include removal of failing paint system (if necessary or if required by the paint system manufacturer), proper cleaning and preparation of surfaces, proper application of product(s) based upon manufacturer's recommendations and requirements, and use of proper products for intended use.
  - 1. The warranty described above shall cover a period of 2 years from the date of Substantial Completion.

2. An additional warranty shall be issued for areas that have failed and have been corrected. This additional warranty shall cover a period of 2 years from the date of acceptance of the corrected work.
- B. The warranty shall not deprive the Owner of other rights or remedies the Owner may have under other provisions of the Contract Documents, and is in addition to and runs concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

#### 1.08 ATTIC STOCK

- A. Furnish extra paint materials for Owners use:
1. Deliver to project site 1 gallon of each finish paint product in each color required for painting. Mark each container with color identification and room names, numbers, or areas where paint was used, without obscuring manufacturer's label.

### PART 2 - PRODUCTS

#### 2.01 MATERIALS

- A. Paints, varnishes, enamels, lacquers, stains, paste fillers and similar materials, must be delivered in their original containers with the seals unbroken and labels intact. Materials shall be used only as specified by the manufacturer's label on the container. Thinners and accessory materials shall be of best quality and of reputable brands.
- B. Material Compatibility: Furnish block fillers, primers, finish coat materials, and related materials that are compatible with one another and with the existing painted substrates, as demonstrated by the manufacturer, based on testing or field experience.
- C. Patching Material Compatibility: Furnish surface preparation products, including patching compounds, that are compatible with selected paint products.
- D. Gasoline, benzene or other materials not provided for under this specification shall not be brought on the job site.
- E. Colors shall be selected or approved by Architect. Colors shall be mixed as directed and sample panels shall be submitted for approval. Paint products shall be factory-tinted and not tinted on the job site.
- F. The completed work of the Contractor shall match colors and surface finishes of approved samples. The Contractor shall do additional mixing and blending as necessary to achieve this result.
- G. Rooms and spaces may have wall(s) painted a different color(s) than other walls in the same room. Ceilings, soffits, trim and reveals may be painted a different color(s) than the walls. Steel roof joists, bridging and related work may be painted a different color(s) than the roof deck in areas with exposed structural elements. Ductwork, conduits, piping and other mechanical/electrical items may be painted a different color(s) than surrounding items where such items are exposed.

### PART 3 - EXECUTION

#### 3.01 EXAMINATION

- A. Examine substrates and conditions under which painting will be performed for compliance with paint application requirements. Comply with the specifications and manufacturer's requirements for condition of surfaces.
  - 1. Conform with manufacturer's requirements for warranty to be furnished by the manufacturer.
- B. Surface preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified herein.
- C. Coordination of Work: Review other Sections in which primers are specified to ensure compatibility of the total system for various substrates.
- D. Test Reports: Review alkalinity, moisture, and adhesion test results.
  - 1. Provide required work and materials necessary to meet specification criteria, and provide for the manufacturer's warranty.
- E. Notify the Architect in writing a minimum of 14 days prior to painting, regarding anticipated problems using the specified materials over substrates previously finished with incompatible materials.
- F. Do not begin to apply paint or finishes until unsatisfactory conditions have been corrected.
  - 1. The application of paint or finishes shall be an indication of the Contractor's acceptance of the surface.

### 3.02 PREPARATORY WORK

- A. Preparatory work to be performed as indicated, and at a minimum shall be performed in strict accordance with coating manufacturer's requirements including applicable Society for Protective Coatings (SSPC) and the National Association of Corrosion Engineers International (NACE) standards.
- B. Surfaces to be painted shall be cleaned free of rust, dirt, foreign and deleterious materials before painting is started. Contractor shall do necessary preparatory work, sizing, sanding, etc. to produce a surface suitable to receive paint, natural finish, etc.
  - 1. Clean substrates of substances that could impair bond of paints, including dust, dirt, oil, grease, and incompatible paints and encapsulants.
  - 2. Use an appropriate cleaner compatible with the coating systems and surfaces as approved by the coating system manufacturer. Properly repair or replace items damaged by this work if repair work is not acceptable to Architect. Properly protect areas and items not to receive above cleaning methods.
  - 3. Confirm compatibility of shop applied primers with specified finish coats to determine proper preparatory methods, and if a barrier primer coat is recommended by the coating system manufacturer.
- C. Knots, pitch streaks and sappy spots shall be first touched up with shellac or sealer where the finish calls for paint or enamel.
- D. Provide necessary filling of nail holes, cracks, etc., after the application of the first coat using a putty or filler of a color to match the finish. Putty and filler shall be brought flush with the adjoining surfaces in a neat and workmanlike manner.

Necessary filling and repair operations shall also be performed to produce a sound and suitable surface to receive the new paint and finish.

- E. Metal surfaces shall be first washed with appropriate solvent to remove any dirt or grease before applying materials. Where rust or scale is present, surfaces shall be properly cleaned and prepared as required by the manufacturer before painting.
  - 1. Rust shall be removed by sanding, wire brushing, etc.
    - a. Treat existing surfaces with a rust conversion primer/sealer compatible with the specified finishes.
  - 2. Shop coats of paint that become marred shall be sanded, cleaned, and touched up with required products. Necessary touch-up operations shall also be performed to produce a sound and suitable surface to receive the new paint and finish.
- F. Galvanized steel should be tested for pre-treatments using the procedure from the National Coil Coaters Association, Technical Bulletin No. II-9 or from ASTM D-2092, Method B201, Volume 06.01. Galvanized metal surfaces that has been treated for wet storage stain control must have the treatment removed prior to painting. If the metal has been treated, solvent clean the steel per SSPC-SP1 and apply a test patch. If adhesion is unacceptable, Brush-Off Blasting per SSPC-SP7/NACE No. 4 is required to remove the treatment.
- G. Existing glossy painted surfaces shall be washed thoroughly with a bi-sodium phosphate solution recommended by the paint manufacturer. Rinse, and allow to dry thoroughly. Properly repair or replace items damaged by this work if repair work is not acceptable to Architect. Properly protect areas and items not to receive above cleaning methods.
- H. Test substrates for proper adhesion of paint and finish. Provide manufacturer's recommended adhesion testing meeting ASTM D 3359 and/or ASTM D 667 as appropriate for substrate being tested.
- I. Test plaster, concrete, and concrete masonry surfaces scheduled to receive paint for alkalinity levels in order to confirm that surfaces do not exceed manufacturer's required alkalinity levels. Where alkalinity levels exceed required levels, provide manufacturer's proper high pH blocker primer.
- J. Test surfaces scheduled to receive paint for moisture levels in order to confirm that surfaces do not exceed manufacturer's required moisture levels.
- K. Where concrete and concrete masonry surface moisture levels exceed required levels, provide manufacturer's proper moisture blocker primer.
- L. All other non-metallic surfaces such as gypsum board, plaster, wood, finished woodwork, etc. follow manufacturer's written requirements.
- M. Test substrates for proper paint coverage. Provide manufacturer's recommended dry opacity testing meeting ASTM D 344.
- N. Following required preparatory work, Contractor shall inspect surfaces for suitability to receive the specified paint or finishes. The application of paint or finishes shall be an indication of the Contractor's acceptance of the surface.

### 3.03 APPLICATION

- A. Painting products shall be applied in strict accordance with manufacturer's requirements.

1. Drying time of primer, initial finish coat, and subsequent finish coats is temperature and humidity dependent and must follow the manufacturer's requirements before any coats are applied.
2. Cure time of the completed coating application is temperature and humidity dependent and must follow the manufacturer's requirements for a fully cured painted surface before any further contractual work occurs to the painted surface, or that could adversely affect the painted surface.
  - a. Painted surfaces must be fully cured prior to installing items subject to direct contact with said surfaces.
- B. Materials shall be thoroughly mixed immediately before application of paint. Materials shall be evenly spread and smoothly flowed on without runs or sags or other defects.
- C. Painting and finishing shall not be done while surfaces are damp. Coats shall be thoroughly dry and cured before applying succeeding coats. Interior work except on masonry, pipe covering or other soft or rough surfaces, shall be sanded between coats with fine sandpaper to produce an even, smooth finish, unless otherwise specified.
- D. Final interior finish coat shall not be applied until other work has been finished and materials and debris have been removed and the premises have been left in a broom clean condition.
  1. Painted surfaces must be fully cured prior to installing items subject to direct contact with said surfaces.
- E. Final exterior finish coat shall not be applied until other work has been finished and materials and debris have been removed.
  1. Painted surfaces must be fully cured prior to installing items subject to direct contact with said surfaces.

#### 3.04 WORKMANSHIP

- A. Workmanship shall be of the very best. Only skilled mechanics shall be employed.
- B. Finish work shall be uniform and of approved color and shall be smooth, free from runs, sags and defective application. Edges of paint adjoining other materials or colors shall be sharp and clean, without overlapping. Before applying succeeding coats, primers and undercoats shall be completely integral and performing the function for which they are specified. Scratches, abrasions or any other disfigurements shall be properly prepared, sanded, and touched up, and any foreign matter removed before proceeding with the following coat.
- C. Paint shall be applied by a brush, roller or spray. Materials when brushed shall be evenly flowed on with brushes best suited for the type of material being applied. When using a roller, covers shall be of a type most suited for approved materials and textures. Spray applied paint shall be uniformly applied under pressure using recommended equipment.
- D. Apply paint to produce surface films without cloudiness, spotting, holidays, laps, brush marks, roller tracking, runs, sags, ropiness, or other surface imperfections. Cut in sharp lines and color breaks. Where applicable due to project conditions blend in with previously painted surfaces not indicated to receive new finishes.
  1. Finished surfaces shall have uniform color, dry opacity, and sheen.

### 3.05 CLEANING AND PROTECTION

- A. Protect work of other trades, whether being painted or not, against damage from paint application. Correct damage to work of other trades by cleaning, repairing, replacing, and refinishing, and leave in an undamaged condition.
- B. Provide "Wet Paint" signs to warn occupants of and to protect newly painted finishes. Remove temporary protective wrappings provided by others to protect their work after completing painting operations.
- C. At completion of construction activities of other trades, touch up and restore damaged or defaced painted surfaces.
- D. At the end of each work day, remove empty cans, rags, cleaning pads, rubbish, and other discarded paint materials from the site.
- E. Just prior to final completion and acceptance, the Contractor shall examine painted and refinished surfaces and retouch or refinish as necessary and required to leave surfaces in perfect condition.
- F. Upon completion of work, painting contractor shall remove paint and varnish spots from floors and other surfaces and remove rubbish and accumulated materials of whatever nature not caused by other trades from premises and leave work in a clean, orderly and acceptable condition. Clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces or to generate dust.

### 3.06 SCHEDULE OF PAINTING

- A. Products listed on the SCHEDULE OF PAINTING have been recommended by the paint system manufacturers for the intended use and establish a level of quality. If the Contractor submits and/or uses the specified products, the Contractor agrees that the specified products are proper for the intended use. If the Contractor does not agree with the use of the specified products, and recommends the use of alternative products that meet or exceed the level of quality of the specified products, the Contractor shall submit written explanation and supporting data from the manufacturer for the proposed products. Only products confirmed in writing by the paint manufacturer that meet or exceed the level of quality of the specified products will be considered. If accepted, proposed products shall be covered under the provisions of the warranty.
- B. Painting and finishing to new and existing surfaces shall be done in accordance with the following schedule except as otherwise noted herein.
  - 1. Prior to application of finishes, perform proper cleaning and preparatory work, moisture/alkalinity/adhesion testing, etc. to all surfaces to be painted/coated as specified within this section. The application of paint or finishes shall be an indication of the Contractor's acceptance of the surface.
  - 2. Paint exposed surfaces unless noted otherwise. Exposed surfaces include areas visible when permanent or built-in fixtures, convector covers, covers for finned-tube radiation, grilles, and similar components are in place. Extend coatings in these areas, as required, to maintain the system integrity and provide desired protection.
  - 3. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before the final installation of permanently

- fixed equipment or furniture, paint surfaces behind such equipment or furniture with prime coat only.
4. Paint interior surfaces of ducts with a flat, non-specular black paint where visible through registers or grilles.
  5. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
  6. Paint access panels, electrical panels, air diffusing outlets, supply and exhaust grilles, louvers, exposed conduit, primed hardware items, primed outlet covers, primed wall and ceiling plates and other items in painted areas to match the areas in which they occur unless otherwise directed by the Architect.
  7. Finish doors on tops, bottoms, and side edges the same as exterior faces.
  8. Sand lightly using low-dust emission wet methods between each succeeding enamel or varnish coat, and any other coating products meeting manufacturer's requirements.
  9. Do not paint prefinished surfaces.
- C. It is the intent that the indicated enumeration of coats on surfaces will give approved coverage coatings and each coat shall be applied heavy enough to obtain this result or additional coat(s) will be required at no additional cost. Finished surfaces shall have uniform color, dry opacity, and sheen.
- D. The indicated enumeration of coats is the minimum acceptable number of each item. Substitution of one heavy coat is not an acceptable substitution for two coats.
1. Each coat at a minimum must achieve the manufacturers recommended minimum dry film thickness for the specified item.
- E. Abbreviations shown are:
1. S-W = Sherwin-Williams
  2. PPG = PPG Paints
- F. Exterior Painting
1. Non-ferrous and galvanized metal, except pre-finished metal work, but including stacks, flues, vents, vent enclosures, fan enclosures, etc. on roof regardless of metal type; eggshell sheen finish, 2 finish coats over 1 primer coat:
    - a. Primer Coat
      1. S-W, Pro Cryl Metal Primer B66-310
      2. PPG, Pitt-Tech DTM Primer 90-712
    - b. First and Second Finish Coats
      1. S-W, Pro Industrial Zero VOC Acrylic B66 Series
      2. PPG, Pitt-Tech DTM Finish 90-374
    - c. Notes:

1. At flues and vents subject to high temperatures, in lieu of above provide manufacturer's high temperature resistant primer coat and finish coats to assure a proper, stable coating.
  2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
  3. Provide specified TSP cleaning to existing surfaces to remove dirt, grease, etc. before painting.
2. Galvanized ferrous metal including railings, guardrail assemblies, pipe bumpers, and wall mounted ladders; gloss sheen finish, 2 finish coats over 1 primer coat:
    - a. Primer Coat
      1. S-W, Pro Cryl Metal Primer B66-310
      2. PPG, Pitt-Tech DTM Primer 90-712
    - b. First and Second Finish Coats
      1. S-W, Pro Industrial Urethane Enamel B54 Series
      2. PPG, Glyptex Urethane Enamel PP4139
    - c. Notes:
    - d. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
  3. Ferrous metal, including but not limited to metal doors and frames; gloss sheen finish, 2 finish coats over shop primer coats:
    - a. First and Second Finish Coats
      1. S-W, Pro Industrial Urethane Enamel B54 Series
      2. PPG, Glyptex Urethane Enamel PP4139
    - b. Notes:
      1. Bare metal surfaces shall be touched up with manufacturers required primer before painting, confirm compatibility with shop primer coats
        - a. S-W, DTM Primer B66W1
        - b. PPG, Pitt-Tech DTM Primer 90-712
      2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
  4. Exposed structural steel, steel lintels, pipe bollards, railings and guardrails, metal doors and frames, wall mounted ladders, entrance skylight canopies including columns, plates, etc.; gloss sheen finish, 2 finish coats over 1 primer coat:

- a. Primer Coat
    - 1. S-W, Macropoxy 646 Fast Cure Epoxy B58 Series
    - 2. PPG, Amerlock 2 Epoxy
  - b. First and Second Finish Coats
    - 1. S-W, Acrolon 218 HS Acrylic Polyurethane B65 Series
    - 2. PPG, Amercoat 450H Polyurethane
  - c. Notes:
    - 1. Clean surfaces prior to application of finishes with:
      - a. S-W, Great Lakes Lab Extra Muscle Prepaint Cleaner
      - b. PPG, Dura Prep 120 Cleaner
    - 2. Galvanized surfaces to receive manufacturers required preparatory methods including any required barrier coats.
    - 3. Shop primed or existing painted surfaces to receive a barrier coat prior to application of Primer Coat:
      - a. S-W, ProIndustrial ProCryl Metal Primer
      - b. PPG, the specified Amerlock 2 Epoxy primer is a “surface tolerant” epoxy mastic that does not require a separate barrier coat over shop primed steel.
5. Precast concrete wall panels, concrete, and CMU; flat sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    - 1. S-W, Loxon Primer A24 series for Concrete and Masonry
    - 2. PPG, Permacrete 4-100 Concrete Block and Masonry Filler
  - b. First and Second Finish Coats
    - 1. S-W, Loxon XP A24 series
    - 2. PPG, Permacrete 4-22 100% Acrylic Coating
  - c. Notes:
    - 1. System to be installed per manufacturers requirements for a pure acrylic water-repellant coating system
    - 2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer’s proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
    - 3. Existing painted surfaces to be media blasted to remove paint down to bare concrete.
    - 4. Provide specified TSP cleaning to existing surfaces to remove dirt, grease, etc. before painting.

6. Exposed surfaces of concrete, and non-textured GFRC to receive textured acrylic elastomeric field applied coating system; flat sheen, fine sand texture finish, 2 finish coats over 1 primer coat:
  - a. Primer Coat
    1. PPG, Permacrete 4-2 High Build Acrylic Primer
    2. Dryvit Systems, Inc., Weatherprime Acrylic Primer
  - b. First and Second Finish Coats
    1. PPG, Permacrete 4-50 Texture Coatings Fine
    2. Dryvit Systems, Inc., Weatherlastic Sandpebble Fine
  - c. Note:
    1. System to be installed only after surface imperfections have been corrected, cracks have been treated, and proper preparatory work has been completed per manufacturer's requirements.
7. Finished wood trim, fascia, soffits, sills, siding, fencing, trash enclosures, etc.; Semi-Transparent Stain, 2 finish coats:
  - a. First and Second Finish Coats
    1. S-W, Woodscapes Semi-Transparent Exterior Stain
    2. PPG, Flood Pro Series, Semi-Transparent Stain, Acrylic/Oil
8. Finished wood trim, fascia, soffits, sills, siding, fencing, trash enclosures, etc.; Opaque Stain, 2 finish coats:
  - a. First and Second Finish Coats
    1. S-W, Woodscapes Solid Color Exterior Stain
    2. PPG, Flood Pro Series, Solid Color Stain, 100% Acrylic Latex

G. Interior Painting

1. Exposed ferrous metal work including but not limited to steel lintels, pipe bollards, railings and guardrails, metal doors and frames; semi-gloss sheen finish, 2 finish coats over shop primer coats:
  - a. First and Second Finish Coats
    1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd B34W08251
    2. PPG, Speedhide WB Alkyd 6-1510
  - b. Notes:
    1. Bare metal surfaces shall be touched up with manufacturers required primer before painting, confirm compatibility with shop primer coats
      - a. S-W, ProCryl Universal Metal Primer
      - b. PPG, Seal Grip 17-921 Acrylic Primer

2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
2. Metal work not primed; semi-gloss sheen finish, 2 finish coats over 1 primer coat:
    - a. Primer Coat
      1. S-W, ProCryl Universal Metal Primer
      2. PPG, Seal Grip 17-921 Acrylic Primer
    - b. First and Second Finish Coats
      1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd B34W08251
      2. PPG, Speedhide WB Alkyd 6-1510
  3. Structural steel, including associated plates, brackets, etc., steel joists, bulb tees, metal floor and roof deck; semi-gloss sheen finish, 2 finish coats over shop primer coats:
    - a. First and Second Finish Coats
      1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd B34W08251
      2. PPG, Speedhide WB Alkyd 6-1510
    - b. Notes:
      1. Bare metal surfaces shall be touched up with manufacturers required primer before painting, confirm compatibility with shop primer coats
        - a. S-W, ProCryl Universal Metal Primer
        - b. PPG, Seal Grip 17-921 Acrylic Primer
      2. At galvanized metal surfaces provide manufacturer's required Primer Coat before applying the 2 finish coats
        - a. S-W, DTM Primer B66W1.
        - b. PPG, Pitt-Tech DTM Primer 90-712
      3. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
  4. Concrete block surfaces; semi-gloss sheen finish, 2 finish coats over 1 primer coat:
    - a. Primer Coat
      1. S-W, Interior/Exterior Latex Block Filler
      2. PPG, Speedhide Block Filler 6-7
    - b. First and Second Finish Coats
      1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd, B34W08251
      2. PPG, Speedhide WB Alkyd 6-1510

- c. Notes:
  - 1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
- 5. Concrete block surfaces indicated to receive epoxy wall coating; semi-gloss sheen finish, 2 finish coats over 1 primer coat:
  - a. Primer Coat
    - 1. S-W, Heavy Duty Block Filler B42W46
    - 2. PPG, Speedhide Block Filler 6-7
  - b. First and Second Finish Coats
    - 1. S-W, Pro Industrial Pre-Catalyzed Waterbased Epoxy K46-150
    - 2. PPG, Pitt-Glaze WB1 Pre-Catalyzed Water-Borne Acrylic Epoxy 16-510
  - c. Notes:
    - 1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
- 6. Concrete block surfaces, indicated to receive epoxy wall coating; gloss sheen finish, 2 finish coats over 1 primer coat:
  - a. Primer Coat
    - 1. S-W, Heavy Duty Block Filler B42W46
    - 2. PPG, Speedhide Block Filler 6-7
  - b. First and Second Finish Coats
    - 1. S-W, Pro Industrial Water Based Catalyzed Epoxy B73 Series
    - 2. PPG, Aquapon WB Water Base Epoxy 98-101 Series
  - c. Notes:
    - 1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
- 7. Gypsum board, impact resistant cement board, plaster, acoustic diffuser ceiling and wall panels, spandrel panels, MDF panels, wood trim indicated to be painted, etc.: finish sheen as noted, 2 finish coats over 1 primer coat:
  - a. Primer Coat
    - 1. S-W, ProMar 200 Zero VOC Interior Latex Primer B28W2600
    - 2. PPG, Speedhide Zero VOC Interior Latex Primer 6-4900xi

- b. First and Second Finish Coats
    - 1. S-W, ProMar 200 Zero VOC Interior Latex B20W12651 / B30W02651
    - 2. PPG, Speedhide Zero VOC Interior Latex 6-4340xi / 6-4110xi
  - c. Notes:
    - 1. Walls and trim to have eggshell sheen finish, ceilings and soffits to have flat sheen finish.
    - 2. MDF panels to have coatings spray applied to achieve the desired results.
    - 3. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
8. Gypsum board surfaces indicated to receive epoxy wall coating; eggshell sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    - 1. S-W, ProMar 200 Zero VOC Wall Primer B28W2600
    - 2. PPG, Speedhide Zero VOC Primer 6-4900xi
  - b. First and Second Finish Coats
  - c. First and Second Finish Coats
    - 1. S-W, Pro Industrial Pre-Catalyzed Waterbased Epoxy K45-150
    - 2. PPG, Pitt-Glaze WB1 Pre-Catalyzed Water-Borne Acrylic Epoxy 16-310
  - d. Notes:
    - 1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
9. Faces and edges of wood base, trim, field finished wood doors, etc., to receive stain finish; satin top coat sheen finish, 3 finish coats over 1 stain coat:
- a. Stain Coat
    - 1. S-W, Wood Classics 250 Oil Stain A49 Series
    - 2. PPG, Deft Oil Based Stain DFT 400
  - b. First and Second Finish Coats, and Third Finish Top Coat (Satin)
    - 1. S-W, Wood Classics WB Poly Satin
    - 2. PPG, Deft WB Poly Satin DFT 157
  - c. Notes:

1. Sand lightly between finish coats per manufacturers requirements.
10. Insulation covering of exposed piping in finished areas; flat sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    1. S-W, ProMar 200 Zero VOC Interior Latex Primer B28W2600
    2. PPG, Speedhide Zero VOC Interior Latex Primer 6-4900xi
  - b. First and Second Finish Coats
    1. S-W, ProMar 200 Zero VOC Interior Latex B30W02651
    2. PPG, Speedhide Zero VOC Interior Latex 6-4110xi
  - c. Notes:
    1. Verify and coordinate compatibility of finish materials with insulation covering materials and provide necessary products for a complete and proper finish.
    2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
11. Exposed uncovered piping, electrical conduit, wire mold, gas lines, unfinished radiation and heating units, in finished areas; low sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    1. S-W, ProCryl Universal Metal Primer
    2. PPG, Seal Grip 17-921 Acrylic Primer
  - b. First and Second Finish Coats
    1. S-W, ProMar 200 Interior Latex Acrylic-Alkyd B33W08251
    2. PPG, Speedhide WB Alkyd 6-1410
  - c. Notes:
    1. At galvanized metal surfaces provide manufacturer's required Primer Coat before applying the 2 finish coats
      - a. S-W, DTM Primer B66W1
      - b. PPG, Pitt-Tech Plus DTM Primer 90-912
    2. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.
12. Exposed galvanized sheet metal, including ductwork, in finished areas; flat sheen finish, 2 finish coats over 1 primer coat:
- a. Primer Coat
    1. S-W, DTM Primer B66W1

2. PPG, Pitt-Tech Plus DTM Primer 90-712
- b. First and Second Finish Coats
1. S-W, ProMar 200 Zero VOC Interior Latex B30W02651
  2. PPG, Speedhide Zero VOC Interior Latex 6-4110xi
- c. Notes:
1. At existing painted surfaces after proper preparatory work has occurred provide manufacturer's proper Primer Coat compatible with existing surfaces before applying the 2 finish coats.

END 09 91 00

## SECTION 22 05 00 - BASIC PLUMBING REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 22 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

#### 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Scope of Work:
  - 1. Plumbing Work shall include, but is not necessarily limited to:
    - a. Furnish and install all items listed in the Plumbing Material List.
    - b. Furnish and install gas piping system as shown on plans downstream of existing building gas meter.
    - c. Furnish and install domestic water piping and makeup water connection to hydronic heating and/or cooling systems including reduced pressure principle type backflow preventer.
    - d. Furnish and install condensate drain piping from terminal equipment. Wall-mounted fan coils to be directly through the wall; all others to be piped to outdoors.
    - e. Furnish and install sump pumps, basin, storm and pumped condensate piping (Lincoln only).
    - f. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
  - 2. Heating Work: Refer to Section 23 05 00 "Basic HVAC Requirements".
  - 3. Air Conditioning and Ventilating Work: Refer to Section 23 05 00 "Basic HVAC Requirements".
  - 4. Temperature Control Work: Refer to Section 23 05 00 "Basic HVAC Requirements".
  - 5. Testing, Adjusting, and Balancing Work: Refer to Section 23 05 00 "Basic HVAC Requirements".

### 1.3 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations for a school, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours and around the school schedule. The Owner reserves the right to determine when restricted construction hours will be required.
- B. Schedule overtime for the following work:
  - 1. Work in mechanical rooms when school is in session.
  - 2. Work on roof when school is in session.
  - 3. Specific tunnel work when school is in session (Flinn).
  - 4. Site work for chiller installation (Flinn).
- C. Itemize all work and list associated hours and pay scale for each item.

### 1.4 ALTERNATES

- A. Alternate #1: East High School - All work associated with installing air conditioning within the existing air handling units that serve the Fieldhouse as shown on the drawings.
- B. Alternate #2: East High School - All work associated with replacing the existing HVAC system within the 1980 Addition as shown on the drawings. Base Bid will leave this area as existing to remain.

### 1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

- A. Definitions:
  - 1. "Mechanical Contractors" refers to the following:
    - a. Plumbing Contractor.
    - b. Heating Contractor.
    - c. Air Conditioning and Ventilating Contractor.
    - d. Temperature Control Contractor.
    - e. Testing, Adjusting, and Balancing Contractor.
- B. General:
  - 1. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:
    - a. Light fixtures.
    - b. Gravity flow piping, including steam and condensate.
    - c. Electrical busduct.
    - d. Sheet metal.
    - e. Electrical cable trays, including access space.
    - f. Sprinkler piping and other piping.
    - g. Electrical conduits and wireway.

## 1.6 COORDINATION DRAWINGS

### A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
  - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

### B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

## 1.7 QUALITY ASSURANCE

### A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

### B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

### C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the Rockford, Illinois Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.
3. Conform to Federal Act S.3874 requiring the reduction of lead in drinking water.

4. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
5. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
6. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
7. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
8. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for service connections, such as sewer and water and gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F. Examination of Drawings:

1. The drawings for the plumbing work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.

6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
  - a. Any item listed as furnished shall also be installed, unless otherwise noted.
  - b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing AutoCAD MEP.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

1.8 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification	Submittal Item
Section	
22 05 00	Owner Training Agenda
22 05 03	Fire Seal Systems

Referenced Specification Section	Submittal Item
22 10 23	Natural Gas Piping Systems
22 10 30	Plumbing Specialties
22 14 29	Sump Pumps
22 40 00	Plumbing Fixtures

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
  - a. Date
  - b. Project title and number
  - c. Contractor's name and address
  - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - e. Description of items submitted and relevant specification number
  - f. Notations of deviations from the contract documents
  - g. Other pertinent data
  
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
  - a. Date
  - b. Project title and number
  - c. Architect/Engineer
  - d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses
  - f. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
  
3. Composition:
  - a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.

4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
  - a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
  - a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
7. Schedule submittals to expedite the project. Coordinate submission of related items.

8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
9. Reproduction of contract documents alone is not acceptable for submittals.
10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
11. Submittals not required by the contract documents may be returned without review.
12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
13. Submittals shall be reviewed and approved by the Architect/Engineer **before** releasing any equipment for manufacture or shipment.
14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.
15. Schedule shall allow for adequate time to perform orderly and proper review of submittals, including time for consultants and Owner if required, and resubmittals by Contractor if necessary, and to cause no delay in Work or in activities of Owner or other contractors.
  - a. Allow at least two weeks for Architect's/Engineer's review and processing of each submittal, excluding mailing.
16. Architect/Engineer reserves the right to withhold action on a submittal which, in the Architect/Engineer's opinion, requires coordination with other submittals until related submittals are received. The Architect/Engineer will notify the Contractor, in writing, when they exercise this right.

C. Electronic Submittal Procedures:

1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 22 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 22 XX XX.description.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

1.9 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.

B. Format:

1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
2. Submit in Excel format.
3. Support values given with substantiating data.

C. Preparation:

1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
2. Break down all costs into:
  - a. Material: Delivered cost of product with taxes paid.
  - b. Labor: Labor cost, excluding overhead and profit.
3. Itemize the cost for each of the following:
  - a. Overhead and profit.
  - b. Bonds.
  - c. Insurance.
  - d. General Requirements: Itemize all requirements.
4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
  - a. Each aboveground piping system (sanitary, etc.). Break down the material and labor for each piping system based on geography (building, floor, wing and/or phase).
  - b. Each plumbing fixture (e.g., WC, lavatory, sink, etc.). Multiple units of the same type can be listed together, provided quantities are also listed so unit costs can be determined.
  - c. Record drawings
  - d. Punchlist and closeout

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.10 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders shall be broken down by sheet or associated individual line item indicated in the change associated narrative, whichever provides the most detailed breakdown. Change orders with inadequate breakdown will be rejected.

- B. Itemized pricing with unit cost shall be provided from all distributors and associated subcontractors.
- C. Change order work shall not proceed until authorized.

#### 1.11 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

#### 1.12 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

### PART 2 - PRODUCTS (Not Used)

### PART 3 - EXECUTION

#### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

#### A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found at the following website (<https://call811.com/>) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

#### B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

#### C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

#### D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

#### E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.
2. Provide all necessary sand and/or CA6 for backfilling.
3. Native soil materials may be used as backfill if approved by the Geotechnical Engineer.
4. Dispose of the excess excavated earth as directed.

5. Backfill materials (native soil material, sand, and/or CA6) shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris, or earth with a high void content.
6. Backfill all trenches and excavations immediately after installing pipes or removal of forms, unless other protection is provided.
7. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch uniform horizontal layers with each layer compacted separately to required density.
8. Lay all piping on a compacted bed of CA6 at least 3 inches deep. Backfill around pipes with CA6, 6 inch layers, and compact each layer.
9. Use native soil material (if approved), sand, or CA6 for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand or CA6 backfill to 6 inches above the top of the pipe.
10. Place all backfill above the sand/CA6 in uniform layers not exceeding 6 inches deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
11. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.

F. Surface Restoration:

1. Where trenches are cut through graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

### 3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:

- a. Pipe insulation is installed and fully sealed.
  - b. Pipe wall penetrations are sealed.
  - c. Pipe identification and valve tags are installed.
2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. IDPH Final Occupancy Checklist for Request of Inspection:
  1. Each Contractor must submit all forms and certifications required by IDPH relating to their work at 85% completion of the project or when directed by the Owner/Architect/Engineer.
- C. Final Jobsite Observation:
  1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
  3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- D. Before final payment is authorized, this Contractor must submit the following:
  1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including marked-up drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
  4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
  5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Architect/Engineer required prior to final payment approval.

### 3.5 OPERATION AND MAINTENANCE MANUALS

#### A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

#### B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div22.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div22.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

#### C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.

4. Copy of final approved test and balance reports.
5. Copies of all factory inspections and/or equipment startup reports.
6. Copies of warranties.
7. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
8. Dimensional drawings of equipment.
9. Capacities and utility consumption of equipment.
10. Detailed parts lists with lists of suppliers.
11. Operating procedures for each system.
12. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
13. Repair procedures for major components.
14. List of lubricants in all equipment and recommended frequency of lubrication.
15. Instruction books, cards, and manuals furnished with the equipment.
16. Owner and Contractor attendance list for domestic water systems operation, maintenance, and flushing training.

### 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by **FACTORY PERSONNEL** in the care, maintenance, and operation of the equipment and systems.
- C. The Owner has the option to make a video recording of all instructions. Coordinate schedule of instructions to facilitate this recording.
- D. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.
- E. Operating Instructions:
  1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
  2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.7 SYSTEM STARTING AND ADJUSTING

- A. The plumbing systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.

- C. Contractor shall adjust the plumbing systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- D. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.
- E. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.8 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of plumbing drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping size and location, both exterior and interior; including locations devices, requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located; Change Orders; concealed control system devices.
- D. Before completion of the project, a set of reproducible plumbing drawings will be given to the Contractor for transfer of all as-built conditions from the paper set maintained at the job site. All marks on reproducibles shall be clear and permanent.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

### 3.9 PAINTING

- A. Refer to Architectural specifications for painting requirements. following items:
  - 1. All exposed piping

- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor.
- D. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- E. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer.

### 3.10 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### 3.11 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

### 3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
  - 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
    - a. Minimizing the amount of dust generated.
    - b. Reducing solvent fumes and VOC emissions.

- c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.
  - d. Protect stored on-site and installed absorptive materials from moisture damage.
2. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
  3. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
  4. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
  5. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".

### 3.13 UTILITY REBATE

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.
  1. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. Pipe insulation complete, pipes labeled and valves tagged.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 22 05 00

## SECTION 22 05 03 - THROUGH PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

#### 1.3 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. The Building Officials and Code Administrators National Building Code
- J. 2018 International Building Code
- K. NFPA 5000 - Building Construction Safety Code

#### 1.4 SUBMITTALS

- A. Submit under provisions of Section 22 05 00.
- B. Submit Firestopping Installers Certification for all installers on the project.
- C. Shop Drawings: Submit for each condition requiring firestopping. Include descriptions of the specific penetrating item, actual wall/floor construction, manufacturer's installation instructions, and UL or Intertek / Warnock Hersey Assembly number.

- D. Through-Penetration Firestop System Schedule: Indicate locations of each through-penetration firestop system, along with the following information:
  - 1. Types of penetrating items.
  - 2. Types of constructions penetrated, including fire-resistance ratings and, where applicable, thicknesses of construction penetrated.
  - 3. Through-penetration firestop systems for each location identified by firestop design designation of qualified testing and inspecting agency.
  - 4. F ratings for each firestop system.
- E. Maintain a notebook on the job site at all times that contains copies of approved submittals for all through penetration firestopping to be installed. Notebook shall be made available to the Authority Having Jurisdiction at their request and turned over to the Owner at the end of construction as part of the O&M Manuals.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

#### 1.6 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.
  - 1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  - 2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
  - 1. F-Rated Systems: Provide through-penetration firestop systems with F-ratings indicated, but not less than that equaling or exceeding fire-resistance rating of constructions penetrated.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.

- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.7 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.
  - 1. 3M; Fire Protection Products Division.
  - 2. Hilti, Inc.
  - 3. RectorSeal Corporation, Metacaulk.
  - 4. Tremco; Sealant/Weatherproofing Division.
  - 5. Johns-Manville.
  - 6. Specified Technologies Inc. (S.T.I.)
  - 7. Spec Seal Firestop Products
  - 8. AD Firebarrier Protection Systems
  - 9. Dow Corning Corp.
  - 10. Fire Trak Corp.
  - 11. International Protective Coating Corp.

### 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Firestopping systems for plumbing and wet pipe sprinkler piping shall be moisture resistant.
- E. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- F. Provide firestopping systems allowing continuous insulation for all insulated pipes.

G. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:

a. F Rating = Floor/Wall Rating

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

a. F Rating = Floor/Wall Rating

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

a. F Rating = Wall/Floor Rating

Penetrating Item	UL System No.
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999

Penetrating Item	UL System No.
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999
*Alternate method of firestopping is patching opening to match original rated construction.	

- H. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- I. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

#### 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.

- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### 3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### 3.4 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the engineer and manufacturer's factory representative. The engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the engineer's discretion and the contractor's expense.

END OF SECTION 22 05 03

SECTION 22 05 29 - PLUMBING SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Sleeves and Seals.
- C. Cutting of Openings.
- D. Escutcheon Plates and Trim.

1.2 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 22 05 00. Include plastic pipe manufacturers' support spacing requirements.

1.3 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

	Hanger Rod Diameter	
Pipe Size	Column #1	Column #2
2" and smaller	3/8"	3/8"

Column #1: Steel, cast iron pipe.

Column #2: Copper pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:

## 2.2 PIPE AND STRUCTURAL SUPPORTS

### A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

### B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.
  - a. Products:
    - 1) Cooper/B-Line Fig B3373 Series
    - 2) Erico 510 Series
    - 3) Nibco/Tolco Fig. 82
  2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.
    - a. Products:
      - 1) Mason RBA, RCA or RDA
      - 2) Mason BR
    3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellent calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.
      - a. Products:
        - 1) Pipeshields E100
  4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.
  5. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.
2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.
3. Vertical cold pipe drops and rough-ins to fixtures shall be supported by insulated pipe clamps to prevent thermal bridging and condensation.
4. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
5. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.

a. Products:

- 1) Anvil Fig. 160, 161, 162, 163, 164, 165
- 2) Cooper/B-Line Fig. 3160, 3161, 3162, 3163, 3164, 3165.
- 3) Erico Model 630, 631, 632, 633, 634, 635.
- 4) Nibco/Tolco Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4

6. Unless otherwise indicated, hangers shall be as follows:

a. Clevis Type:

- 1) Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches & Smaller
- 2) Products: Bare Steel Plastic or Insulated Pipe:
  - a) Anvil Fig. 260
  - b) Cooper/B-Line Fig. 3100
  - c) Erico Model 400
  - d) Nibco/Tolco Fig. 1
- 3) Products: Bare Copper Pipe:
  - a) Cooper/B-Line Fig. B3100C
  - b) Nibco/Tolco Fig. 81PVC

b. Adjustable Swivel Ring Type:

- 1) Service: Bare Metal Pipe - 4 inches and Smaller
- 2) Bare Steel Pipe:
  - a) Anvil Fig. 69
  - b) Cooper/B-Line Fig. B3170NF
  - c) Erico Model FCN
  - d) Nibco/Tolco Fig. 200

- 3) Bare Copper Pipe:
  - a) Cooper/B-Line Fig. B3170CTC
  - b) Erico 102A0 Series
  - c) Nibco/Tolco Fig. 203
  
7. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
  - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
  - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
  
8. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
  - a. Clamp Type:
    - 1) Service: Bare Metal Pipe, Insulated Cold Pipe,
    - 2) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
    - 3) Bare Steel Pipe:
      - a) Unistrut Fig. P1100 or P2500
      - b) Cooper/B-Line Fig. B2000 or B2400
      - c) Nibco/Tolco Fig. A-14 or 2STR
    - 4) Bare Copper Pipe:
      - a) Cooper/B-Line Fig. BVT

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:
  - a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):
    - 1) Products:
      - a) Anvil Fig. 92
      - b) Cooper/B-Line Fig. B3033/B3034
      - c) Erico Model 300
      - d) Nibco/Tolco 68

- b. Steel Structure Clamps: Scissor Type Beam Clamps (for use with bar-joists and wide flange):
  - 1) Products:
    - a) Anvil Fig. 228, 292
    - b) Cooper/B-Line Fig. B3054
    - c) Erico Model 360
    - d) Nibco/Tolco Fig. 329
- c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
  - 1) Products:
    - a) MCL. M1, M2 or M3
- d. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-17. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
- e. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.
- f. Steel Structure Welding:
  - 1) Unless otherwise noted, hangers, clips, and auxiliary support steel may be welded in lieu of bolting, clamping, or riveting to the building structural frame. Take adequate precautions during all welding operations for fire prevention and protecting walls and ceilings from smoke damage.

### 2.3 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

## 2.4 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
- G. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- H. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- I. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

## 2.5 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

## 2.6 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## PART 3 - EXECUTION

### 3.1 PLUMBING SUPPORTS AND ANCHORS

#### A. General Installation Requirements:

1. Install all items per manufacturer's instructions.
2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.

#### B. Supports Requirements:

1. Where building structural steel is fireproofed, all hangers, clamps, auxiliary steel, etc., which attach to it shall be installed prior to application of fireproofing. Repair all fireproofing damaged during pipe installation.
2. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
3. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.

#### C. Pipe Requirements:

1. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
2. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
3. Piping shall not introduce strains or distortion to connected equipment.
4. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
5. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
6. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
7. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.

#### D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:

1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
  - a. The hanger is attached within 6" from a web/chord joint.
  - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.

3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
  4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
1. Steel (Std. Weight or Heavier - Liquid Service):
    - a. Maximum Spacing:
      - 1) 1-1/4" & under: 7'-0"
      - 2) 1-1/2": 9'-0"
      - 3) 2": 10'-0"
      - 4) 2-1/2": 11'-0"
      - 5) 3": 12'-0"
      - 6) 4" & larger: 12'-0"
  2. Hard Drawn Copper & Brass (Liquid Service):
    - a. Maximum Spacing:
      - 1) 3/4" and under: 5'-0"
      - 2) 1": 6'-0"
      - 3) 1-1/4": 7'-0"
      - 4) 1-1/2" 8'-0"
      - 5) 2": 8'-0"

END OF SECTION 22 05 29

## SECTION 22 05 53 - PLUMBING IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Identification of products installed under Division 22.

#### 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 22 05 00. Include list of items identified, wording, letter sizes, and color coding.
- B. Include valve chart and schedule listing valve tag number, location, function, and valve manufacturer's name and model number.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

1. 3M
2. Bunting
3. Calpico
4. Craftmark
5. Emedco
6. Kolbi Industries
7. Seton
8. W.H. Brady
9. Marking Services

#### 2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4"	8"	1/2"
1-1/2" to 2"	8"	3/4"

- B. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.

- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Pipe Markers:
  - 1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
  - 2. Apply markers and arrows in the following locations where clearly visible:
    - a. At each valve.
    - b. On both sides of walls that pipes penetrate.
    - c. At least every 20 feet along all pipes.
    - d. On each riser and each leg of each "T" joint.
    - e. At least once in every room and each story traversed.

### 3.2 SCHEDULE

- A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:
  - 1. CONDENSATE DRAIN: White lettering; green background
  - 2. DOMESTIC COLD WATER: White lettering; green background
  - 3. SANITARY SEWER: Black lettering; yellow background
  - 4. VENT: Black lettering; yellow background
  - 5. STORM SEWER (PRIMARY AND SECONDARY): White lettering; green background
  - 6. NATURAL GAS: Black lettering; yellow background
  - 7. NON-POTABLE WATER: Black lettering; yellow background

END OF SECTION 22 05 53

## SECTION 22 07 19 - PLUMBING PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Insulation Jackets.

#### 1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required). Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 22 05 00. Include product description, list of materials and thickness for each service, and locations.

### PART 2 - PRODUCTS

#### 2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534 Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

## 2.2 VAPOR BARRIER JACKETS

- A. All-purpose polymer or polypropylene service jacket vapor barrier with self-sealing adhesive joints. Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Single, self-seal acrylic adhesive on longitudinal jacket laps and butt strips.

## 2.3 JACKET COVERINGS

- A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color selected by Architect.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.

### 3.2 INSTALLATION

#### A. General Installation Requirements:

1. Install materials per manufacturer's instructions, building codes and industry standards.
2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.

#### B. Insulated Piping Operating Below 60°F:

1. Insulate fittings, valves, unions, flanges, strainers, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.
2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
3. All balance valves with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow reading and adjusting of the valve.

#### C. Insulated Piping Operating Between 60°F and 140°F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

#### D. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.

3. On exposed piping serving kitchen equipment or plumbing fixtures, the piping shall be insulated unless local code allows it to be uninsulated. In no instance should the uninsulated portion of the piping be more than 4ft in developed length.

### 3.3 SUPPORT PROTECTION

- A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.
- B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:
  1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
    - a. Polyisocyanurate insulation (for pipes below 300°F with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, Where insulation is installed on piping located within return air plenums and mechanical rooms, insulation shall have 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
    - b. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
      - 1) Products:
        - a) Buckaroo CoolDry
        - b) Cooper/B-Line Fig. B3380 through B3384
        - c) Pipe Shields A1000, A2000
    - c. Insulation Couplings:
      - 1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
      - 2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
        - a) Klo-Shure or equal
      - 3) Vertical:
        - a) Manufacturers: Klo-Shure Titan or equal
    - d. Rectangular blocks, plugs, or wood material are not acceptable.
    - e. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

- C. Neatly finish insulation at supports, protrusions, and interruptions.
- D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.
- E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge

### 3.4 INSULATION

#### A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.
4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F seal fitting covers with vapor retarder mastic in addition to tape.

#### B. Type B Insulation:

1. Install per manufacturer's instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
  - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
  - b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.

4. Insulation Installation on Valves and Pipe Specialties:
  - a. Install preformed sections of same material as straight segments of pipe insulation when available.
  - b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
  - c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

### 3.5 JACKET COVER INSTALLATION

#### A. Metal Covering:

1. Provide vapor barrier as specified for insulation type. Cover with aluminum jacket covering with seams located on the bottom of horizontal piping. Include fittings, joints and valves.
2. Seal all interior and exterior butt joints with metal draw bands and sealant. Seal all exterior joints watertight.
3. Interior joints do not need to be sealed.
4. Use metal covering on the following pipes:
  - a. Exposed condensate piping.
5. Use colored aluminum jacket covers on the following pipes:
  - a. All exterior piping.
  - b. All horizontal and vertical condensate piping associated with the terminal equipment to the exterior wall penetration.

### 3.6 SCHEDULE

- A. Refer to drawings for insulation schedule.

END OF SECTION 22 07 19

## SECTION 22 10 00 - PLUMBING PIPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Check Valves.

#### 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store valves in shipping containers with labeling in place.

#### 1.4 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 22 05 00 for required plumbing systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

### PART 2 - PRODUCTS

#### 2.1 CAST IRON PIPE

- A. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets:
  - 1. Pipe: Standard weight no-hub cast iron soil pipe, corrosion protective coating inside and outside, CISPI 301 and CISPI Trademark.
  - 2. Design Pressure: Gravity Maximum Design Temperature: 180°F
  - 3. Joints: Heavy duty, neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with at least four screw type clamps, FM 1680 or ASTM C1540.
  - 4. Adapters: Transitions from cast iron soil pipe to other pipe materials with manufactured adapters. Heavy duty neoprene sleeve gasket, ASTM C-564, 300 Series stainless steel shield, clamp, and screws with not less than four screw type clamps, FM 1680 or ASTM C1540.

## 2.2 COPPER PIPE

### A. Copper Pipe; Type L; Solder Joints:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Wrought copper solder joint, ANSI B16.22.

### B. Copper Pipe; Type L; Mechanical Press Connection:

1. Pipe: Type L hard drawn seamless copper tube, ASTM B88.
2. Design Pressure: 175 psi; Maximum Design Temperature: 200°F.
3. Joints: Mechanical press connection.
4. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.
5. Manufacturers:
  - a. Viega ProPress
  - b. Elkhart Xpress
  - c. Nibco Press System Fittings and Valves
  - d. Mueller Streamline PRS

### C. Copper Pipe; Type K; Solder Joints:

1. Pipe: Type K annealed copper tube, ASTM B88.
2. Design Pressure: 150 psi. Maximum Design Temperature: 200°F.
3. Joints: Solder with 100% lead-free solder and flux ASTM B32.
4. Fittings: Wrought copper solder joint, ANSI B16.22.

### D. Copper Pipe; Type K; Mechanical Press Connection:

1. Pipe: Type K annealed copper tube, ASTM B88.
2. Design Pressure: 150 psi. Maximum Design Temperature: 200°F.
3. Joints: Mechanical press connection.
4. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.
5. Manufacturers:
  - a. Viega ProPress
  - b. Elkhart Xpress
  - c. Nibco Press System Fittings and Valves
  - d. Mueller Streamline PRS.

### E. Copper Pipe: Type DWV; Solder Joints:

1. Pipe: Type DWV hard temper seamless copper drainage tube, ASTM B306.
2. Design Pressure: Gravity Maximum Design Temperature: 180°F
3. Joints: Solder with 100% lead-free solder and flux, ASTM B32.
4. Fittings: Cast brass solder joint drainage type, ANSI B16.23 or wrought copper solder joint drainage type, ANSI B16.29.

## 2.3 PLASTIC PIPE

### A. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints:

1. Plastic piping not allowed for Flinn Middle School
2. Pipe: Schedule 40 rigid, PVC-DWV, or ABS-DWV, normal impact Type I, with plain ends, conforming to ASTM Standards D2665 or D2661. Cellular core piping is not acceptable.
3. Joints: Solvent-weld socket type with solvent recommended by pipe manufacturer.
4. Fittings: PVC-DWV, or ABS-DWV, normal impact Type I, with solvent-weld socket type ends for Schedule 40 pipe.
5. Limits: Schedule 40 PVC-DWV, or ABS-DWV pipe must not be threaded. Do not use where exposed or in return air plenums.
6. Use: Use PVC or ABS only where allowed by local jurisdiction. Comply with all special requirements or limitations.
7. Special Requirements: Provide expansion loop(s) and/or expansion joints in the piping system per the manufacturer's guidelines and as shown on the drawings. Refer to Section 22 05 16 for expansion joint requirements.

### B. PVC Perforated; Footing Tile; Schedule 40:

1. Pipe: Schedule 40 Perforated PVC Footing Tile - ASTM D1785/76 or DWV Perforated Footing Tile - ASTM D2665/76.
  - a. Manufacturers:
    - 1) JM Eagle
    - 2) Charlotte
    - 3) Cresline
2. Geotextile Fabric: As recommended by the manufacturer for this application.
  - a. Manufacturers:
    - 1) Typar
    - 2) Cerex
    - 3) Big 'O'

## 2.4 VALVES

### A. Shutoff Valves:

1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

## 2. Ball Valves:

- a. BA-1: 3" and under, 150 psi saturated steam, 600 psi CWP, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-255-FB-P-UL, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.
  - 1) Provide solid extended shaft for all insulated piping.
  - 2) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

## 2.5 CHECK VALVES

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319-Y, Walworth #3406, Milwaukee #509, Watts #G-5000, Nibco T-413B.
- C. CK-13: 2-1/2" thru 12", 200# CWP, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size. Mueller Steam Specialty Co. #71-AHB-6-H, Stockham #WG-961 EPDM or #WG-970 BUNA, NIBCO W-920-W, Crane.

## 2.6 VALVE CONNECTIONS

- A. Provide all connections to match pipe joints. Valves shall be same size as pipe unless noted otherwise.

## 2.7 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel and stainless steel are commonly used and require isolation from each other with the following exceptions:
  1. Iron and steel connected to each other.
  2. Brass, copper, and bronze connected to each other.

3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Install all products per manufacturer's recommendations.
- B. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- C. Remove scale and dirt, on inside and outside, before assembly.
- D. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

### 3.2 SYSTEM, PIPING AND VALVE SCHEDULE

- A. Cold Water, Hot Water, Tempered Water - Potable and Non-Potable (Above Ground):
  1. Copper Pipe; Type L; Solder Joints: All Sizes
  2. Copper Pipe; Type L; Mechanical Press Connection: 4" and Under
  3. Shutoff Valves: BA-1
  4. Check Valves: CK-1
- B. Sanitary Waste and Vent, Gravity (Above Ground):
  1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
- C. Storm Drainage, Gravity (Above Ground):
  1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
- D. Sanitary Waste and Vent, Gravity (Underground - Inside Building):
  1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
- E. Storm Drainage, Gravity (Underground - Inside Building):
  1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
- F. Sanitary Waste and Vent, Gravity (Underground - Outside Building):
  1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"

- G. Storm Drainage, Gravity (Underground - Outside Building):
  - 1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
- H. Storm - Pumped (Above Ground - Inside Building):
  - 1. Copper Pipe; Type K; Solder Joints: All Sizes
  - 2. Copper Pipe; Type K; Mechanical Press Connection: All Sizes
  - 3. Shutoff Valves: BA-1
  - 4. Check Valves: CK-1, CK-13
- I. Condensate/Equipment Drainage:
  - 1. Cast Iron; Standard Weight; No-Hub Sleeve Gaskets: 1-1/2" to 15"
  - 2. Copper Pipe: Type DWV; Solder Joints: 1-1/4" to 4"
  - 3. PVC-DWV or ABS-DWV; Schedule 40; Solvent Weld Joints: All Sizes
- J. Footing Tile:
  - 1. PVC Perforated; Footing Tile; Schedule 40: All Sizes

### 3.3 TESTING PIPING

- A. Sanitary Drainage, Sanitary Vent, Storm Drainage:
  - 1. Test all piping with water to prove tight.
  - 2. Test piping before insulation is applied.
  - 3. Hydrostatically test all soil, waste, and vent piping inside of building with 10 feet head of water for 15 minutes. Inspect before fixtures are connected. If leaks appear, repair them and repeat the test.
  - 4. Hydrostatically test interior downspouts with 10 feet head of water for 15 minutes with no leaks.
  - 5. Test force mains with water at 105% of the operating pump discharge pressure for 15 minutes.
  - 6. Test pressures stated above shall be as listed or as required by the Authority Having Jurisdiction, whichever is most stringent.
- B. Cold Water - Potable and Non-Potable:
  - 1. Test pipes underground or in chases and walls before piping is concealed.
  - 2. Test all pipes before the insulation is applied. If insulation is applied before the pipe is tested and a leak develops which ruins the insulation, replace damaged insulation.
  - 3. Test the pipe with 100 psig water pressure or equal inert gas such as nitrogen. Exception: Inert gas test shall not be used to test plastic piping.
  - 4. Hold test pressure for at least 2 hours.

### 3.4 CLEANING PIPING

- A. All Water Piping:
  - 1. Flush all piping using faucets, flush valves, etc. until the flow is clean.

2. After flushing, thoroughly clean all inlet strainers, aerators, and other such devices.
3. If necessary, remove valves to clean out all foreign material.

### 3.5 INSTALLATION

#### A. General Installation Requirements:

1. Provide dielectric connections between dissimilar metals.
2. Route piping in orderly manner and maintain gradient. Install to conserve building space.
3. Group piping whenever practical at common elevations.
4. Install piping to allow for expansion and contraction without stressing pipe, joints, or equipment.
5. Slope water piping and arrange to drain at low points.
6. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
7. Seal pipes passing through exterior walls with a wall seal per Section 22 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.

#### B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

#### C. Valves/Fittings and Accessories:

1. Install shutoff valves that permit the isolation of equipment/fixtures in each room without isolating any other room or portion of the building. Individual fixture angle stops do not meet this requirement. Exception: Back-to-back rooms in no more than two adjacent rooms.
2. Provide clearance for installation of insulation and access to valves and fittings.
3. Provide access doors for concealed valves and fittings.
4. Install valve stems upright or horizontal, not inverted.

#### D. Sanitary and Storm Piping:

1. Install all sanitary and storm piping inside the building with a slope as shown on the drawings.
2. Install horizontal offset at all connections to roof drains to allow for pipe expansion.
3. Slope sanitary and storm piping outside the building to meet invert elevations shown on drawings and to maintain a minimum velocity of 2 feet per second.

### 3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied markings, stampings, or nameplates with sufficient data to determine their conformance with specified requirements.

- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not install any item that is not clean.
- D. Until system is fully operational, all openings in piping and equipment shall be kept closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items specifically designed and intended for this purpose.
- E. Run pipes straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required to provide needed headroom or clearance and to provide needed flexibility in pipe lines.
- F. Make changes in direction of pipes only with fittings or pipe bends. Changes in size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be of the long radius type, unless otherwise shown on the drawings or specified.
- G. Arrange piping and connections so equipment served may be totally removed without disturbing piping beyond final connections and associated shutoff valves.
- H. Use full and double lengths of pipe wherever possible.
- I. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.
- J. Unless otherwise indicated, branch take-offs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for air lines, and from top, bottom or side for liquids.
- K. Do not use geotextile fabric with footing tile if silt content of soil exceeds 40% or if clay content exceeds 50%. The fabric shall be installed around 1" river rock or 2" limestone.

### 3.7 BRANCH CONNECTIONS

- A. For domestic water and vent systems only, make branch connections with standard tee or cross fittings of the type required for the service.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Branch connections from the headers and mains may be mechanically formed using an extraction device. The branch piping connection shall be brazed connection for the following services only:
  - 1. Domestic water piping above ground.
- D. Branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

### 3.8 JOINING OF PIPE

#### A. Solder Joints (Copper Pipe):

1. Make up joints with 100% lead-free solder, ASTM B32. Cut tubing so ends are perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, over all surfaces to be joined. Heat joints uniformly so solder will flow to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
2. Flux shall be non-acid type.
3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove discs and seals during soldering if they are not suitable for 470°F.

#### B. Mechanical Press Connection (Copper Pipe):

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Fully insert tubing into the fitting and mark tubing.
3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
4. Joint shall be pressed with a tool approved by the manufacturer.
5. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

#### C. Solvent Weld Joints (PVC):

1. Make joints with a two-step process. Use primer conforming to ASTM F656 and solvent cement conforming to ASTM D2564.

#### D. No-Hub Sleeve Gaskets (No-Hub) (Cast Iron Pipe):

1. Gasket shall be heavy weight class, conforming to ASTM C564.
2. The gasket shall have an internal center stop.
3. The gasket shall be covered by a stainless steel band secured with a minimum of four stainless steel bands per fitting/joint.
4. Sleeve gaskets shall be installed in accordance with the manufacturer's installation instructions.

### 3.9 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Disinfection of the domestic water piping shall be completed within three (3) weeks prior to building occupancy. Contractor is responsible for disinfecting water piping if used by workers during construction; disinfection during construction does not eliminate the requirement for final disinfection prior to occupancy. Flushing of piping shall be completed within two (2) weeks prior to building occupancy.
- B. Provide necessary connections at the start of individual sections of mains for adding chlorine.
- C. Before starting work, verify system is complete, flushed and clean.

- D. Ensure pH of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- E. Inject disinfectant, free chlorine in liquid, powder, tablet or gas form, throughout system to obtain 50 to 80 mg/L residual.
- F. Bleed water from all outlets to ensure chlorine distribution throughout the entire domestic water system.
- G. Verify initial chlorination levels by testing at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main.
- H. Maintain disinfectant in system for 24 hours, after which test at minimum 15% of outlets located throughout entire building, including the last fixture connected to each main and each branch extending over 50 feet from a main. If final disinfectant residual tests less than 25 mg/L at any one of the tested outlets, flush the entire system and repeat disinfection and testing procedure.
- I. After final disinfectant residuals test at or above 25 mg/L after a minimum 24-hour duration, flush disinfectant from system at a minimum velocity of 3.0 feet/second until residual is equal to that of incoming water or 1.0 mg/L.
- J. Take water samples, no sooner than 24 hours after flushing, from 2% of outlets and from water entry. Obtain, analyze, and test samples in accordance with AWWA C651, Section 5 - Verification.

END OF SECTION 22 10 00

## SECTION 22 10 23 - NATURAL GAS PIPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Natural Gas Piping System.

#### 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.
- C. Welders Certification: In accordance with ANSI/ASME Sec 9 or ANSI/AWS D1.1.

#### 1.3 SUBMITTALS

- A. Submit product data under provisions of Section 22 05 00. Include data on pipe materials, fittings, valves, and accessories.
- B. Test Reports: Provide results of piping system pressure test.
- C. Welders Certificates: Certify welders employed on the Work, verifying AWS qualification within previous 12 months.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

#### 1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 22 05 00 for the required natural gas piping system electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

## PART 2 - PRODUCTS

### 2.1 NATURAL GAS (0 to 125 PSI)

- A. Design Pressure: 125 psi. Maximum Design Temperature: 350°F
- B. Piping - 2" and Under:
  - 1. Pipe: Standard weight steel, threaded and coupled, ASTM A53.
  - 2. Joints: Screwed. (NOTE: For below ground, all sizes to have welded joints.)
  - 3. Fittings: 150# steam - 300# CWP, black malleable iron, banded, ASTM A197, ANSI B16.3.
  - 4. Unions: 250# - 500# CWP, black malleable iron, ANSI B16.39, ground joint with brass seat.
- C. Piping - 2-1/2" and Over:
  - 1. Pipe: Standard weight steel, beveled ends, ASTM A53.
  - 2. Joints: Butt welded or flanged.
  - 3. Fittings: Standard weight seamless steel, butt weld type, ASTM A234, Grade I, ANSI B16.9.
  - 4. Flanges: 150# forged steel, weld neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.
- D. Shutoff Valves/Throttling Valves:
  - 1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
  - 2. BA-13: 2" and under, threaded 600 psi CWP; UL listed for 250# LP, flammable liquid, heating oil, natural and manufactured gases, 150 psi steam, bronze body and chrome plated brass ball, Teflon seats and packing.
    - a. Manufacturers:
      - 1) Apollo #80-100
      - 2) Nibco #T580-70-UL or #T585-70-UL
      - 3) Watts #B-6000
- E. Check Valves:
  - 1. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
  - 2. CK-1: 2" and under, 125# steam @ 406°F, 200# CWP @ 150°F, screwed, bronze, horizontal swing.
    - a. Manufacturers:
      - 1) Crane #37
      - 2) Hammond #IB904

- 3) Stockham #B319-Y
- 4) Walworth #3406
- 5) Milwaukee #509
- 6) Watts #B-5000
- 7) Nibco Y-413B

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- D. Connect to all equipment with flanges or unions.
- E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for treatment.

### 3.2 TESTING PIPING

- A. Low Pressure - Up to 1 psi:
  1. Test piping with 20 psi air pressure. System must hold this pressure without adding air for two hours.
- B. A non-combustible odorant, such as oil of wintergreen, may be added to help locate leaks.

### 3.3 CLEANING PIPING

- A. Assembly:
  1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
  2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
  3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
  4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

### 3.4 INSTALLATION

- A. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
- B. Install piping to conserve building space, and not interfere with other work.
- C. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- D. Group piping whenever practical at common elevations.
- E. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- F. Provide valve position indicator on all valves 10'-0" or greater above finish floor and not located above ceiling.
- G. Provide clearance for access to valves and fittings.
- H. Prepare pipe, fittings, supports, and accessories for finish painting.
- I. Install valves with stems upright or horizontal, not inverted.
- J. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
- K. Provide shutoff valves to isolate part of systems and vertical risers.
- L. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.
- M. Reducers are generally not shown. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
- N. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
- O. Refer to Section 23 05 00 for Excavation, Fill, Backfill and Compaction requirements.

### 3.5 BONDING AND GROUNDING

- A. Each above ground portion of a gas piping system, other than corrugated stainless steel tubing systems, that is likely to become energized shall be electrically continuous and bonded to an effective ground-fault current path. Gas piping, other than corrugated stainless steel tubing, shall be considered to be bonded when it is connected to appliances that are connected to the appliance grounding conductor of the circuit supplying that appliance.
- B. Gas piping shall not be used as a grounding conductor or electrode.

### 3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Cut all pipe to exact measurement and install without springing or forcing.
- H. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

### 3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage.
- B. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install gas pipes with bottom of pipe and eccentric reducers in a continuous line.
- C. Provide drip legs at low points and at the base of all risers in gas pipes. Drip legs shall be full line size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, capped with a reducer to a drain valve.

### 3.8 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

- C. Use of forged weld-on fittings is also limited as follows:
  - 1. Must have at least same pressure rating as the main.
  - 2. Header or main must be 2-1/2" or over.
  - 3. Branch line is at least two pipe sizes under header or main size.
- D. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- E. All branch piping connections for natural gas shall take off on the top or on the side of the main.

### 3.9 JOINING OF PIPE

- A. Threaded Joints:
  - 1. Ream pipe ends and remove all burrs and chips.
  - 2. Protect plated pipe and valve bodies from wrench marks when making up joints.
  - 3. Apply Teflon tape to male threads.
- B. Flanged Joints:
- C. Welded Joints:
  - 1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
  - 2. Furnish certificates qualifying each welder to the Owner's Representative prior to start of work.
  - 3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
  - 4. Ends of pipe and fittings to be joined by butt-welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

### 3.10 PAINTING EXPOSED PIPE

- A. Paint all outdoor exposed natural gas piping white for horizontal piping, color selected by Owner or Architect/Engineer for vertical piping to go from one roof level to the other where against brick or other surfaces that require a color match.

### 3.11 SERVICE CONNECTIONS

- A. Flinn Middle School: 4 PSIG downstream of meter per NICOR.
- B. IMEG has attempted to get existing equipment gas loads to provide to NICOR and have not received nor have access to them. IMEG has completed the load letter for NICOR for all new equipment only.

- C. Contractor to provide information to NICOR as required for changes to the existing gas regulator and meter given the new equipment load.

END OF SECTION 22 10 23

## SECTION 22 10 30 - PLUMBING SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Floor Drains and Sinks
- B. Roof Drains.
- C. Backflow Preventers.
- D. Dielectric Fittings (Connections Between Dissimilar Metals).

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. Piping, Fittings, Valves, and Flux for Potable Water Systems: All components shall be lead free per Federal Act S.3874, Reduction of Lead in Drinking Water Act.

### PART 2 - PRODUCTS

#### 2.1 FLOOR DRAINS AND SINKS

- A. Floor drains and sinks shall be in the form of a receptor with grate/strainer set flush with the surrounding floor.
- B. Provide floor drains and sinks as shown and specified on the drawings as well as required by code.

#### 2.2 ROOF DRAINS

- A. Provide roof drains as shown and specified on the drawings as well as required by code.

#### 2.3 BACKFLOW PREVENTERS

- A. Provide backflow preventers as shown and specified on the drawings as well as required by code.

#### 2.4 DIELECTRIC FITTINGS (CONNECTIONS BETWEEN DISSIMILAR METALS)

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.

- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.
- C. Aluminum, iron, steel, brass, copper, bronze, and stainless steel are commonly used and require isolation from each other with the following exceptions:
  - 1. Iron, steel, and stainless steel connected to each other.
  - 2. Brass, copper, and bronze connected to each other.
  - 3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
  - 1. Dielectric waterway rated for 300 psi CWP and 225°F.
  - 2. Acceptable Manufacturers: Elster Group ClearFlow fittings, Victaulic Series 47, Grinnell Series 407, Matco-Norca.
- F. Flanged Joints (any size):
  - 1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
  - 2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
  - 3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
  - 4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
  - 5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
  - 6. Acceptable Manufacturers: EPCO, Central Plastics, Pipeline Seal and Insulator, F. H. Maloney, or Calpico.

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND APPLICATION

- A. Coordinate construction to receive drains at required invert elevations.
- B. Install all items per manufacturer's instructions.
- C. Floor Drains and Floor Sinks:

1. Drains in upper floors shall have a flashing of EPDM or similar membrane sheet. The sheet shall be at least 36" X 36" square with the drain in the center. Clamp membrane in auxiliary clamping ring of floor drain. Membrane is not required if upper floor construction is single pour, cast-in-place concrete.
2. Use alternate sealing method when installing drains in existing floor slabs.
3. Coordinate sloping requirements with the architectural plans and specifications.
4. Top of floor drain and sinks grate/strainer shall not extend above the finished floor elevation.
5. Top of floor drain and sink grate/strainer shall not extend above the finished floor elevation. Grate/strainer shall be installed flush with surrounding finished floor. Should the Plumbing Contractor believe this presents a conflict with code, the issue should be evaluated before installation of the floor drain or sink begins. Proceeding with installing a floor drain or sink raised above the finished floor without prior approval will result in the Contractor being required to remove the drain or sink in question and reinstall it at the approved elevation.

D. Roof Drains:

1. Roof drains shall have bearing pans.
2. Provide auxiliary support steel under drains as required to prevent movement of the drain.
3. All roof drains shall have underdeck clamps.
4. Drains in built-up roofing systems shall have a 36" x 36", 3 lb density lead sheet flashing.

E. Backflow Preventer:

1. Provide an air gap fitting and piping to drain. On 2-1/2" and larger units, install a tail piece from air gap fitting to drain to prevent water from spraying out of drain air gap receptor. Maintain air gap distance required by Code.
2. Units shall be field tested and tagged in accordance with manufacturer's instructions and applicable codes by a certified tester before initial operation.
3. Install unit between 12" and 60" above finish floor.

END OF SECTION 22 10 30

## SECTION 22 14 29 - SUMP PUMPS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Sump Pumps. Contractor note: Only applies to Lincoln.

#### 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 22 05 00.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Pumps with motors operating above the RPM the pump curves are based on shall have impellers trimmed to deliver GPM and head scheduled.
- D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

### PART 2 - PRODUCTS

#### 2.1 GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Motors shall comply with Section 22 05 13.
- F. The discharge pipe sizes shall meet or exceed the scheduled pump.

#### 2.2 SUMP PUMPS

- A. Provide pumps as specified on the drawings.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.

- B. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings and accessories.
- C. Support piping so weight of piping is not supported by pumps.
- D. Mount control panel on adjacent wall within required distance for cables and wiring. Provide unistrut mounting frame for the control panel if wall space is not available. Properly anchor frame to floor.
- E. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
- F. Pumps shall be factory aligned. If alignment is not satisfactory, as determined by the Architect/Engineer, manufacturer shall provide a factory trained representative to field align the shafts.
- G. Sump pumps that discharge to storm shall be installed with the top of the sump basin 2" above floor level. A 2" high x 4" wide concrete curb around the perimeter of the basin lid may be used in lieu of raising the entire sump basin.
- H. Set submersible sump pumps on basin/pit floor. Make direct connections to storm drainage piping.
- I. Install sump pump basins and connect to drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

END OF SECTION 22 14 29

## SECTION 23 05 00 - BASIC HVAC REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 23 Sections. Also refer to Division 1 - General Requirements.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

#### 1.2 SCOPE OF WORK

- A. This Specification and the associated drawings govern the furnishing, installing, testing and placing into satisfactory operation the Mechanical Systems.
- B. Each Contractor shall provide all new materials indicated on the drawings and/or in these specifications, and all items required to make the portion of the Mechanical Work a finished and working system.
- C. All work will be awarded under a single General Contract. The division of work listed below is for the Contractor's convenience and lists normal breakdown of the work.
- D. Scope of Work:
  - 1. Plumbing Work shall include, but is not necessarily limited to:
    - a. Refer to Section 22 05 00.
  - 2. Heating Work shall include, but is not necessarily limited to:
    - a. Furnish and install steam-to-water heat exchanger and all associated accessories, with connection to existing steam system.
    - b. Furnish and install a complete heating water system including pumps, piping, insulation, air control equipment, terminal heating equipment, and specialties. Make final connections to all coils, including those furnished by others.
    - c. Furnish and install a complete steam distribution system including piping, insulation, terminal heating equipment, traps, and specialties. Make final connections to all coils, including those furnished by others.
    - d. Furnish and install an air-cooled chiller on grade with a remote evaporator.
      - 1) Flinn: Evaporator to be located in the storage room adjacent to the boiler mechanical room.
      - 2) Washington and Lincoln: Evaporator to be located in the adjacent boiler mechanical room.
    - e. Furnish and install ceiling-mounted fan coil units/blower coil units.

- f. Furnish and install a condensate pump with fan coil unit/blower coils unit as defined on drawings.
  - g. Furnish and install floor-mounted fan coil units.
  - h. Furnish and install cabinet heaters.
  - i. Furnish and install fin tube radiation heaters.
  - j. Furnish and install DX mini-split system where indicated on plan.
  - k. Furnish and install a complete chilled water system including pumps, piping, insulation, air control equipment, terminal cooling equipment, and specialties. Make final connections to all coils, including those furnished by others.
  - l. Furnish and install refrigerant piping, accessories, and final charge of refrigerant.
  - m. Furnish and install vacuum condensate piping reconnecting to the existing vacuum pumping system. (Flinn)
  - n. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
3. Air Conditioning and Ventilating Work shall include, but is not necessarily limited to:
- a. Furnish and install a custom indoor dedicated outdoor air handling unit (DOAS-4) in the basement Area C plan. (Flinn)
  - b. Furnish and install packaged indoor dedicated outdoor air handling units (DOAS) in basement and lower level areas. (Washington and Lincoln)
  - c. Furnish and install a packaged indoor dedicated outdoor air handling unit designed for pool applications. (Lincoln)
  - d. Furnish and install package rooftop air handling units. Provide complete with curbs (Flinn). Provide with curbs at duct penetrations only; unit to sit on raised steel support structure provided by Structural Contractor (Washington and Lincoln).
  - e. Furnish and install package rooftop dedicated outdoor air units. Provide complete with curbs (Flinn). Provide with curbs at duct penetrations only, unit to sit on raised steel support structure provided by structural contractor (Washington and Lincoln).
  - f. Furnish and install a kitchen makeup air unit. (Flinn)
  - g. Furnish and install air-cooled condensing units and curbs.
  - h. Furnish and install complete supply air ductwork systems including all fittings, insulation, and outlets.
  - i. Furnish and install complete return/exhaust air ductwork systems including all fittings, insulation, and inlets.
  - j. Furnish and install complete exhaust ductwork systems including all fittings, insulation, inlets, and fans.
  - k. Furnish and install all temperature control systems.
  - l. Furnish and install all fire dampers where noted on plan and as required by code.
  - m. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
4. Temperature Control Work shall include, but is not necessarily limited to:
- a. Furnish and install a complete temperature control system as specified in Section 23 09 00.
  - b. Temperature control system shall consist of a full Direct Digital Control (DDC) system including all accessories, sensors, and programming.
  - c. Furnish automatic control valves and dampers for installation by others.
  - d. Coordinate installation with JACE system specific to Rockford Public Schools.

- e. Furnish and install firestopping systems for penetrations of fire-rated construction associated with this Contractor's work.
5. Testing, Adjusting, and Balancing Work shall include, but is not necessarily limited to:
- a. Furnish complete testing, adjusting, and balancing as specified in Section 23 05 93, including, but not limited to, air systems, hydronic systems, plumbing systems, and verification of control systems.

### 1.3 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations for a school, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours and around the school schedule. The Owner reserves the right to determine when restricted construction hours will be required.
- B. Schedule overtime for the following work:
  - 1. Work in mechanical rooms when school is in session.
  - 2. Work on roof when school is in session.
  - 3. Specific tunnel work when school is in session (Flinn).
  - 4. Site work for chiller installation (Flinn).

### 1.4 ALTERNATES

- A. Alternate Bid No. 1: East High School - All work associated with installing air conditioning within the existing air handling units that serve the Fieldhouse as shown on the drawings.
- B. Alternate Bid No. 2: East High School - All work associated with replacing the existing HVAC system within the 1980 Addition as shown on the drawings. Base Bid will leave this area as existing to remain.

### 1.5 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL & CONTROL CONTRACTORS

- A. Definitions:
  - 1. "Mechanical Contractors" refers to the following:
    - a. Plumbing Contractor.
    - b. Heating Contractor.
    - c. Air Conditioning and Ventilating Contractor.
    - d. Temperature Control Contractor.
    - e. Testing, Adjusting, and Balancing Contractor.
  - 2. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case the devices are usually single phase and are usually connected to the motor power wiring through a manual motor starter having "Manual-Off-Auto" provisions.

3. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
4. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. Generally, where the motor power wiring exceeds 120 volts, a control transformer is used to give a control voltage of 120 volts.
5. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring which directly powers or controls a motor used to drive equipment such as fans, pumps, etc.
  - a. This wiring will be from a 120 volt source and may continue as 120 volt, or be reduced in voltage (24 volt) in which case a control transformer shall be furnished as part of the temperature control wiring.
6. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
7. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230
277	265
480	460

B. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractor's responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors and the like. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals reviewed. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall provide complete electrical power/controls wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.
3. All electrical work shall conform to the National Electrical Code. All provisions of the Electrical Specifications concerning wiring, protection, etc., apply to wiring provided by the Mechanical Contractor unless noted otherwise.
4. All Contractors shall establish utility elevations prior to fabrication and shall coordinate their material and equipment with other trades. When a conflict arises, priority is as follows:

- a. Light fixtures.
- b. Gravity flow piping, including steam and condensate.
- c. Electrical busduct.
- d. Sheet metal.
- e. Electrical cable trays, including access space.
- f. Sprinkler piping and other piping.
- g. Electrical conduits and wireway.

C. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment provided by the Mechanical Contractor, for example:
  - a. Chillers.
  - b. Computer Room Air Conditioning Units.
  - c. Condensate Return Stations.
  - d. Condensing Units.
  - e. Makeup Air Units.
  - f. Gas Trains.
  - g. Package Air Handling Units.
  - h. Packaged Rooftop Units.
2. Assumes all responsibility for the Temperature Control wiring, when the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
3. Temperature Control Contractor's Responsibility:
  - a. Wiring of all devices needed to make the Temperature Control System functional.
  - b. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Subcontractor .
  - c. Coordinating equipment locations (such as relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

D. Electrical Contractor's Responsibility:

1. Provides all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor on the Mechanical Drawings or Specifications.
2. Installs and wires all remote control devices furnished by the Mechanical Contractor or Temperature Control Subcontractor when so noted on the Electrical Drawings.
3. Provides motor control and temperature control wiring, where so noted on the drawings.
4. Furnishes, installs and connects all relays, etc., for automatic shutdown of certain fans upon actuation of the Fire Alarm System as indicated and specified in Division 28.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.6 COORDINATION DRAWINGS

### A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Technology trades shall include, but are not limited to, technology equipment, racks, conduit 1.5" (40 mm) and larger, conduit racks, cable trays, ladder rack, pull boxes, raceway, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - d. Maintenance clearances and code-required dedicated space shall be included.
  - e. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
  - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

### B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

#### 1.7 QUALITY ASSURANCE

##### A. Contractor's Responsibility Prior to Submitting Pricing Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guidelines, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Design Team any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Design Team will be done at the Contractor's risk.

##### B. Qualifications:

1. Only products of reputable manufacturers are acceptable.
2. All Contractors and subcontractors shall employ only workers skilled in their trades.

##### C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the Rockford, Illinois Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all State Codes.

3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after letting of the contract, to comply with codes or requirements of Inspectors, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by the State, Municipal and/or other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.

E. Utility Company Requirements:

1. Secure from the appropriate private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. Make application for and pay for service connections, such as gas.
4. Make application for and pay for all meters and metering systems required by the utility company.

F. Examination of Drawings:

1. The drawings for the mechanical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of pipes and ducts to best fit the layout of the job.
3. Scaling of the drawings is not sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in indicated arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as fittings, boxes, valves, unions, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.

6. If an item is either on the drawings or in the specifications, it shall be included in this contract.
7. Determination of quantities of material and equipment required shall be made by the Contractor from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater number shall govern.
8. Where used in mechanical documents, the word "furnish" shall mean supply for use, the word "install" shall mean connect complete and ready for operation, and the word "provide" shall mean to supply for use and connect complete and ready for operation.
  - a. Any item listed as furnished shall also be installed, unless otherwise noted.
  - b. Any item listed as installed shall also be furnished, unless otherwise noted.

G. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any materials or fabricating any supports, pipes or ducts.

H. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing AutoCAD MEP.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

## 1.8 SUBMITTALS

- A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals List:

Referenced Specification Section	Submittal Item
23 05 00	Owner Training Agenda
23 05 03	Fire Seal Systems
23 05 13	Motors
23 05 93	Testing, Adjusting, and Balancing
23 09 00	Controls
23 09 13	Instrumentation
23 21 23	HVAC Pumps
23 25 00	Chemical Treatment Systems
23 31 00	Ductwork Layout Drawings
23 33 00	Fire Dampers
23 34 16	Centrifugal Fans
23 34 23	Power Ventilators
23 37 00	Grilles, Registers, and Diffusers
23 37 00	Louvers
23 57 00	Heat Exchangers
23 64 30	Air Cooled Water Chillers
23 72 00	Energy Recovery Devices
23 73 23	Custom Air Handling Units
23 74 13	Rooftop Modular Air Handling Units
23 74 16.12	Packaged Rooftop Air Conditioning Units - 25T and Below
23 74 16.13	Packaged Rooftop Air Conditioning Units - Above 25T
23 74 23.13	Gas Fired Make-Up Air Units
23 81 26	Split System Air Conditioning Units
23 82 00	Terminal Heat Transfer Equipment
23 82 16	Coils
23 84 19	Pool Dehumidification Units

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:
  - a. Date
  - b. Project title and number
  - c. Contractor's name and address
  - d. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - e. Description of items submitted and relevant specification number
  - f. Notations of deviations from the contract documents
  - g. Other pertinent data
2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:
  - a. Date
  - b. Project title and number
  - c. Architect/Engineer
  - d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses

- f. Division of work (e.g., plumbing, heating, ventilating, etc.)
  - g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; electrical power criteria (e.g., voltage, phase, amps, horsepower, kW, etc.) wiring and control diagrams; Short Circuit Current Rating (SCCR); dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).
  - d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.

- e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
- 7. Schedule submittals to expedite the project. Coordinate submission of related items.
  - 8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
  - 9. Reproduction of contract documents alone is not acceptable for submittals.
  - 10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
  - 11. Submittals not required by the contract documents may be returned without review.
  - 12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
  - 13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
  - 14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

- 1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
- 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
- 3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
- 4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 23 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 23 XX XX.description.YYYYMMDD
- 5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

## 1.9 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
  - 1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
  - 2. Submit in Excel format.
  - 3. Support values given with substantiating data.
- C. Preparation:
  - 1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
  - 2. Break down all costs into:
    - a. Material: Delivered cost of product with taxes paid.
    - b. Labor: Labor cost, excluding overhead and profit.
  - 3. Itemize the cost for each of the following:
    - a. Overhead and profit.
    - b. Bonds.
    - c. Insurance.
    - d. General Requirements: Itemize all requirements.
  - 4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
    - a. Each piece of equipment requiring shop drawings (e.g., each air handling unit, pump, exhaust fan, etc.). Use the equipment nomenclature (AHU-1, P-1, EF-1, etc.) on the Schedule of Values.
    - b. Each type of small unitary equipment (e.g., FCUs, UHs, CABs, etc.). Multiple units of the same type can be listed together, provided quantities are also listed so unit costs can be determined.
    - c. Each piping system (chilled water, heating water, steam, condensate, etc.). In addition, for larger projects, break down the material and labor for each piping system based on geography (building, floor, and/or wing).
    - d. Each duct system (supply, return, relief, outside air, etc.) listed separately for each unit they serve (AHU-1 supply air ductwork, AHU-1 return air ductwork, etc.).
    - e. Pipe insulation with separate material and labor line items for each piping system listed above.
    - f. Duct insulation with separate material and labor line items for each duct system listed above.
    - g. Temperature controls broken down into material and labor for the following:
      - 1) Engineering
      - 2) Controllers, devices, sensors, etc.

- 3) Control valves
- 4) Control dampers
- 5) Conduit
- 6) Wiring
- 7) Programming
- 8) Commissioning

- h. Air balancing
- i. Water balancing
- j. Record drawings
- k. Punchlist and closeout

D. Update Schedule of Values when:

1. Indicated by Architect/Engineer.
2. Change of subcontractor or supplier occurs.
3. Change of product or equipment occurs.

1.10 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

1.11 EQUIPMENT SUPPLIERS' INSPECTION

- A. The following equipment shall not be placed in operation until a competent installation and service representative of the manufacturer has inspected the installation and certified that the equipment is properly installed, adjusted and lubricated; that preliminary operating instructions have been given; and that the equipment is ready for operation:
  1. Air Cooled Chiller
  2. Base Mounted Pumps
  3. Computer Room Units
  4. Condensing Units
  5. Gas Fired Makeup Air Units
  6. Fire Seal Systems
  7. Water Chillers
- B. Contractor shall arrange for and obtain supplier's on-site inspection(s) at proper time(s) to assure each phase of equipment installation and/or connection is in accordance with the manufacturer's instructions.
- C. Submit copies of start-up reports to the Architect/Engineer and include copies of Owner's Operation and Maintenance Manuals.

1.12 PRODUCT DELIVERY, STORAGE, HANDLING & MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage. Keep materials clean, dry and free from harmful conditions. Immediately remove any materials that become wet or that are suspected of becoming contaminated with mold or other organisms.
- B. Keep all bearings properly lubricated and all belts properly tensioned and aligned.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Mechanical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.13 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.14 WARRANTY

- A. Provide one-year warranty, unless otherwise noted, to the Owner for all fixtures, equipment, materials, and workmanship.
- B. The warranty period for all work in this Division of the specifications shall commence on the date of final acceptance, unless a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements shall extend to correction, without cost to the Owner, of all Work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage resulting from defects or nonconformance with contract documents.

PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locators can be found at the following website (<https://call811.com/>) or by calling 811.
2. The Contractor shall do all excavating, filling, backfilling and compacting associated with the work.

B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. Where excavations are made in error below foundations, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer, shall be placed in such excess excavations. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment, or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workers.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.
8. Where satisfactory bearing soil for foundations is not found at the indicated levels, the Architect/Engineer or their representative shall be notified immediately, and no further work shall be done until further instructions are given by the Architect/Engineer or their representative.

C. Dewatering:

1. Contractor shall furnish, install, operate, and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Use great care in making installations near underground obstruction.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.
2. Provide all necessary sand and/or CA6 for backfilling.
3. Native soil materials may be used as backfill if approved by the Geotechnical Engineer.
4. Dispose of the excess excavated earth as directed.
5. Backfill materials (native soil material, sand, and/or CA6) shall be suitable for required compaction, clean and free of perishable materials and stones greater than 4 inches (100 mm) in diameter. Water shall not be permitted to rise in unbackfilled trenches. No material shall be used for backfilling that contains frozen earth, debris, or earth with a high void content.
6. Backfill all trenches and excavations immediately after installing pipes or removal of forms, unless other protection is provided.
7. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Fill and backfill materials shall be spread in 6 inch (150 mm) uniform horizontal layers with each layer compacted separately to required density.
8. Lay all piping on a compacted bed of CA6 at least 3 inches (80 mm) deep. Backfill around pipes with CA6, 6 inch (150 mm) layers, and compact each layer.
9. Use native soil material (if approved), sand, or CA6 for backfill up to grade for all piping under slabs or paved areas. All other piping shall have sand or CA6 backfill to 6 inches (150 mm) above the top of the pipe.
10. Place all backfill above the sand/CA6 in uniform layers not exceeding 6 inches (150 mm) deep. Each layer shall be placed, then carefully and uniformly tamped, to eliminate lateral or vertical displacement.
11. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content determined by AASHTO T-99 or ASTM D-698 test.

F. Surface Restoration:

1. Where trenches are cut through graded, planted, or landscaped areas, the areas shall be restored to the original condition. Replace all planting removed or damaged to its original condition. A minimum of 6 inches (150 mm) of topsoil shall be applied where disturbed areas are to be seeded or sodded.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

- A. The Contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Installing hard or suspended ceilings and soffits.
- B. The Architect/Engineer will have the opportunity to review the installation and provide a written report noting deficiencies requiring correction. The Contractor's schedule shall account for these reviews and show them as line items in the approved schedule.
- C. Above-Ceiling Final Observation
  1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
    - a. Pipe insulation is installed and fully sealed.
    - b. Pipe and duct wall penetrations are sealed.
    - c. Pipe identification and valve tags are installed.
    - d. Main, branch and flexible ducts are installed.
    - e. Diffusers, registers and grilles are installed and connected to ductwork.
    - f. Terminal air box reheat coil piping or wiring is complete.
    - g. Terminal air box control wiring is complete and all control boxes are closed.
  2. In order to prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to 7 days elapsing, the Architect/Engineer may not recommend further payments to the contractor until such time as full access has been provided.

### 3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  1. In order to prevent the Final Jobsite Observation from occurring too early, the Contractor is required to review the completion status of the project and certify that the job is ready for the final jobsite observation.
  2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review.
  3. Upon Contractor certification that the project is complete and ready for a final observation, the Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  4. It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineer's additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.
- C. Before final payment is authorized, this Contractor must submit the following:
  1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including marked-up drawings and specifications.

3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of This Contractor and shall be signed by the Owner's representatives.
4. Start-up reports on all equipment requiring a factory installation inspection or start-up.
5. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site; receipt by Architect/Engineer required prior to final payment approval.

### 3.5 OPERATION AND MAINTENANCE MANUALS

#### A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

#### B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div23.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div23.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.
3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Refer to Section 23 09 00 for additional requirements for Temperature Control submittals.
5. Copy of final approved test and balance reports.
6. Copies of all factory inspections and/or equipment startup reports.
7. Copies of warranties.
8. Schematic electrical power/controls wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
9. Dimensional drawings of equipment.
10. Capacities and utility consumption of equipment.
11. Detailed parts lists with lists of suppliers.
12. Operating procedures for each system.
13. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
14. Repair procedures for major components.
15. List of lubricants in all equipment and recommended frequency of lubrication.
16. Instruction books, cards, and manuals furnished with the equipment.

3.6 INSTRUCTING THE OWNER'S REPRESENTATIVES

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of all systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by **FACTORY PERSONNEL** in the care, maintenance, and operation of the equipment and systems.
- C. The instructions shall include:
  1. Explanation of all system flow diagrams.
  2. Explanation of all air handling systems.
  3. Temperature control system operation including calibration, adjustment and proper operating conditions of all sensors.
  4. Maintenance of equipment.
  5. Start-up procedures for all major equipment.
  6. Explanation of seasonal system changes.
  7. Description of emergency system operation.
- D. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can attend if desired.

E. Minimum hours of instruction for each item shall be:

1. Heating Water System - 2 hours.
2. Chilled Water System - 2 hours.
3. Steam/Condensate System - 2 hours.
4. Refrigeration System - 1 hours.
5. Chemical Treatment System - As defined in Section 23 25 00.
6. Air Handling System(s) - 8 hours.
7. Exhaust System(s) - 1 hours.
8. Temperature Controls - As defined in Section 23 09 00.

F. The Contractor shall prepare a detailed, written training agenda and submit it to the Architect/Engineer a minimum of two weeks prior to the formal training for approval. The written agenda shall include specific training points within the items described above. For example: how to adjust setpoints, troubleshooting, proper start-up, proper shut-down, seasonal changes, draining, venting, changing filters, changing belts, etc. Failure to provide and follow an approved training agenda may result in additional training required at the expense of the Contractor.

G. Operating Instructions:

1. Contractor is responsible for all instructions to the Owner's representatives for the mechanical and control systems.
2. If the Contractor does not have staff that can adequately provide the required instructions the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.7 SYSTEM STARTING AND ADJUSTING

- A. The mechanical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes calibration and adjustments of all controls, noise level adjustments and final comfort adjustments as required.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper motor rotation, electrical power voltage is within equipment limitations, equipment controls maintain pressures and temperatures within acceptable ranges, all filters and protective guards are in-place, acceptable access is provided for maintenance and servicing, and equipment operation does not pose a danger to personnel or property.
- C. Operate all HVAC systems continuously for at least one week prior to occupancy to bring construction materials to suitable moisture levels. Areas with mechanical cooling shall be maintained below 60% RH.
- D. Contractor shall adjust the mechanical systems and controls at season changes during the one year warranty period, as required, to provide satisfactory operation and to prove performance of all systems in all seasons.
- E. All operating conditions and control sequences shall be tested during the start-up period. Test all interlocks, safety shutdowns, controls, and alarms.

- F. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.8 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of mechanical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings to indicate revisions to piping and ductwork, size and location, both exterior and interior; including locations of coils, dampers, other control devices, filters, and other units requiring periodic maintenance or repair; actual equipment locations, dimensioned from column lines; actual inverts and locations of underground piping; concealed equipment, dimensioned from column lines; mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (e.g., traps, strainers, expansion compensators, tanks, etc.); Change Orders; concealed control system devices.
- D. Refer to Section 23 09 00 for additional requirements for Temperature Control documents.
- E. Mark specifications to show approved substitutions; Change Orders, and actual equipment and materials used.
- F. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- G. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.

### 3.9 PAINTING

- A. This Contractor shall paint the following items:
  - 1. All exposed chilled water, heating water and condensate piping below ceiling within school. Color selection shall be mainly white, verify with architect
- B. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available.
- C. Equipment cabinets, casings, covers, metal jackets, etc., in equipment rooms or concealed spaces, shall be furnished in standard or prime finish, free from scratches, abrasions, chips, etc.

- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chips, etc. If color option is specified or is standard to the unit, this Contractor shall, before ordering, verify with the Architect/Engineer the color preference and furnish this color.
- E. Paint all outdoor uninsulated steel piping the color selected by Owner or Architect/Engineer.
- F. Paint all outdoor exposed natural gas piping the color selected by Owner or Architect/Engineer. All horizontal gas piping on the roof shall be primarily white. All vertical piping offset on roof shall match the wall color, verify with architect/engineer.

### 3.10 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project. Clean all foreign paint, grease, oil, dirt, labels, stickers, and other foreign material from all equipment.
- B. Clean all drain pans and areas where moisture is present. Immediately report any mold, biological growth, or water damage.
- C. Remove all rust, scale, dirt, oils, stickers and thoroughly clean exterior of all exposed bare metal ductwork, piping, hangers, and accessories.
- D. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### 3.11 SPECIAL REQUIREMENTS

- A. Contractor shall coordinate the installation of all equipment, valves, dampers, operators, etc., with other trades to maintain clear access area for servicing.
- B. All equipment shall be installed in such a way to maximize access to parts needing service or maintenance. Review the final field location, placement, and orientation of equipment with the Owner's designated representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's designated representative will result in removal and reinstallation of the equipment at the Contractor's expense.

### 3.12 IAQ MAINTENANCE FOR OCCUPIED FACILITIES UNDER CONSTRUCTION

- A. Contractors shall make all reasonable efforts to prevent construction activities from affecting the air quality of the occupied areas of the building or outdoor areas near the building. These measures shall include, but not be limited to:
  - 1. All contractors shall endeavor to minimize the amount of contaminants generated during construction. Methods to be employed shall include, but not be limited to:
    - a. Minimizing the amount of dust generated.
    - b. Reducing solvent fumes and VOC emissions.
    - c. Maintain good housekeeping practices, including sweeping and periodic dust and debris removal. There should be no visible haze in the air.

- d. Protect stored on-site and installed absorptive materials from moisture damage.
2. Request that the Owner designate an IAQ representative.
3. Review and receive approval from the Owner's IAQ representative for all IAQ-related construction activities and negative pressure containment plans.
4. Inform the IAQ representative of all conditions that could adversely impact IAQ, including operations that will produce higher than normal dust production or odors.
5. Schedule activities that may cause IAQ conditions that are not acceptable to the Owner's IAQ representative during unoccupied periods.
6. Request copies of and follow all of the Owner's IAQ and infection control policies.
7. Unless no other access is possible, the entrance to construction site shall not be through the existing facility.
8. To minimize growth of infectious organisms, do not permit damp areas in or near the construction area to remain for over 24 hours.
9. In addition to the criteria above, provide measures as recommended in the SMACNA "IAQ Guidelines for Occupied Buildings Under Construction".
10. If permanently installed air handlers are used to serve both construction and occupied areas, all return grilles throughout construction areas shall be sealed to prevent air from construction areas being supplied to occupied areas.
11. If permanently installed air handlers are used during construction to serve only construction areas and do not supply air to adjacent occupied areas, MERV 8 filtration media shall be used to protect each return air grille or opening. The intent of this will be to prevent construction dust and debris from entering any return or supply air ductwork in the facility. All filtration media shall be replaced immediately prior to occupancy.

### 3.13 MAINTAINING CLEAN DUCTWORK THROUGHOUT CONSTRUCTION

- A. Throughout the duration of construction, all ductwork shall be capped or sealed with sheet metal caps, polyethylene film, or other airtight protective to keep dust, dirt, and construction debris out of ducts. Similar means shall be used to seal air-side connections of HVAC equipment to include, but not limited to, air handling units, fans, terminal air boxes, fan coil units, cabinet heaters, blower coils, and the like.
- B. When air terminal devices are installed, contractors shall seal all supply, return, and exhaust grilles with polyethylene film or other airtight protective to keep dust, dirt, and construction debris out of ducts.
- C. Should HVAC equipment be started during construction, Contractor shall remove airtight protectives and shall install one-inch thick MERV 8 filter media over all return and exhaust grilles to prevent dust, dirt, and construction debris from entering ductwork. Filter media shall cover the entire grille face and shall be secured such that air cannot bypass filter media.
- D. Should filter media become laden with dust and dirt, Contractor shall replace filter media with new media to prevent damage to air distribution system and equipment.
- E. The following steps shall be taken during testing, adjusting, and balancing of each air system:
  1. All construction activities in all spaces served by the air system shall stop.
  2. All airtight protectives and temporary filter media shall be removed from all portions of the air system.

3. Testing, adjusting, and balancing work shall not commence until all construction activity is stopped and all airtight protectives and temporary filter media is removed.
  4. Once testing, adjusting, and balancing work is complete for the air system, airtight protectives or temporary filter media shall be installed over all ductwork openings and air terminals on the air system prior to resuming construction activities in any spaces served by the air system.
- F. The Owner shall agree the building is sufficiently clean prior to the removal of any filtration media and airtight protectives from air terminal devices.

## READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations fire sealed and labeled in accordance with specifications.
2. All air handling units operating and balanced.
3. All fans shall be operating and balanced.
4. All pumps, and chillers operating and balanced.
5. All miscellaneous mechanical systems (unit heaters, fan coil units, cabinet heaters, etc.) operating.
6. All temperature control systems operating, programmed and calibrated.
7. Pipe insulation complete, pipes labeled and valves tagged.
8. Fire damper and fire/smoke damper access doors labeled in accordance with specifications.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 23 05 00

## SECTION 23 05 05 - HVAC DEMOLITION FOR REMODELING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Mechanical demolition.
- B. Cutting and Patching.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment shall be as specified in individual Sections.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE GENERAL SCOPE OF WORK AND DO NOT SHOW EVERY PIPE, DUCT, OR PIECE OF EQUIPMENT THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE AND VERIFY CONDITIONS PRIOR TO SUBMITTING A BID.
- B. Where walls, ceilings, etc., are shown as being removed on general drawings, the Contractor shall remove all mechanical equipment, devices, fixtures, piping, ducts, systems, etc., from the removed area.
- C. Where ceilings, walls, partitions, etc., are temporarily removed and replaced by others, This Contractor shall remove, store, and replace equipment, devices, fixtures, pipes, ducts, systems, etc.
- D. Verify that abandoned utilities serve only abandoned equipment or facilities. Extend services to facilities or equipment that shall remain in operation following demolition.
- E. Coordinate work with all other Contractors and the Owner. Schedule removal of equipment to avoid conflicts.
- F. This Contractor shall verify all existing equipment sizes and capacities where equipment is scheduled to be replaced or modified, prior to ordering new equipment.
- G. Bid submittal shall mean the Contractor has visited the project site and verified existing conditions and scope of work.

### 3.2 PREPARATION

- A. Disconnect mechanical systems in walls, floors, and ceilings scheduled for removal.
- B. Provide temporary connections to maintain existing systems in service during construction. When work must be performed on operating equipment, use personnel experienced in such operations.
- C. Existing Heating System: Maintain existing system in service until new system is complete and ready for service. Drain system only to make switchovers and connections. Obtain permission from the Owner at least 48 hours before partially or completely draining system. Minimize outage duration.

### 3.3 DEMOLITION AND EXTENSION OF EXISTING MECHANICAL WORK

- A. Demolish and extend existing mechanical work under provisions of Division 2 and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned ducts and piping to source of supply and/or main lines.
- D. Remove exposed abandoned pipes and ducts, including abandoned pipes and ducts above accessible ceilings. Where piping or ducts are located above ceilings not being removed, cap both ends where accessible. Cut ducts flush with walls and floors, cap duct that remains, and patch surfaces. Cut pipes above ceilings, below floors and behind walls. Cap remaining lines. Repair building construction to match original. Remove all clamps, hangers, supports, etc. associated with pipe and duct removal.
- E. Disconnect and remove mechanical devices and equipment serving equipment that has been removed.
- F. Repair adjacent construction and finishes damaged during demolition and extension work.
- G. Maintain access to existing mechanical installations which remain. Modify installation or provide access panels as appropriate.
- H. Remove unused sections of supply and return air ductwork back to mains. Patch opening with sheet metal and seal airtight. Patch existing insulation to match existing. Where existing ductwork is to be capped and reused, locate the end cap within 6" of the last branch. End caps shall be 3" pressure class and seal class "A".
- I. Extend existing installations using materials and methods compatible with existing installations, or as specified.

### 3.4 CUTTING AND PATCHING

- A. This Contractor is responsible for all penetrations of existing construction required to complete the work of this project. Refer to Section 23 05 29 for additional requirements.
- B. Penetrations in existing construction should be reviewed carefully prior to proceeding with any work.

- C. Penetrations shall be neat and clean with smooth and/or finished edges. Core drill where possible for clean opening.
- D. Repair existing construction as required after penetration is complete to restore to original condition. Use similar materials and match adjacent construction unless otherwise noted or agreed to by the Architect/Engineer prior to start of work.
- E. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

### 3.5 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment which remain or are to be reused.
- B. Clean all systems adjacent to project which are affected by the dust and debris caused by this construction.
- C. MECHANICAL ITEMS REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL DISPOSE OF MATERIAL THE OWNER DOES NOT WANT TO REUSE OR RETAIN FOR MAINTENANCE PURPOSES.

### 3.6 SPECIAL REQUIREMENTS

- A. Review locations of all new penetrations in existing floor slabs or walls. Determine construction type and review for possible interferences. Bring all concerns to the attention of the Architect/Engineer before proceeding.

END OF SECTION 23 05 05

## SECTION 23 05 13 - MOTORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Single Phase and Three Phase Electric Motors.

#### 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 05 00. Include nominal efficiency and power factor for all premium efficiency motors. Efficiencies must meet or exceed the nominal energy efficiency levels presented below.
- B. Submit shop drawings for all three phase motors.
- C. Submit motor data with equipment when motor is installed by the manufacturer at the factory.
- D. Submit shaft grounding device for all motors as required.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof coverings. For extended outdoor storage, follow manufacturer's recommendations for equipment and motor.

#### 1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data including assembly drawings, bearing data including replacement sizes, and lubrication instructions.

#### 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in the manufacture of commercial and industrial motors and accessories, with a minimum of three years documented manufacturing experience.

### PART 2 - PRODUCTS

#### 2.1 MOTORS - GENERAL CONSTRUCTION AND REQUIREMENTS

- A. Refer to the drawings for required electrical characteristics. Voltage is generally specified and scheduled as distribution voltage. Motor submittals may be based on utilization voltage if it corresponds to the correct distribution voltage.

Distribution/Nominal Voltage	Utilization Voltage
120	115
208	200
240	230

Distribution/Nominal Voltage	Utilization Voltage
277	265
480	460

- B. Design motors for continuous operation in 40°C environment, and for temperature rise in accordance with ANSI/NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
- C. Visible Nameplate: Indicating horsepower, voltage, phase, hertz, RPM, full load amps, locked rotor amps, frame size, manufacturer's name and model number, service factor, power factor, insulation class.
- D. Electrical Connection: Boxes, threaded for conduit. For fractional horsepower motors where connection is made directly, provide conduit connection in end frame.
- E. Unless otherwise indicated, motors 3/4 HP and smaller shall be single phase, 60 hertz, open drip-proof or totally enclosed fan-cooled type.
- F. Unless otherwise indicated, motors 1 HP and larger shall be three phase, 60 hertz, squirrel cage type, NEMA Design Code B (low current in-rush, normal starting torque), open drip-proof or totally enclosed fan-cooled type.
- G. Each contractor shall set all motors furnished by the contractor.
- H. All motors shall have a minimum service factor of 1.15.
- I. All motors shall have ball or roller bearings with a minimum L-10 fatigue life of 150,000 hours in direct-coupled applications and 50,000 hours for belted applications. Belted rating shall be based on radial loads and pulley sizes called out in NEMA MG1-14.43.
- J. Bearings shall be sealed type for 10 HP and smaller motors. Bearings shall be regreasable type for larger motors.
- K. Aluminum end housings are not permitted on motors 15 HP or larger.
- L. Motor Driven Equipment:
  1. No equipment shall be selected or operate above 90% of its motor nameplate rating. Motor size may not be increased to compensate for equipment with efficiency lower than that specified.
  2. If a larger motor than specified is required on equipment, the contractor supplying the equipment is responsible for all additional costs due to larger starters, wiring, etc.
- M. Provide all belted motors with a means of moving and securing the motor to tighten belts. Motors over 2 HP shall have screw type tension adjustment. Motors over 40 HP shall have dual screw adjusters. Slide bases shall conform to NEMA standards.

- N. Motors for fans and pumps 1/12 HP or greater and less than 1 HP shall be electronically-commutated motors or shall have a minimum motor efficiency of 70% when rated in accordance with DOE 10 CFR 431. These motors shall also have the means to adjust motor speed for either balancing or remote control. Belt-driven fans may use sheave adjustments for airflow balancing in lieu of varying motor speed.

2.2 ELECTRICALLY COMMUTATED MOTORS (ECM)

- A. Motor shall be variable speed, constant torque, brushless DC motor for direct-drive applications. Electronics shall be encapsulated for moisture protection and shall integral surge protection. Motor shall be pre-wired for specific voltage and phase.
- B. Motor frame shall be NEMA 48; UL recognized components shall be provided for the motor construction.
- C. All EC motors shall be a minimum of 85% efficient at all speeds.
- D. Motors shall be permanently lubricated; utilize ball bearings to match with the connected driven equipment.
- E. Provide motor with on-board motor control module. Motor speed shall be limited to provide electronic over current protection. Starter shall provide soft start to reduce inrush current and shall be controllable from 20% to 100% of full rated speed.
- F. Operational mode shall be as scheduled and shall be one of the following:
  - 1. Constant Flow
  - 2. Constant Temperature
  - 3. Constant Pressure

2.3 PREMIUM EFFICIENCY MOTORS (INCLUDING MOST 3-PHASE GENERAL PURPOSE MOTORS)

- A. All motors, unless exempted by EPA legislation that became federal law on December 19, 2010, shall comply with the efficiencies listed in that standard, which are reprinted below. These match the 2010 NEMA premium efficiency ratings. All ratings listed are nominal full load efficiencies, verified in accordance with IEEE Standard 112, Test Method B. Average expected (not guaranteed minimum) power factors shall also be at least the following:

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
1.0	82.5	85.5	77.0	82.5	85.5	77.0
1.5	86.5	86.5	84.0	87.5	86.5	84.0
2.0	87.5	86.5	85.5	88.5	86.5	85.5
3.0	88.5	89.5	85.5	89.5	89.5	86.5
5.0	89.5	89.5	86.5	89.5	89.5	88.5
7.5	90.2	91.0	88.5	91.0	91.7	89.5
10.0	91.7	91.7	89.5	91.0	91.7	90.2
15.0	91.7	93.0	90.2	91.7	92.4	91.0

HP	Full-Load Efficiencies %					
	Open Drip-Proof			Totally Enclosed Fan Cooled		
	1200 rpm	1800 rpm	3600 rpm	1200 rpm	1800 rpm	3600 rpm
20.0	92.4	93.0	91.0	91.7	93.0	91.0
25.0	93.0	93.6	91.7	93.0	93.6	91.7
30.0	93.6	94.1	91.7	93.0	93.6	91.7

B. Motor nameplate shall be noted with the above ratings.

#### 2.4 MOTORS ON VARIABLE FREQUENCY DRIVES

- A. All motors driven by VFDs shall be premium efficiency type.
- B. Motors shall be designed for use with VFDs in variable torque applications with 1.15 service factor. Motors shall not be equipped with auxiliary blowers.
- C. Motors driven by VFDs shall have Class F or H insulation and be designated by the motor manufacturer to be suitable for inverter duty service in accordance with NEMA MG 1 Section IV, "Performance Standards Applying to All Machines," Part 31 "Definite-Purpose Inverter-Fed Polyphase Motors.
- D. All 480-volt motors controlled by VFDs shall be equipped with an alternate discharge path, such as a shaft grounding ring or grounding brush, to divert adverse shaft currents from the motor bearings on the drive end of the motor shaft. Motor shafts 2"50 mm and larger require shaft grounding on the drive end and the non-drive end. This Contractor shall ensure (via field observation and measurement) that the shaft is effectively grounded upon startup.
1. Providing grounding rings internal to the motor housing is an acceptable solution, provided the motor is affixed with a label clearly indicating the presence of a grounding assembly. The grounding ring shall be listed for 40,000 hours of motor service and shall be accessible via the drive endplate.
  3. The following critical motors shall also be equipped with shaft grounding kits:
    - a. Chilled water pumps
    - b. Heating water pumps
    - c. DOAS/RTU

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. All rotating shafts and/or equipment shall be completely guarded from all contact. Partial guards and/or guards that do not meet all applicable OSHA standards are not acceptable. Contractor is responsible for providing this guarding if it is not provided with the equipment supplied.

- B. For flexible coupled drive motors, mount coupling to the shafts in accordance with the coupling manufacturer's recommendations. Align shafts to manufacturer's requirements or within 0.002 inch per inch diameter of coupling hub.
- C. For belt drive motors, mount sheaves on the appropriate shafts per manufacturer's instructions. Use a straight edge to check alignment of the sheaves. Reposition sheaves as necessary so the straight edge contacts both sheave faces squarely. After sheaves are aligned, loosen the adjustable motor base so the belt(s) can be added, and tighten the base so the belt tension is in accordance with the drive manufacturer's recommendations. Frequently check belt tension and adjust if necessary during the first day of operation and again after 80 hours of operation.

END OF SECTION 23 05 13

SECTION 23 05 29 - HVAC SUPPORTS AND ANCHORS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Hangers, Supports, and Associated Anchors.
- B. Equipment Bases and Supports.
- C. Sleeves and Seals.
- D. Flashing and Sealing of Equipment and Pipe Stacks.
- E. Cutting of Openings.
- F. Escutcheon Plates and Trim.

1.2 WORK FURNISHED BUT INSTALLED UNDER OTHER SECTIONS

- A. Furnish sleeves and hanger inserts to General Contractor for placement into formwork.

PART 2 - PRODUCTS

2.1 HANGER RODS

- A. Hanger rods for single rod hangers shall conform to the following:

Pipe Size	Hanger Rod Diameter	
	Column #1	Column #2
2" and smaller	3/8"	3/8"
2-1/2" through 3-5/8"	1/2"	1/2"
4" and 5"	5/8"	1/2"
6"	3/4"	5/8"

Column #1: Steel pipe.

Column #2: Copper pipe.

- B. Rods for double rod hangers may be reduced one size. Minimum rod diameter is 3/8 inches.
- C. Hanger rods and accessories used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
- D. All hanger rods, nuts, washers, clevises, etc., in damp areas shall have ASTM A123 hot-dip galvanized finish applied after fabrication. This applies to the following areas:
  - 1. Tunnels (Flinn)

## 2.2 PIPE AND STRUCTURAL SUPPORTS

### A. General:

1. Pipe hangers, clamps, and supports shall conform to Manufacturers Standardization Society MSS SP-58, 69, 89, and 127 (where applicable).
2. On all insulated piping, provide at each support an insert of same thickness and contour as adjoining insulation, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Refer to insulation specifications for materials and additional information.

### B. Vertical Supports:

1. Support and laterally brace vertical pipes at every floor level in multi-story structures, unless otherwise noted by applicable codes, but never at intervals over 15 feet. Support vertical pipes with riser clamps installed below hubs, couplings, or lugs. Provide sufficient flexibility to accommodate expansion and contraction to avoid compromising fire barrier penetrations or stressing piping at fixed takeoff locations.
  - a. Products:
    - 1) Cooper/B-Line Fig B3373 Series
    - 2) Erico 510 Series
    - 3) Nibco/Tolco Fig. 82
  2. Cold Pipe: Place restrained neoprene mounts beneath vertical pipe riser clamps to prevent sweating of cold pipes. Select neoprene mounts based on the weight of the pipe to be supported. Insulate over mounts.
    - a. Products:
      - 1) Mason RBA, RCA or RDA
      - 2) Mason BR
    3. Cold Pipe Alternative: Insulated pipe riser clamp with no thermal bridging between clamp and pipe; water repellant calcium silicate insulation material adhered inside the clamp; ASTM A653 galvanized steel clamp.
      - a. Products:
        - 1) Pipeshields E100
    4. Wall supports shall be used where vertical height of structure exceeds minimum spacing requirements. Install wall supports at same spacing as hangers or strut supports along vertical length of pipe runs. Wall supports shall be coordinated with the Structural Engineer.

### C. Hangers and Clamps:

1. Oversize all hangers, clamps, and supports on insulated piping to allow insulation and jacket to pass through unbroken. This applies to both hot and cold pipes.

2. Hangers in direct contact with bare copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp within their temperature limits of -65°F to +275°F.
3. On all insulated piping, provide a semi-cylindrical metallic shield and vapor barrier jacket.
4. Ferrous hot piping 4 inches and larger shall have steel saddles tack welded to the pipe at each support with a depth not less than specified for the insulation. Factory fabricated inserts may be used.
  - a. Products:
    - 1) Anvil Fig. 160, 161, 162, 163, 164, 165
    - 2) Cooper/B-Line Fig. 3160, 3161, 3162, 3163, 3164, 3165
    - 3) Erico Model 630, 631, 632, 633, 634, 635
    - 4) Nibco/Tolco Fig. 260-1, 261-1 1/2, 262-2, 263-2 1/2, 264-3, 265-4
5. Unless otherwise indicated, hangers shall be as follows:
  - a. Clevis Type: Service: Bare Metal Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and Smaller:
    - 1) Products: Bare Steel, Plastic or Insulated Pipe:
      - a) Anvil Fig. 260
      - b) Cooper/B-Line Fig. 3100
      - c) Erico Model 400
      - d) Nibco/Tolco Fig. 1
    - 2) Products: Bare Copper Pipe:
      - a) Cooper/B-Line Fig. B3100C
      - b) Nibco/Tolco Fig. 81PVC
  - b. Roller Type: Service: Insulated Hot Pipe - 4 inches and Larger:
    - 1) Products: 4" through 6":
      - a) Anvil Fig. 181, 271
      - b) Cooper/B-Line Fig. 3110, 3117
      - c) Erico Model 610
      - d) Nibco/Tolco Fig. 324, 327
  - c. Adjustable Swivel Ring Type: Service: Bare Metal Pipe - 4 inches and Smaller:
    - 1) Products: Bare Steel Pipe:
      - a) Anvil Fig. 69
      - b) Cooper/B-Line Fig. B3170NF
      - c) Erico Model FCN
      - d) Nibco/Tolco Fig. 200.

- 2) Products: Bare Copper Pipe:
  - a) Cooper/B-Line Fig. B3170CTC
  - b) Erico 102A0 Series
  - c) Nibco/Tolco Fig. 203
  
6. Support may be fabricated from U-channel strut or similar shapes. Piping less than 4" in diameter shall be secured to strut with clamps of proper design and capacity as required to maintain spacing and alignment. Strut shall be independently supported from hanger drops or building structure. Size and support shall be per manufacturer's installation requirements for structural support of piping. Clamps shall not interrupt piping insulation.
  - a. Strut used in mechanical spaces or otherwise dry areas shall have ASTM B633 electro-plated zinc finish.
  - b. Strut used in damp areas listed in hanger rods shall have ASTM A123 hot-dip galvanized finish applied after fabrication.
  
7. Unless otherwise indicated, pipe supports for use with struts shall be as follows:
  - a. Clamp Type: Service: Bare Metal Pipe, Rigid Plastic Pipe, Insulated Cold Pipe, Insulated Hot Pipe - 3 inches and smaller:
    - 1) Clamps in direct contact with copper pipe shall include plastic pipe insert similar to Unistrut Cush-A-Clamp, Hydra-Zorb, Erico Cushion Clamp or Cooper Vibra-Clamp.
    - 2) Pipes subject to expansion and contraction shall have clamps oversized to allow limited pipe movement.
    - 3) Products: Bare Steel, Plastic or Insulated Pipe:
      - a) Unistrut Fig. P1100 or P2500
      - b) Cooper/B-Line Fig. B2000 or B2400
      - c) Nibco/Tolco Fig. A-14 or 2STR
    - 4) Products: Bare Copper Pipe:
      - a) Cooper/B-Line Fig. BVT
  - b. Roller Type: Service: Insulated Hot Pipe - 4 inches and larger:
    - 1) Products: 4" through 6":
      - a) Unistrut Fig. P2474
      - b) Cooper/B-Line Fig. B218
      - c) Nibco/Tolco Fig. ROL-12

D. Upper (Structural) Attachments:

1. Unless otherwise shown, upper attachments for hanger rods or support struts shall be as follows:

- a. Steel Structure Clamps: C-Type Wide Flange Beam Clamps (for use on top and/or bottom of wide flanges. Not permitted for use with bar-joists.):
  - 1) Products:
    - a) Anvil Fig. 92
    - b) Cooper/B-Line Fig. B3033/B3034
    - c) Erico Model 300
    - d) Nibco/Tolco 68
  
- b. Scissor Type Beam Clamps (for use with bar-joists and wide flange):
  - 1) Products:
    - a) Anvil Fig. 228, 292
    - b) Cooper/B-Line Fig. B3054
    - c) Erico Model 360
    - d) Nibco/Tolco Fig. 329
  
- c. Concentrically Loaded Open Web Joist Hangers (for use with bar joists):
  - 1) Products:
    - a) MCL. M1, M2 or M3

## 2.3 FOUNDATIONS, BASES, AND SUPPORTS

### A. Basic Requirements:

- 1. Furnish and install foundations, bases, and supports (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for mechanical equipment.
- 2. All concrete foundations, bases and supports, shall be reinforced. All steel bases and supports shall receive a prime coat of zinc chromate or red metal primer. After completion of work, give steel supports a final coat of gray enamel.

### B. Concrete Bases (Housekeeping Pads):

- 1. Refer to Section 23 05 50 for additional requirements for concrete bases in seismic applications.
- 2. Unless shown otherwise on the drawings, concrete bases shall be nominal 4 inches thick and shall extend 3 inches on all sides of the equipment (6 inches larger than factory base).
- 3. Where a base is less than 12 inches from a wall, extend the base to the wall to prevent a "dirt-trap".
- 4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6"x6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at 28 days (be 20 MPa strength).

5. Equipment requiring bases is as follows:
- a. Air Handling Unit (DOAS-4 Flinn)
  - b. Chiller, (refer to detail shown on plans)
  - c. Expansion Tank
  - d. Heat Exchanger
  - e. Pump
  - f. Expansion Tank
  - g. Bypass Bag Filter
  - h. Chiller - Remote Evaporator (Flinn)
  - i. Remote Evaporator (Flinn)

C. Supports:

- 1. Provide sufficient clips, inserts, hangers, racks, rods, and auxiliary steel to securely support all suspended material, equipment and conduit without sag.
- 2. Hang heavy equipment from concrete floors or ceilings with Architect/Engineer-approved concrete inserts, furnished and installed by the Contractor whose work requires them, except where indicated otherwise.

D. Grout:

- 1. Grout shall be non-shrinking premixed (Master Builders Company "Embecco"), unless otherwise indicated on the drawings or approved by the Architect/Engineer.
- 2. Use Mix No. 1 for clearances of 1" or less, and Mix No. 2 for all larger clearances.
- 3. Grout under equipment bases, around pipes, at pipe sleeves, etc., and where shown on the drawings.

## 2.4 OPENINGS IN FLOORS, WALLS AND CEILINGS

- A. Exact locations of all openings for the installation of materials shall be determined by the Contractor and given to the General Contractor for installation or construction as the structure is built.
- B. Coordinate all openings with other Contractors.
- C. Hire the proper tradesman and furnish all labor, material and equipment to cut openings in or through existing structures, or openings in new structures that were not installed, or additional openings. Repair all spalling and damage to the satisfaction of the Architect/Engineer. Make saw cuts before breaking out concrete to ensure even and uniform opening edges.
- D. Said cutting shall be at the complete expense of each Contractor. Failure to coordinate openings with other Contractors shall not exempt the Contractor from providing openings at Contractor's expense.
- E. Do not cut structural members without written approval of the Architect or Structural Engineer.

## 2.5 ROOF PENETRATIONS

- A. Roof Curb Enclosure: Provide weatherproof roof curb and enclosure for pipe and duct penetrations. Refer to drawings for details.

- B. Conical Pipe Boot: Seal pipes with surface temperature below 150°F penetrating single-ply roofs with conical stepped, UV-resistant silicone, EPDM or neoprene pipe flashings and stainless steel clamps equal to Portals Plus Pipe Boots or Pipetite. Color: White shall match roofing material.
- C. Break insulation only at the clamp for pipes between 60°F and 150°F. Seal outdoor insulation edges watertight.

## 2.6 SLEEVES AND LINTELS

- A. Each Contractor shall provide sleeves and lintels for all duct and pipe openings required for the Contractor's work in masonry walls and floors, unless specifically shown as being by others.
- B. Fabricate all sleeves from standard weight black steel pipe or as indicated on the drawings. Provide continuous sleeve. Cut or split sleeves are not acceptable.
- C. Fabricate all lintels for masonry walls from structural steel shapes or as indicated on the drawings. Have all lintels approved by the Architect or Structural Engineer.
- D. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
- E. Sleeves shall not penetrate structural members or masonry walls without approval from the Structural Engineer. Sleeves shall then comply with the Architect/Engineer's design.
- F. Install all sleeves concentric with pipes. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
- G. Where pipes rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (e.g., foam, rubber, asphalt-coated fiber, bituminous-impregnated felt, or cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
- H. Size sleeves large enough to allow expansion and contraction movement. Provide continuous insulation wrapping.

## 2.7 ESCUTCHEON PLATES AND TRIM

- A. Fit escutcheons to all insulated or uninsulated exposed pipes passing through walls, floors, or ceilings of finished rooms.
- B. Escutcheons shall be heavy gauge, cold rolled steel, copper coated under a chromium plated finish, heavy spring clip, rigid hinge and latch.
- C. Install galvanized steel (unless otherwise indicated) trim strip to cover vacant space and raw construction edges of all rectangular openings in finished rooms. This includes pipe openings.

## 2.8 PIPE PENETRATIONS

- A. Seal all pipe penetrations. Seal non-rated walls and floor penetrations with grout or caulk. Backing material may be used.
- B. Seal fire rated wall and floor penetrations with fire seal system as specified.

## 2.9 PIPE ANCHORS

- A. Provide all items needed to allow adequate expansion and contraction of all piping. All piping shall be supported, guided, aligned, and anchored as required.
- B. Repair all piping leaks and associated damage. Pipes shall not rub on any part of the building.

## 2.10 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

# PART 3 - EXECUTION

## 3.1 HVAC SUPPORTS AND ANCHORS

- A. General Installation Requirements:
  - 1. Install all items per manufacturer's instructions.
  - 2. Coordinate the location and method of support of piping systems with all installations under other Divisions and Sections of the Specifications.
  - 3. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welding.
  - 4. Supports shall extend directly to building structure. Do not support piping from duct hangers unless coordinated with sheet metal contractor prior to installation. Do not allow lighting or ceiling supports to be hung from piping supports.
- B. Supports Requirements:
  - 1. Furnish, install and prime all auxiliary structural steel for support of piping systems that are not shown on the Drawings as being by others.
  - 2. Install hangers and supports complete with lock nuts, clamps, rods, bolts, couplings, swivels, inserts and required accessories.
  - 3. Hangers for horizontal piping shall have adequate means of vertical adjustment for alignment.
- C. Pipe Requirements:
  - 1. Support all piping and equipment, including valves, strainers, traps and other specialties and accessories to avoid objectionable or excessive stress, deflection, swaying, sagging or vibration in the piping or building structure during erection, cleaning, testing and normal operation of the systems.

2. Do not, however, restrain piping to cause it to snake or buckle between supports or to prevent proper movement due to expansion and contraction.
  3. Support piping at equipment and valves so they can be disconnected and removed without further supporting the piping.
  4. Piping shall not introduce strains or distortion to connected equipment.
  5. Parallel horizontal pipes may be supported on trapeze hangers made of structural shapes and hanger rods; otherwise, pipes shall be supported with individual hangers.
  6. Trapeze hangers may be used where ducts interfere with normal pipe hanging.
  7. Provide additional supports where pipe changes direction, adjacent to flanged valves and strainers, at equipment connections and heavy fittings.
  8. Provide at least one hanger adjacent to each joint in grooved end steel pipe with mechanical couplings.
- D. Provided the installation complies with all loading requirements of truss and joist manufacturers, the following practices are acceptable:
1. Loads of 100 lbs. or less may be attached anywhere along the top or bottom chords of trusses or joists with a minimum 3' spacing between loads.
  2. Loads greater than 100 lbs. must be hung concentrically and may be hung from top or bottom chord, provided one of the following conditions is met:
    - a. The hanger is attached within 6" from a web/chord joint.
    - b. Additional L2x2x1/4 web reinforcement is installed per manufacturer's requirements.
  3. It is prohibited to cantilever a load using an angle or other structural component that is attached to a truss or joist in such a fashion that a torsional force is applied to that structural member.
  4. If conditions cannot be met, coordinate installation with truss or joist manufacturer and contact Architect/Engineer.
- E. After piping and insulation installation are complete, cut hanger rods back at trapeze supports so they do not extend more than 3/4" below bottom face of lowest fastener and blunt any sharp edges.
- F. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (limitation not required with concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and architectural items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- G. Do not exceed the manufacturer's recommended maximum load for any hanger or support.
- H. Steel/Concrete Structure: Spacing of hangers shall not exceed the compressive strength of the insulation inserts, and in no case shall exceed the following:
1. Steel and Fiberglass (Std. Weight or Heavier - Liquid Service):
    - a. Maximum Spacing:
      - 1) 1-1/4" & under: 7'-0"

- 2) 1-1/2": 9'-0"
- 3) 2": 10'-0"
- 4) 2-1/2": 11'-0"
- 5) 3": 12'-0"
- 6) 4" & larger: 12'-0"

2. Steel (Std. Weight or Heavier - Vapor Service):

a. Maximum Spacing:

- 1) 1-1/4" and under: 9'-0"
- 2) 1-1/2": 12'-0"
- 3) 2" & larger: 12'-0"

3. Hard Drawn Copper & Brass (Liquid Service):

a. Maximum Spacing:

- 1) 3/4" and under: 5'-0"
- 2) 1": 6'-0"
- 3) 1-1/4": 7'-0"
- 4) 1-1/2" 8'-0"
- 5) 2": 8'-0"
- 6) 2-1/2": 9'-0"
- 7) 3": 10'-0"
- 8) 4": 12'-0"
- 9) 6": 12'-0"

I. Installation of hangers shall conform to MSS SP-58, 69, and 89.

END OF SECTION 23 05 29

## SECTION 23 05 48 - HVAC VIBRATION ISOLATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Bases.
- B. Vibration Isolation.
- C. Flexible Connectors.

#### 1.2 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00 and the Vibration Isolation Submittal Form at the end of this section.
- B. Vibration isolation submittals may be included with equipment being isolated, but must comply with this section.
- C. Base submittals shall include equipment served, construction, coatings, weights, and dimensions.
- D. Isolator submittals shall include:
  - 1. Type of Isolator
  - 2. Load in Pounds per Isolator
  - 3. Recommended Maximum Load for Isolator
  - 4. Spring Constants of Isolators (for Spring Isolators)
  - 5. Load vs. Deflection Curves (for Neoprene Isolators)
  - 6. Specified Deflection
  - 7. Deflection to Solid (at least 150% of calculated deflection)
  - 8. Loaded (Operating) Deflection
  - 9. Free Height
  - 10. Loaded Height
  - 11.  $K_x/K_y$  (horizontal to vertical stiffness ratio - for spring isolators)
  - 12. Materials and Coatings
  - 13. Spring Diameters
- E. Make separate calculations for each isolator on equipment where the load is not equally distributed.
- F. Flexible connector shop drawings shall include overall face-to-face length and all specified properties.

## PART 2 - PRODUCTS

### 2.1 BASIC CONSTRUCTION AND REQUIREMENT

- A. Vibration isolators shall have either known undeflected heights or other markings so deflection under load can be verified.
- B. All isolators shall operate in the linear portion of their load versus deflection curve. The linear portion of the deflection curve of all spring isolators shall extend 50% beyond the calculated operating deflection (e.g., 3" for 2" calculated deflection). The point of 50% additional deflection shall not exceed the recommended load rating of the isolator.
- C. The lateral to vertical stiffness ratio ( $K_x/K_y$ ) of spring isolators shall be between 0.8 and 2.0.
- D. All neoprene shall have UV resistance sufficient for 20 years of outdoor service.
- E. All isolators shall be designed or treated for corrosion resistance. Steel bases shall be cleaned of welding slag and primed for interior use, and hot dip galvanized after fabrication for exterior use. All bolts and washers over 3/8" diameter located outdoors shall be hot dip galvanized per ASTM A153. All other bolts, nuts and washers shall be zinc electroplated. All ferrous portions of isolators, other than springs, for exterior use shall be hot dip galvanized after fabrication. Outdoor springs shall be neoprene dipped or hot dip galvanized. All damage to coatings shall be field repaired with two coats of zinc rich coating.
- F. Equip all mountings used with structural steel bases with height-saving brackets. Bottoms of the brackets shall be 1-1/2" to 2-1/2" above the floor or housekeeping pad, unless shown otherwise on the drawings. Steel bases shall have at least four points of support.
- G. Provide motor slide rails for belt-driven equipment per Section 23 05 13.
- H. All isolators, except M1, shall have provision for leveling.

### 2.2 MOUNTINGS

- A. Type M1:
  - 1. 0.75" thick waffled neoprene pad with minimum static deflection of 0.07" at calculated load and 0.11" at maximum load. For loads less than 15 pounds, the deflection at calculated load requirement is waived, but the isolator must have a maximum stiffness of the ratio of 45#/0.35".
  - 2. Units need not be bolted down unless called for or needed to prevent movement. If bolted down, prevent short circuiting with neoprene bushings and washers between bolts and isolators.
  - 3. Manufacturers:
    - a. Mason "Super W"
    - b. Kinetics "NGS"
    - c. Amber/Booth "SPNR"
    - d. Vibration Eliminator Co. "400N"

## 2.3 HANGERS

### A. Type H1:

1. Vibration hangers shall consist of a double-deflection neoprene element with a projecting bushing or oversized opening to prevent steel-to-steel contact.
2. Static deflection shall be at least 0.15" at calculated load and 0.35" at maximum rated load.
3. Provide hangers with end connections as required for hanging ductwork or piping.
4. Manufacturers:
  - a. Mason "HD"
  - b. Kinetics "RH"
  - c. Aeroflex "RHD"
  - d. Vibration Eliminator Co. "IC/3C/3CTD"
  - e. Vibro Acoustics "RH"

### B. Type H2:

1. Vibration hangers shall contain a steel spring in a neoprene cup with a grommet to prevent short circuiting the hanger rod.
2. The cup shall have a steel washer to distribute load on the neoprene and prevent its extrusion.
3. Spring diameters and hanger box lower hole sizes shall be large enough to permit the hanger rod to swing through a 30° arc before contacting the grommet and short circuiting the spring.
4. Provide end connections for hanging ductwork or piping.
5. Manufacturers:
  - a. Mason "30"
  - b. Kinetics "SRH"
  - c. Amber/Booth "BSRA"
  - d. Aeroflex "RSH"
  - e. Vibration Eliminator Co. "SNC"
  - f. Vibro Acoustics "SH/SHC"

## 2.4 BASES

### A. Type B2:

1. Steel members welded to height-saving brackets to cradle machines having legs or bases that do not require complete supplementary bases.
2. Members shall be sufficiently rigid to prevent strains in the equipment.
3. Manufacturers:
  - a. Mason "ICS"
  - b. Kinetics "SFB"
  - c. Aeroflex

## 2.5 FLEXIBLE CONNECTORS (NOISE AND VIBRATION ELIMINATORS)

### A. Type FC1:

1. Spherical flexible connectors with multiple plies of nylon tire cord fabric and either EPDM or molded and cured neoprene. Outdoor units shall be EPDM.
2. Steel aircraft cables or threaded steel rods shall be used to prevent excess elongation.
3. All straight through connections shall be made with twin-spheres properly pre-extended as recommended by the manufacturer.
4. Connectors up to 2" size may have threaded ends.
5. Connectors 2-1/2" and over shall have floating steel flanges recessed to lock raised face neoprene flanges.
6. All connectors shall be rated for a minimum working pressure of 150 psi at 200°F.
7. Manufacturer:
  - a. Metraflex "Double Cable-Sphere"
  - b. Minnesota Flex Corp.
  - c. Mercer "200 Series"
  - d. Twin City Hose "MS2".

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Provide vibration isolation as indicated on the drawings and as described herein.
- C. Clean the surface below all mountings that are not bolted down and apply adhesive cement equal to Mason Type WG between mounting and floor. If movement occurs, bolt mountings down. Isolate bolts from baseplates with neoprene washers and bushings.
- D. All static deflections listed in the drawings and specifications are the minimum acceptable actual deflection of the isolator under the weight of the installed equipment - not the maximum rated deflection of the isolator.
- E. Support equipment to be mounted on structural steel frames with isolators under the frames or under brackets welded to the frames. Where frames are not needed, fasten isolators directly to the equipment.
- F. Where a specific quantity of hangers is noted in these specifications, it shall mean hanger pairs for support points that require multiple hangers, such as rectangular ducts or pipes supported on a strut rack.

### 3.2 PIPE ISOLATION

- A. The first five hangers from vibration-isolated equipment shall have spring isolators with the same static deflection as the equipment. Use type H1 as required for the specified deflection. The next five hangers shall be type H2.
- B. For base mounted pumps without resilient mountings, the first five hangers shall be Type H1.

- C. Install flexible connectors in all piping connected to vibration producing equipment. This includes all fans, base-mounted pumps, compressors, etc. Absence of flexible connectors on piping diagrams does not imply that they are not required.
- D. Use Type FC1 where pressures are lower than 150 psi, temperatures are below 220°F , and the fluid handled is compatible with neoprene and EPDM.
- E. Provide sufficient piping flexibility for vibrating refrigerant equipment, or furnish flexible connectors with appropriate temperature and pressure ratings.
- F. Support piping to prevent extension of flexible connectors.

### 3.3 VIBRATION ISOLATION OF DUCTWORK

- A. The first three hangers on all fan systems shall be Type H1 with at least 0.20" minimum static deflection.

### 3.4 VIBRATION ISOLATION SCHEDULE

#### A. Inline Pumps:

1. Base Type: NA
2. Isolator Type: M3 H2
3. Static Deflection: 0.75"
4. Flexible Connections: NA

#### B. Base-Mounted Pumps:

1. Base Type: NA
2. Isolator Type: NA
3. Static Deflection: NA
4. Flexible Connections: FC-1

#### C. Air Cooled Chillers (mounted on grade):

1. Base Type: NA
2. Isolator Type: NA
3. Static Deflection: NA
4. Flexible Connections: FC-1

#### D. AHU Fans:

1. Base Type: B1
2. Isolator Type: M3 and/or TR1
3. Static Deflection: Refer to ASHRAE Table
4. Flexible Connections: Per Section 23 33 00

END OF SECTION 23 05 48



## SECTION 23 05 53 - HVAC IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Identification of products installed under Division 23.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. 3M
- B. Bunting
- C. Calpico
- D. Craftmark
- E. Emedco
- F. Kolbi Industries
- G. Seton
- H. W.H. Brady
- I. Marking Services.

#### 2.2 MATERIALS

- A. All pipe markers (purchased or stenciled) shall conform to ANSI A13.1. Marker lengths and letter sizes shall be at least the following:

OD of Pipe or Insulation	Marker Length	Size of Letters
Up to and including 1-1/4" (32mm)	8" (200 mm)	1/2" (12 mm)
1-1/2" (40 mm) to 2" (50 mm)	8" (200 mm)	3/4" (20 mm)
2-1/2" (65 mm) to 6" (150 mm)	12" (300 mm)	1-1/4" (32 mm)

Plastic tags may be used for outside diameters under 3/4" (20 mm)

- B. Plastic Nameplates: Laminated three-layer phenolic with engraved black, 1/4" minimum letters on light contrasting background.
- C. Plastic Tags: Minimum 1-1/2" square or round laminated three-layer phenolic with engraved, 1/4" minimum black letters on light contrasting background.

- D. Plastic Pipe Markers: Semi-rigid plastic, preformed to fit around pipe or pipe covering; indicating flow direction and fluid conveyed.
- E. Vinyl Pipe Markers: Colored vinyl with permanent pressure sensitive adhesive backing.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install all products per manufacturer's recommendations.
- B. Degrease and clean surfaces to receive adhesive for identification materials.
- C. Valves:
  - 1. All valves (except shutoff valves at equipment) shall have numbered tags.
  - 2. Provide or replace numbered tags on all existing valves that are connected to new systems or that have been revised.
  - 3. Provide all existing valves used to extend utilities to this project with numbered tags. Review tag numbering sequence with the Owner prior to ordering tags.
  - 4. Secure tags with heavy duty key chain and brass "S" link or with mechanically fastened plastic straps.
  - 5. Attach to handwheel or around valve stem. On lever operated valves, drill the lever to attach tags.
  - 6. Number all tags and show the service of the pipe.
  - 7. Provide one Plexiglas framed valve directory listing all valves, with respective tag numbers, uses and locations. Mount directory in location chosen by the Architect/Engineer.
- D. Pipe Markers:
  - 1. Adhesive Backed Markers: Use Brady Style 1, 2, or 3 on pipes 3" diameter and larger. Use Brady Style 4, 6, or 8 on pipes under 3" diameter. Similar styles by other listed manufacturers are acceptable. Secure all markers at both ends with a wrap of pressure sensitive tape completely around the pipe.
  - 2. Snap-on Markers: Use Seton "Setmark" on pipes up to 5-7/8" OD. Use Seton "Setmark" with nylon or Velcro ties for pipes 6" OD and over. Similar styles by other listed manufacturers are acceptable.
  - 3. Apply markers and arrows in the following locations where clearly visible:
    - a. At each valve.
    - b. On both sides of walls that pipes penetrate.
    - c. At least every 20 feet along all pipes.
    - d. On each riser and each leg of each "T" joint.
    - e. At least once in every room and each story traversed.

E. Equipment:

1. All equipment not easily identifiable such as controls, relays, gauges, etc.; and all equipment in an area remote from its function such as air handling units, exhaust fans, filters, reheat coils, dampers, etc.; shall have nameplates or plastic tags listing name, function, and drawing symbol. Do not label exposed equipment in public areas.
2. Fasten nameplates or plastic tags with stainless steel self-tapping screws or permanently bonding cement.
3. Mechanical equipment that is not covered by the U.S. National Appliance Energy Conservation Act (NAECA) of 1987 shall carry a permanent label installed by the manufacturer stating that the equipment complies with the requirements of ASHRAE 90.1.

F. Miscellaneous:

1. Attach self-adhesive vinyl labels at all duct access doors used to reset fusible links or actuators on fire, fire/smoke, or smoke dampers. Lettering shall be a minimum of 1/2" high. Labels shall indicate damper type.
2. Provide engraved plastic tags at all hydronic or steam system make-up water meters.

3.2 SCHEDULE

A. Pipes to be marked shall be labeled with text as follows, regardless of which method or material is used:

1. STEAM - 30 PSI: Black lettering; yellow background
2. STEAM - 15 PSI: Black lettering; yellow background
3. HEATING WATER SUPPLY: White lettering; green background
4. HEATING WATER RETURN: White lettering; green background
5. VACUUM CONDENSATE: Black lettering; yellow background
6. CHILLED WATER SUPPLY: White lettering; green background
7. CHILLED WATER RETURN: White lettering; green background
8. CONDENSATE DRAIN: White lettering; green background
9. NATURAL GAS: Black lettering; yellow background
10. REFRIGERANT LIQUID: White lettering; purple background
11. REFRIGERANT SUCTION: White lettering; purple background
12. REFRIGERANT HOT GAS: White lettering; purple background

B. Steam pipe markers shall include operating steam pressure within pipes shown above.

END OF SECTION 23 05 53

## SECTION 23 05 93 - TESTING, ADJUSTING, AND BALANCING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Testing, adjusting, and balancing of air systems.
- B. Testing, adjusting, and balancing of heating systems.
- C. Testing, adjusting, and balancing of cooling systems.
- D. Testing, adjusting, and balancing of energy recovery systems.

#### 1.2 QUALITY ASSURANCE

- A. Agency shall be a company specializing in the adjusting and balancing of systems specified in this section with minimum three years' experience. Perform work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, SMARTA Certified Air and Hydronic Balancer, or TABB Certified Supervisor.
- B. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

#### 1.3 REFERENCES

- A. AABC - National Standards for Total System Balance, Seventh Edition.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. AMCA - Publication 203-90; Field Performance Measurement of Fan Systems.
- D. ASHRAE - 2019 HVAC Applications Handbook; Chapter 39, Testing, Adjusting and Balancing.
- E. ASHRAE/ANSI - Standard 111-2008; Practices for Measurement, Testing, Adjusting and Balancing of Building HVAC&R Systems.
- F. NEBB - Procedural Standards for Testing, Adjusting and Balancing of Environmental Systems, Ninth Edition, 2019.
- G. SMACNA - HVAC Systems; Testing, Adjusting and Balancing, Third Edition, 2002.
- H. TABB - International Standards for Environmental Systems Balance.

#### 1.4 SUBMITTALS

- A. Submit copies of report forms, balancing procedures, and the name and qualifications of testing and balancing agency for approval within 30 days after award of Contract.

B. Electronic Copies:

1. Submit a certified copy of test reports to the Architect/Engineer for approval. Electronic copies shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Copies that are not legible will be returned to the Contractor for resubmittal. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
2. Electronic file size shall be limited to a maximum of 10MB. Larger files shall be divided into files that are clearly labeled as "1 of 2", "2 of 2", etc.
3. All text shall be searchable.
4. Bookmarks shall be used. All bookmark titles shall be an active link to the index page and index tabs.

1.5 REPORT FORMS

- A. Submit reports on AABC, SMACNA or NEBB forms. Use custom forms approved by the Architect/Engineer when needed to supply specified information.
- B. Include in the final report a schematic drawing showing each system component, including balancing devices, for each system. Each drawing shall be included with the test reports required for that system. The schematic drawings shall identify all testing points and cross-reference these points to the report forms and procedures.
- C. Refer to PART 4 for required reports.

1.6 WARRANTY/GUARANTEE

- A. The TAB Contractor shall include an extended warranty of 90 days after owner receipt of a completed balancing report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 24 manhours of onsite service time. If it is determined that the new test results are not within the design criteria, the balancer shall rebalance the system according to design criteria.
- B. Warranty/Guarantee must meet one of the following programs: TABB International Quality Assurance Program, AABC National Project Performance Guarantee, NEBB's Conformance Certification.

1.7 SCHEDULING

- A. Coordinate schedule with other trades. Provide a minimum of seven days' notice to all trades and the Architect/Engineer prior to performing each test.
- B. Project will be constructed in phases over a two year period. Provide balancing report after each phase is complete.

## PART 2 - PRODUCTS (Not Used)

## PART 3 - EXECUTION

### 3.1 GENERAL REQUIREMENTS

- A. All procedures must conform to a published standard listed in the References article of this section. All equipment shall be adjusted in accordance with the manufacturer's recommendations. Any system not listed in this specification but installed under the contract documents shall be balanced using a procedure from a published standard listed in the References article.
- B. The Balancing Contractor shall incorporate all pertinent documented construction changes (e.g. submittals/shop drawings, change orders, RFIs, ASIs, etc.) and include in the balancing report.
- C. Recorded data shall represent actual measured or observed conditions.
- D. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing is complete, close probe holes and patch insulation with new materials as specified. Restore vapor barrier and finish as specified.
- E. Permanently mark setting of valves, dampers, and other adjustment devices allowing for settings to be restored. Set and lock memory stops.
- F. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test holes, and restoring thermostats to specified settings.
- G. Installations with systems consisting of multiple components shall be balanced with all system components operating.

### 3.2 EXAMINATION

- A. Before beginning work, verify that systems are complete and operable. Ensure the following:
  - 1. General Equipment Requirements:
    - a. Equipment is safe to operate and in normal condition.
    - b. Equipment with moving parts is properly lubricated.
    - c. Temperature control systems are complete and operable.
    - d. Proper thermal overload protection is in place for electrical equipment.
    - e. Direction of rotation of all fans and pumps is correct.
    - f. Access doors are closed and end caps are in place.
  - 2. Duct System Requirements:
    - a. All filters are clean and in place. If required, install temporary media.
    - b. Duct systems are clean and free of debris.
    - c. Manual volume dampers are in place, functional and open.

- d. Air outlets are installed and connected.
- e. Duct system leakage has been minimized.

3. Pipe System Requirements:

- a. Coil fins have been cleaned and combed.
- b. Hydronic systems have been cleaned, filled, and vented.
- c. Strainer screens are clean and in place.
- d. Shutoff, throttling and balancing valves are open.

- B. Report any defects or deficiencies to Architect/Engineer.
- C. Promptly report items that are abnormal or prevent proper balancing.
- D. If, for design reasons, system cannot be properly balanced, report as soon as observed.
- E. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to the Architect/Engineer for spot checks during testing.
- B. Instruments shall be calibrated within six months of testing performed for project, or more recently if recommended by the instrument manufacturer.

3.4 INSTALLATION TOLERANCES

- A.  $\pm 10\%$  of scheduled values:
  - 1. Adjust air inlets and outlets to  $\pm 10\%$  of scheduled values.
  - 2. Adjust piping systems to  $\pm 10\%$  of design values.
- B. Adjust supply, return, and exhaust air-handling systems to  $+10\%$  /  $-5\%$  of scheduled values.

3.5 ADJUSTING

- A. After adjustment, take measurements to verify balance has not been disrupted or that disruption has been rectified.
- B. Once balancing of systems is complete, at least one damper or valve must be 100% open.
- C. After testing, adjusting and balancing are complete, operate each system and randomly check measurements to verify system is operating as reported in the report. Document any discrepancies.
- D. Contractor responsible for each motor shall also be responsible for replacement sheaves. Coordinate with contractor.
- E. Contractor responsible for pump shall trim impeller to final duty point as instructed by this contractor on all pumps not driven by a VFD. Coordinate with contractor.

### 3.6 SUBMISSION OF REPORTS

- A. Fill in test results on appropriate forms.

## PART 4 - SYSTEMS TO BE TESTED, ADJUSTED AND BALANCED

### 4.1 Verification of existing systems.

- A. Where indicated on the drawings, perform a pre-balance of systems serving the area of construction prior to the start of any other work. Do not make adjustments to the systems. If the systems are not operating at maximum capacity, temporarily drive system to maximum and take readings for the system. Return the system to its original state when measurements are complete.
- B. Report findings to Architect/Engineer on standard forms.

### 4.2 GENERAL REQUIREMENTS

#### A. Title Page:

1. Project name.
2. Project location.
3. Project Architect.
4. Project Engineer (IMEG Corp.).
5. Project General Contractor.
6. TAB Company name, address, phone number.
7. TAB Supervisor's name and certification number.
8. TAB Supervisor's signature and date.
9. Report date.

#### B. Report Index

#### C. General Information:

1. Test conditions.
2. Nomenclature used throughout report.
3. Notable system characteristics/discrepancies from design.
4. Test standards followed.
5. Any deficiencies noted.
6. Quality assurance statement.

#### D. Instrument List:

1. Instrument.
2. Manufacturer, model, and serial number.
3. Range.
4. Calibration date.

#### 4.3 AIR SYSTEMS

##### A. Duct Leakage Test:

1. Air system and fan.
2. Leakage class.
3. Test pressure.
4. Construction pressure.
5. Flow rate (cfm): specified and actual.
6. Leakage (refer to Section 23 31 00 in the specifications): specified and actual.
7. Statement that fire dampers, reheat coils and other accessories were included in the test.
8. Pass or Fail.
9. Test performed by.
10. Test witnessed by.

##### B. Air Moving Equipment:

###### 1. General Requirements:

- a. Drawing symbol.
- b. Location.
- c. Manufacturer, model, arrangement, class, discharge.
- d. Fan RPM.
- e. Multiple RPM fan curve with operating point marked. (Obtain from equipment supplier).
- f. Final frequency of motor at maximum flow rate (on fans driven by VFD).

###### 2. Flow Rate:

- a. Supply flow rate (cfm): specified and actual.
- b. Return flow rate (cfm): specified and actual.
- c. Outside flow rate (cfm): specified and actual.
- d. Exhaust flow rate (cfm): specified and actual.

###### 3. Pressure Drop and Pressure:

- a. Filter pressure drop: specified and actual.
- b. Total static pressure: specified and actual. (Indicate if across fan or external to unit).
- c. Inlet pressure.
- d. Discharge pressure.

##### C. Fan Data:

1. Drawing symbol.
2. Location.
3. Manufacturer and model.
4. Flow rate (cfm): specified and actual.
5. Total static pressure: specified and actual. (Indicate measurement locations).
6. Inlet pressure.

7. Discharge pressure.
8. Fan RPM.

D. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.

E. Air Flow Measuring Station:

1. Drawing symbol.
2. Service.
3. Location.
4. Manufacturer and model.
5. Size.
6. Flow rate (cfm): specified and actual.
7. Pressure drop: specified and actual.

#### 4.4 HEATING SYSTEMS

A. Pump Data (Primary and Secondary Heating Water Loop Pumps):

1. Existing drawing symbol or equipment TAG
2. Service.
3. Manufacturer, size, and model.
4. Impeller size: specified, actual, and final (if trimmed).
5. Flow Rate (gpm): specified and actual.
6. Pump Head: specified, operating and shutoff.
7. Suction Pressure: Operating and shutoff.
8. Final frequency of motor at maximum flow rate (on pumps driven by VFD).

B. Electric Motors (Associated Heating Water Loop Pump Motors):

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps in each phase.

C. Heat Exchangers (not all items apply to all units):

1. General Requirements:
  - a. Drawing symbol.
  - b. Location.
  - c. Manufacturer and model.
2. Primary Heat Exchanger:
  - a. Steam pressure in exchanger: specified and actual.
  - b. Primary water entering temperature: specified and actual.

- c. Primary water leaving temperature: specified and actual.
- d. Primary water flow: specified and actual.
- e. Primary water pressure drop: specified and actual.
- f. Primary water Btuh (gpm x temperature drop x 500). Heating Coils:

1. General Requirements:

- a. Drawing symbol.
- b. Service.
- c. Location.
- d. Manufacturer and model.
- e. Size.

2. Flow Rate:

- a. Flow rate (cfm): specified and actual.
- b. Water flow rate: specified and actual.

3. Temperature:

- a. Entering air temperature: specified and actual.0
- b. Leaving air temperature: specified and actual.
- c. Entering water temperature: specified and actual.
- d. Leaving water temperature: specified and actual.

4. Pressure Drop and Pressure:

- a. Air pressure drop: specified and actual.
- b. Steam pressure after valve: specified and actual.
- c. Water pressure drop: specified and actual.

5. Energy:

- a. Air Btuh (cfm x temp rise x 1.09).
- b. Water Btuh (gpm x temp drop x 500). Repeat tests if not within 10% of air Btuh.

E. Terminal Heat Transfer Units:

1. General Requirement:

- a. Drawing symbol.
- b. Location.
- c. Manufacturer and model.
- d. Include air data only for forced air units.

2. Flow Rate:

- a. Flow rate (cfm): specified and actual.
- b. Water flow rate (cfm): specified and actual.

3. Temperature:
  - a. Entering air temperature: specified and actual.
  - b. Leaving air temperature: specified and actual.
  - c. Entering water temperature: specified and actual.
  - d. Leaving water temperature: specified and actual.
4. Energy:
  - a. Air Btuh (cfm x temperature rise x 1.09).
  - b. Water Btuh (gpm x temperature drop x 500). Repeat tests if not within 10% of air Btuh.

#### 4.5 COOLING SYSTEMS

##### A. Pump Data:

1. General Requirements:
  - a. Drawing symbol.
  - b. Service.
  - c. Manufacturer, size, and model.
  - d. Impeller size: specified, actual, and final (if trimmed).
  - e. Final frequency of motor at maximum flow rate. (On pumps driven by VFD.)
2. Flow Rate:
  - a. Flow Rate (gpm): specified and actual.
3. Pressure Drop and Pressure:
  - a. Pump Head: specified, operating and shutoff.
  - b. Suction Pressure: Operating and shutoff.
  - c. Discharge Pressure: Operating and shutoff.

##### B. Electric Motors:

1. Drawing symbol of equipment served.
2. Manufacturer, Model, Frame.
3. Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
4. Measured: Amps for each phase.

##### C. Air Cooled Chillers:

1. General Requirements:
  - a. Drawing symbol.
  - b. Manufacturer and model.
  - c. Refrigerant type and capacity.
  - d. Starter type, size, and thermal protection.
  - e. Capacity: specified and actual.

2. Temperature:
  - a. Evaporator leaving water temperature: specified and actual.
  - b. Condenser entering air temperature.
  - c. Condenser leaving air temperature.
3. Pressure Drop and Pressure:
  - a. Evaporator pressure drop: specified and actual.
4. Flow Rate:
  - a. Evaporator water flow rate: specified and actual.

D. Cooling Coils:

1. General Requirements:
  - a. Drawing symbol.
  - b. Service.
  - c. Location.
  - d. Size.
  - e. Manufacturer and model.
2. Temperature:
  - a. Entering air DB temperature: specified and actual.
  - b. Entering air WB temperature: specified and actual.
  - c. Leaving air DB temperature: specified and actual.
  - d. Leaving air WB temperature: specified and actual.
  - e. Entering water temperature: specified and actual.
  - f. Leaving water temperature: specified and actual.
3. Flow Rate:
  - a. Flow rate (cfm): specified and actual.
  - b. Water flow rate (gpm): specified and actual.
4. Pressure Drop and Pressure:
  - a. Water pressure drop: specified and actual.
  - b. Air pressure drop: specified and actual.

E. Terminal Heat Transfer Units:

1. General Requirements:
  - a. Drawing symbol.
  - b. Location.
  - c. Manufacturer and model.
  - d. Include air data only for forced air units.

2. Temperature:
  - a. Entering air DB temperature: specified and actual.
  - b. Leaving air DB temperature: specified and actual.
  - c. Entering water temperature: specified and actual.
  - d. Leaving water temperature: specified and actual.
3. Flow rate:
  - a. Flow rate (cfm): specified and actual.
  - b. Water flow (gpm): specified and actual.

#### 4.6 ENERGY RECOVERY SYSTEMS

- A. Air Systems - Air energy recovery devices shall be tested at ambient temperatures of less than 40°F or greater than 85°F.

1. Energy Recovery Wheel:
  - a. General Requirements:
    - 1) Drawing Symbol.
    - 2) Location.
    - 3) Wheel RPM.
  - b. Primary Air:
    - 1) Primary Entering Air Temperature.
    - 2) Primary Leaving Air Temperature.
    - 3) Primary Air Pressure Drop.
    - 4) Primary Air Flow Rate (cfm).
  - c. Secondary Air:
    - 1) Secondary Entering Air Temperature.
    - 2) Secondary Leaving Air Temperature.
    - 3) Secondary Air Pressure Drop.
    - 4) Secondary Air Flow Rate (cfm).
2. Air to Air Plate Exchanger:
  - a. General Requirements:
    - 1) Drawing Symbol
    - 2) Location.
  - b. Primary Air:
    - 1) Primary Entering Air Temperature.
    - 2) Primary Leaving Air Temperature.
    - 3) Primary Air Flow Rate (cfm).

4) Primary Air Pressure Drop.

c. Secondary Air:

1) Secondary Entering Air Temperature.

2) Secondary Leaving Air Temperature.

3) Secondary Air Flow Rate (cfm).

4) Secondary Air Pressure Drop.

B. Water Systems:

1. Heat Exchanger

a. General Requirements:

1) Drawing Symbol.

2) Location.

b. Primary Water:

1) Primary Entering Water Temperature.

2) Primary Leaving Water Temperature.

3) Primary Water Pressure Drop.

4) Primary Water Flow Rate (gpm).

c. Secondary Water:

1) Secondary Entering Water Temperature.

2) Secondary Leaving Water Temperature.

3) Secondary Water Pressure Drop.

4) Secondary Water Flow Rate (gpm).

END OF SECTION 23 05 93

## SECTION 23 07 13 - DUCTWORK INSULATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Insulation Jackets.

#### 1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in ductwork insulation application with five years minimum experience. When requested, installer shall submit manufacturer's certificate indicating qualifications.
- B. Materials:
  - 1. Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723.
  - 2. Fungal Resistance: No growth when tested in accordance with ASTM G21 (antifungal test).
  - 3. Rated velocity on coated air side for air erosion in accordance with UL 181 at 5,000 fpm minimum.
- C. Adhesives: UL listed, meeting NFPA 90A/90B requirements.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Type A: Flexible Fiberglass - Outside Wrap; ANSI/ASTM C553; commercial grade; 0.28 / 0.26 (Out-Of-Package/Installed-Compressed 25%) maximum 'K' value at 75°F; foil scrim Kraft facing, 1.0 lb./cu. ft. density. Submit both "Out of Package" and "Installed-Compressed 25%" K and R-values.
- B. Type B: Semi-rigid Fiberglass Board Wrap - Outside Application; ANSI/ASTM C612, Class 1; 0.25 maximum 'K' value at 75°F; foil scrim Kraft facing, 3 lb./cu. ft. density.
- C. Type C: Flexible Fiberglass Liner; ANSI/ASTM C1071; 0.28 maximum 'K' value at 75°F; 1.5 lb/cu ft minimum density; coated air side for 5000 fpm air velocity.
- D. Type E: Double wall ductwork insulation; fiberglass; 0.27 maximum 'K' value at 75°F mean temperature; 1.5 lb/cu ft density.

- E. Type G: Preformed rigid fiberglass acoustical liner. ANSI/ASTM C1071; 0.23 maximum 'K' value at 75°F mean temperature; Noise Reduction Coefficient (NRC) per ASTM C423 Type "A" mounting of 0.70 for 1" thickness, 0.90 for 1.5" thickness. Liner shall be factory coated with an anti-microbial agent to prevent fungus and bacteria growth per ASTM G-21 and G-22. Max flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723.
- F. Type I: Flexible Elastomeric Liner; EPDM (NBR/PVC Blend is not permitted) Elastomeric cellular foam sheet; ANSI/ASTM C534; 0.25 maximum 'K' value at 75°F; 25/50 flame spread/smoke developed when tested in accordance with ASTM E84 (UL 723); coated air side for 5000 fpm air velocity.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install materials in accordance with manufacturer's instructions, codes, and industry standards.
- B. Install materials after ductwork has been tested.
- C. Clean surfaces for adhesives.
- D. Provide insulation with vapor barrier when air conveyed may be below ambient temperature.
- E. Exterior Duct Wrap - Flexible, Type A:
  1. Apply with edges tightly butted.
  2. Cut slightly longer than perimeter of duct to insure full thickness at corners. Do not wrap excessively tight.
  3. Seal joints with adhesive backed tape.
  4. Apply so insulation conforms uniformly and firmly to duct.
  5. Provide high-density insulation inserts at trapeze duct hangers and straps to prevent crushing of insulation. Maintain continuous vapor barrier through the hanger.
  6. Seal all penetrations of the vapor barrier by strap hangers or slip cable hangers with adhesive backed tape.
  7. Tape all joints with Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK. No substitutions will be accepted without written permission from the Architect/Engineer.
  8. Press tape tightly to the duct covering with a squeegee for a tight continuous seal. Fish mouths and loose tape edges are not acceptable.
  9. Staples may be used, but must be covered with tape.
  10. Vapor barrier must be continuous.
  11. Mechanically fasten on 12" centers at bottom of ducts over 24" wide and on all sides of vertical ducts.
- F. Semi Rigid Fiberglass Board Wrap - Type B (Indoor Use):
  1. Impale on pins welded to the duct and secured with speed clips. Clip pins off close to speed clips.

2. Space pins as needed to hold insulation firmly against duct, but not less than one pin per square foot. Pins must be long enough to avoid compressing the insulation.
3. Seal all joints and speed clips with glass fabric set in adhesive or a 3" wide strip of Royal Tapes #RT 350 (216-439-7229), Venture Tape 1525CW, or Compac Type FSK facing tape.
4. For small areas, secure insulation with adhesive over the entire surface of the duct. Use adhesive in addition to pins as needed to prevent sagging on horizontal surfaces.

G. Double-Wall Ductwork Insulation - Type E:

1. Install insulation per manufacturer's recommendations.
2. Duct dimensions given are net inside dimensions of inner wall.

H. Preformed Fiberglass Acoustical Liner, Rigid - Type G:

1. Cut and secure duct liner inside duct.
2. Install insulation pins or adhesives in locations as recommended by the manufacturer.
3. Seal all damaged duct liner and fill all gaps with manufacturer approved sealant. Do not damage duct liner surface coatings.
4. Where edges show evidence of delamination, the damaged areas shall be secured by manufacturer approved sealant.
5. Duct dimensions given are net inside dimensions. Increase sheet metal to allow for insulation thickness.

I. Exterior Duct Wrap - Type I:

1. On ducts with any sides having a dimension 20" and greater: Impale insulation on spindle anchors welded or mechanically fastened to the duct and secured with speed clips. Clip pins off close to speed clips. Adhesive or glue fastened anchors are not acceptable. Maximum anchor spacing per SMACNA Duct Construction Standards or manufacturer's recommendations, whichever is more restrictive. Locate pins within 4" from edges and at intervals not over 16" in all directions. Pins shall be long enough to prevent compressing the insulation.

J. Continue insulation with vapor barrier through penetrations unless code prohibits.

K. Provide 2" wide, 24" high, 26 gauge, galvanized sheet metal corner protection angles for all externally insulated ductwork extending to a floor or curb.

### 3.2 SCHEDULE

A. Refer to Section 23 31 00 for scheduling of insulation.

END OF SECTION 23 07 13

## SECTION 23 07 16 - HVAC EQUIPMENT INSULATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Equipment Insulation.
- B. Equipment Insulation Finishes.

#### 1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in insulation application with five years minimum experience.
- B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required).

### PART 2 - PRODUCTS

#### 2.1 INSULATION

- A. Type C: Glass Fiber Blanket; ANSI/ASTM C612; 0.40 maximum 'K' value at 300°F ; 2.5 lb/cu ft. ; suitable to 850°F , with all service jacket (ASJ) vapor retarder jacket having 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
- B. Type D: Glass Fiber Board; ANSI/ASTM C612; 0.28 maximum 'K' value at 200°F ; 6.0 lb/cu ft ; suitable to 850°F , 25/50 flame spread/smoke developed when tested in accordance with ASTM E84 (UL 723).
- C. Type E: EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F , 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.
- D. Type F: Semi-Rigid Mineral Wool Fiberboard; ANSI/ASTM C612; 0.30 maximum 'K' value at 200°F ; suitable to 1200°F .

#### 2.2 INSULATION FINISHES

- A. Type 1: Glass Fabric; ASTM D1668, woven glass fabric with two coats of mastic approved for insulation type. Use vapor barrier mastics that are approved for both indoor and outdoor use on insulation systems covering surfaces having temperatures less than 70°F and having maximum 0.013 perms/inch ) rating at 0.043 inch dry-film thickness when tested in accordance with ASTM E-96 Procedure B (Foster 30-80 or approved equivalent). Use breather mastics that are approved for both indoor and outdoor use on insulation systems covering surfaces having temperatures 70°F or greater (Foster 35-00 or approved equivalent).

- B. Type 2: All Service Jacket; ASTM C921; Factory or Field Applied; all-purpose polymer or polypropylene service jacket; Beach puncture resistance ratio of at least 50 units. Tensile strength: 35 psi minimum. Seal all joints with manufacturer approved tape and adhesive to maintain vapor barrier. Indoor use only, if used outdoors add type 4 finish.
- C. Type 3: Flexible Elastomeric Thermal Insulation; After adhesive has fully cured, apply two coats of latex enamel paint approved by insulation manufacturer for outdoor use.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install all materials per manufacturer's instructions, codes and industry standards.
- B. Maintain ambient temperatures and conditions required by manufacturers of adhesive and insulation.
- C. Do not insulate factory insulated equipment.
- D. Apply insulation as close as possible to equipment by grooving, scoring, and bevelling insulation. Secure to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier mastic.
- F. Do not insulate over nameplates or ASME stamps. Bevel and seal insulation around such, unless omitting insulation would cause condensation problem. When such is the case, appropriate tagging shall be provided to identify the presence of these items.
- G. When equipment with insulation requires periodic opening for maintenance, repair, or cleaning; install specially fabricated removable insulation sections. Covers shall have mechanical fasteners and be reusable.
- H. Install 26 gauge galvanized sheet metal corner protection angles where insulation extends to the floor. Minimum 2" coverage of insulation.
- I. Insulate all equipment surfaces that are not factory insulated and are intended to operate below 60°F and/or above 100°F . Verify insulation type and thickness with equipment manufacturer and Architect/Engineer.
- J. Insulate all supports on equipment operating below ambient temperature.

### 3.2 INSULATION

- A. Type C and D:
  - 1. Apply with edges tightly butted and joints staggered.
  - 2. Secure with welded pins and washers, 4" from each edge and 16" on center, or 1/2" x 0.015" galvanized steel bands, 12" on center.

B. Type E:

1. Apply with edges tightly butted and joints staggered. Install multiple layers if required thickness is greater than 1" thick.
2. Do not wrap sheet insulation around square corners, but cut and overlap insulation at corners to provide full insulation thickness on all sides. Seal all overlapping insulation surfaces with manufacturer approved adhesive.
3. Secure with manufacturer approved adhesive in accordance with installation instructions. Where applied to underside surfaces or on surfaces with temperatures 140°F and above, cover all surfaces with full application of adhesive. Seal all joints and seams with manufacturer approved adhesive.

3.3 SCHEDULE

- A. Steam-to-Water Heat Exchanger (200°F to 299°F): 2" thick Type D; Finish 1 or 2.
- B. Heating Water Air Separator/Coalescing Filter: 2" thick Type C, Finish 1 or 2.
- C. Chilled Water Air Separator/Coalescing Filter: 2" thick Type C, Finish 1 or 2.
- D. Steam Condensate Receiver Tank: 2" thick Type D, Finish 1 or 2.
- E. Chilled Water Pumps: 1" thick Type E, Finish 3.
- F. Chilled Water Flexible Connections & Expansion Joints: 3/4" thick Type E, Finish 3.
- G. Chiller Cold Surfaces (not factory insulated): 1" thick Type E, Finish 3.

END OF SECTION 23 07 16

## SECTION 23 07 19 - HVAC PIPING INSULATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Piping Insulation.
- B. Insulation Jackets.

#### 1.2 QUALITY ASSURANCE

- A. Applicator: Company specializing in piping insulation application with five years minimum experience.
- B. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255, or UL 723 (where required). Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

### PART 2 - PRODUCTS

#### 2.1 INSULATION

- A. Type A: Glass fiber; ANSI/ASTM C547; 0.24 maximum 'K' value at 75°F; non-combustible. All-purpose polymer or polypropylene service jacket, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
  - 1. Not allowed in Boiler Room and tunnels.
- B. Type B: Flexible elastomeric foam insulation; closed-cell, sponge or expanded rubber (polyethylene type is not permitted); ANSI/ASTM C534, Grade 1 Type I for tubular materials; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

- C. Type E: Preformed rigid cellular polyisocyanurate insulation; ANSI/ASTM C591; maximum 'K' value of 0.19 at 75°F; density 4.0lb/ft; minimum compressive strength 95 psi parallel to rise; moisture resistant; 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723); suitable for -297°F to +300°F.

## 2.2 VAPOR BARRIER JACKETS

- A. Polyvinylidene Chloride (PVDC or Saran) film and tape: Durable and highly moisture and moisture vapor resistant. Please refer to manufacturer's recommended installation guidelines.

## 2.3 JACKET COVERINGS

- A. Aluminum Jackets: ASTM C1729; 0.016" thick (thicker where required by ASTM C1729); stucco embossed finish with Z edge seams and aluminum bands for outdoor use. Where colored jacket covers are called for, provide factory-applied hard film acrylic paint in color white.
- B. Plastic Jackets and Fitting Covers: High impact, glossy white, 0.020" thick, self-extinguishing plastic. Suitable for use indoors or outdoors with ultraviolet inhibitors. Suitable for -40°F to 150°F. 25/50 maximum flame spread/smoke developed.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Install insulation after piping has been tested. Pipe shall be clean, dry and free of rust before applying insulation.
- B. Patch and repair torn insulation. Paint to match adjacent insulation surface.

### 3.2 INSTALLATION

- A. General Installation Requirements:
  - 1. Install materials per manufacturer's instructions, building codes and industry standards.
  - 2. Continue insulation with vapor barrier through penetrations. This applies to all insulated piping. Maintain fire rating of all penetrations.
  - 3. All piping and insulation that does not meet 25/50 that is in an air plenum shall have written approval from the Authority Having Jurisdiction and the local fire department for authorization and materials approval. If approval has been allowed, the non-rated material shall be wrapped with a product that has been listed and labeled having a flame spread index of not more than 25 and a smoke-developed index of not more than 50 when tested as a composite in accordance with ASTM E84 or UL 723.
  - 4. On 1" and smaller piping routed through metal wall studs, provide a plastic grommet to protect the piping. The piping shall be insulated between the wall studs, and the insulation shall butt up to each stud.
- B. Insulated Piping Operating Below 60°F:
  - 1. Insulate fittings, valves, unions, flanges, flexible connections, flexible hoses, and expansion joints. Seal all penetrations of vapor barrier.

2. On piping operating below 60°F in locations that are not mechanically cooled (e.g., penthouses, mechanical rooms, tunnels, chases at exterior walls, etc.), Type B insulation shall be used.
3. All balance valves and strainers with fluid operating below 60°F shall be insulated with a removable plug wrapped with vapor barrier tape to allow access for reading and adjusting of the balancing valve and cleaning and servicing of the balancing valve.

C. Insulated Piping Operating Between 60°F and 140°F:

1. Do not insulate flanges and unions, but bevel and seal ends of insulation at such locations. Insulate all fittings, valves and strainers.

D. Insulated Piping Operating Above 140°F:

1. Insulate fittings, valves, flanges, float & thermostatic steam traps, and strainers. On gate valves, the insulation shall be extended to cover the entire valve bonnet, leaving only the portion of the stem that is above the bonnet and valve operator exposed.
2. All balance valves with fluid operating above 140°F shall be insulated and an opening shall be left in the insulation to allow for reading and adjusting the valve.
3. The use of removable insulation jackets is acceptable for insulating large and non-cylindrical shaped piping components (e.g., check valves, pressure regulating valves, calibrated balance valves, gate valve bonnets, F&T traps, strainers, line sets, and the like).

E. Refrigerant Piping:

1. On refrigerant piping (25°F and above) and not required to meet the 25/50 flame/smoke, provide at each strut or clevis support an insulation coupling to support pipe and to accept insulation thickness of adjoining insulation, to prevent insulation from sagging and crushing. The coupling shall be suitable for planned temperatures, use with specified pipe material, and shall be a 360°, one-piece cylindrical segment. Use mechanical fasteners where coupling cannot be installed on pipe during installation. Contractor shall apply adhesive to ends of insulation entering insulation coupling to maintain vapor barrier.

F. Exposed Piping:

1. Locate and cover seams in least visible locations.
2. Where exposed insulated piping extends above the floor, provide a sheet metal guard around the insulation extending 12" above the floor. Guard shall be 0.016" cylindrical smooth or stucco aluminum and shall fit tightly to the insulation.

### 3.3 SUPPORT PROTECTION

A. Provide a shield on all insulated piping at each support between the insulation jacket and the support.

- B. On all insulated piping greater than 1-1/2", provide shield with insulation insert of same thickness and contour as adjoining insulation at each support, between the pipe and insulation jacket, to prevent insulation from sagging and crushing. Inserts shall be as follows:

1. The insert shall be suitable for planned temperatures, be suitable for use with specific pipe material, and shall be a minimum 180° cylindrical segment the same length as metal shields. Inserts shall be:
  - a. Molded hydrous calcium silicate (only use for pipes with operating temperatures above 90°F, with a minimum compressive strength of 100 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14", provide rolled steel plate in addition to the shield.
  - b. Polyisocyanurate insulation (for pipes below 300°F with a minimum compressive strength of 24 psi is acceptable for pipe sizes 3" and below, minimum 60 psi for pipe sizes 4" to 10". For pipe sizes larger than 10", provide rolled steel plate in addition to the shield. Where insulation is installed on piping located within return air plenums and mechanical rooms, insulation shall have 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723).
  - c. Cellular glass (for all temperature ranges) with a minimum compressive strength of 90 psi is acceptable for pipe sizes 14" and below. For pipe sizes larger than 14, provide rolled steel plate in addition to the shield.
  - d. As an alternative to separate pipe insulation insert and saddle, properly sized manufactured integral rigid insulation insert and shield assemblies may be used.
    - 1) Products:
      - a) Buckaroo CoolDry
      - b) Cooper/B-Line Fig. B3380 through B3384
      - c) Pipe Shields A1000, A2000
  - e. Insulation Couplings:
    - 1) Molded thermoplastic slip coupling, -65°F to 275°F, sizes up to 4-1/8" OD, and receive insulation thickness up to 1". Suitable for use indoors or outdoors with UV stabilizers. Vertical insulation riser clamps shall have a 1,000lb vertical load rating. On cold pipes operating below 60°F, cover joint and coupling with vapor barrier mastic to ensure continuous vapor barrier.
    - 2) Horizontal Strut Mounted Insulated Pipe Manufacturers:
      - a) Klo-Shure or equal
    - 3) Vertical Manufacturers:
      - a) Manufacturers: Klo-Shure Titan or equal
  - f. Rectangular blocks, plugs, or wood material are not acceptable.
  - g. Temporary wood blocking may be used by the Piping Contractor for proper height; however, these must be removed and replaced with proper inserts by the Insulation Contractor. Refer to Supports and Anchors specification section for additional information.

C. Neatly finish insulation at supports, protrusions, and interruptions.

D. Install metal shields between all hangers or supports and the pipe insulation. Shields shall be galvanized sheet metal, half-round with flared edges. Adhere shields to insulation. On cold piping, seal the shields vapor-tight to the insulation as required to maintain the vapor barrier, or add separate vapor barrier jacket.

E. Shields shall be at least the following lengths and gauges:

Pipe Size	Shield Size
1/2" to 3-1/2"	12" long x 18 gauge
4"	12" long x 16 gauge
5" to 6"	18" long x 16 gauge

F. Ferrous hot piping 4 inches and larger, provide steel saddle at rollers as described in Section 23 05 29 "HVAC Supports and Anchors".

G. Minimum 1/4" rolled galvanized steel plates shall be provided in addition to the sleeves as reinforcement on large pipes to reduce point loading on roller, trapeze hanger and strut support locations depending on insulation compressive strength. Refer to section above for exact locations.

### 3.4 INSULATION

A. Type A Insulation:

1. All Service Jackets: Seal all longitudinal joints with self-seal laps using a single pressure sensitive adhesive system. Do not staple.
2. Insulation without self-seal lap may be used if installed with Benjamin Foster 85-20 or equivalent Chicago Mastic, 3M or Childers lap adhesive.
3. Apply insulation with laps on top of pipe.
4. Fittings, Valve Bodies and Flanges: For 4" and smaller pipes, insulate with 1 lb. density insulation wrapped under compression to a thickness equal to the adjacent pipe insulation. For pipes over 4", use mitered segments of pipe insulation. Finish with preformed plastic fitting covers. Secure fitting covers with pressure sensitive tape at each end. Overlap tape at least 2" on itself. For pipes operating below 60°F, seal fitting covers with vapor retarder mastic in addition to tape.

B. Type B Insulation:

1. Install per manufacturer<sup>TM</sup>s instructions or ASTM C1710.
2. Elastomeric Cellular Foam: Where possible, slip insulation over the open end of pipe without slitting. Seal all butt ends, longitudinal seams, and fittings with adhesive. At elbows and tees, use mitered connections. Do not compress or crush insulation at cemented joints. Joints shall be sealed completely and not pucker or wrinkle. Paint the outside of outdoor insulation with two coats of latex enamel paint recommended by the manufacturer.
3. Insulation Installation on Straight Pipes and Tubes:
  - a. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

- b. Insulation must be installed in compression to allow for expansion and contraction. Insulation shall be pushed onto the pipe, never pulled. Stretching of insulation may result in open seams and joints.

4. Insulation Installation on Valves and Pipe Specialties:

- a. Install preformed sections of same material as straight segments of pipe insulation when available.
- b. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
- c. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

C. Type D Insulation:

- 1. Use pre-molded half sections. Butt longitudinal and circumferential joints tightly. Wire in place with 16 gauge stainless steel wire on maximum 12" centers.
- 2. Apply in two layers. Stagger all joints between layers. Wire each layer individually.

### 3.5 JACKET COVER INSTALLATION

A. Metal Covering:

- 1. Provide vapor barrier as specified for insulation type. Cover with aluminum jacket covering with seams located on the bottom of horizontal piping. Include fittings, joints and valves.
- 2. Seal all interior and exterior butt joints with metal draw bands and sealant. Seal all exterior joints watertight.
- 3. Interior joints do not need to be sealed.
- 4. Use metal covering on the following pipes:
  - a. All exterior piping (does not include gas piping) - Flinn.
  - b. Exposed vertical piping (does not include mechanical or Kitchen spaces)
- 5. Use colored aluminum jacket covers on the following pipes:
  - a. All exterior refrigeration piping (does not include gas piping) - Flinn
  - b. All exposed piping not enclosed in a chase, (does not include mechanical spaces)

B. Plastic Covering:

- 1. Provide vapor barrier as specified for insulation type. Cover with plastic jacket covering. Position seams to shed water.
- 2. Solvent weld all joints with manufacturer recommended cement.
- 3. Overlap all laps and butt joints 1-1/2" minimum. Repair any loose ends that do not seal securely. Solvent weld all fitting covers in the same manner. Final installation shall be watertight.
- 4. Use plastic insulation covering on all exposed pipes including, but not limited to:
  - a. All piping in mechanical rooms including mechanical space housing remote evaporator and includes all tunnels (Flinn). routinely.)

b. All exposed piping in kitchen areas.

3.6 SCHEDULE

A. Refer to drawings for insulation schedule.

END OF SECTION 23 07 19

## SECTION 23 09 00 - CONTROLS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Complete System of Automatic Controls.
- B. Control Devices, Components, Wiring and Material.
- C. Instructions for Owners.
- D. Remodeling.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum five years' experience.
- B. TCC: Company specializing in the work of this section with minimum five years temperature control experience.
- C. Technician: Minimum five years' experience installing commercial temperature control systems.
- D. TCCs are limited to firms regularly employing a minimum of five full-time temperature control technicians within 100 miles of the job site.

#### 1.3 SUBMITTALS

- A. Equipment Coordination:
  - 1. The Controls Contractor shall obtain approved equipment submittals from other contractors to determine equipment wiring connections, to choose appropriate controllers, and to provide programming.
  - 2. Control valve selections shall be based on flow rates shown in approved shop drawings.
  - 3. Coordinate the control interface of all equipment with the equipment manufacturers prior to submittal submission.
- B. Shop Drawings:
  - 1. Submit shop drawings per Section 23 05 00. In addition, submit an electronic copy of the shop drawings in Adobe Acrobat (.pdf) format to the Owner for review.
  - 2. Cross-reference all control components and point names in a single table located at the beginning of the submittal with the identical nomenclature used in this section.
  - 3. Submittal shall also include a trunk cable schematic diagram depicting operator workstations, control panel locations and a description of the communication type, media and protocol.

4. System Architecture: Provide riser diagrams of wiring between central control unit and all control panels. This shall include specific protocols associated with each level within the architecture. Identify all interface equipment between CPU and control panels. The architecture shall include interface requirements with other systems including, but not limited to, security systems, lighting control, fire alarm, elevator status, and power monitoring system.
5. Diagrams shall include:
  - a. Wiring diagrams and layouts for each control panel showing all termination numbers.
  - b. Schematic diagrams for all control, communication, and power wiring. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers and functions. Show all interface wiring to the control system.
  - c. Identification of all control components connected to emergency power.
  - d. Schematic diagrams for all field sensors and controllers.
  - e. A schematic diagram of each controlled system. The schematics shall have all control points labeled. The schematics shall graphically show the location of all control elements in the system.
  - f. A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, label it with the same name. Label all terminals.
  - g. A tabular instrumentation list for each controlled system. The table shall show element name, type of device, manufacturer, model number and product data sheet number.
  - h. All installation details and any other details required to demonstrate that the system will function properly.
  - i. All interface requirements with other systems.
6. The network infrastructure shall conform to the published guidelines for wire type, length, number of nodes per channel, termination, and other relevant wiring and infrastructure criteria as published. The number of nodes per channel shall be no more than 80% of the defined segment (logical or physical) limit in order to provide future system enhancement with minimal infrastructure modifications.
7. Sequences: Submit a complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system. The wording of the control sequences in the submittal shall match verbatim that included in the construction documents to ensure there are no sequence deviations from that intended by the Architect/Engineer. Clearly highlight any deviations from the specified sequences on the submittals.
8. Points List Schedule: Submit a complete points list of all points to be connected to the TCS and FMCS. The points list for each system controller shall include both inputs and outputs (I/O), point number, the controlled device associated with the I/O point, the location of the I/O device, and reference drawings. Where a control point is the same as that shown on the control system schematic, label it with the same name. Points list shall specifically identify alarms, trends, event history, archive, totalization, graphic points, and all mapped points from other systems (security systems, lighting control, fire alarm, etc.). Provide points lists, point naming convention, and factory support information for systems provided and integrated into the FMCS.

9. Damper Schedule: Schedule shall include a separate line for each damper and a column for each of the damper attributes:
  - a. Damper Identification Tag.
  - b. Location.
  - c. Damper Type.
  - d. Damper Size.
  - e. Duct Size.
  - f. Arrangement.
  - g. Blade Type.
  - h. Velocity.
  - i. Pressure Drop.
  - j. Fail Position.
  - k. Actuator Identification Tag.
  - l. Actuator Type.
  - m. Mounting.
  
10. Valve Schedule: Valve manufacturer shall size valves and create a valve schedule. Schedule shall include a separate line for each valve and a column for each of the valve attributes:
  - a. Valve Identification Tag.
  - b. Location.
  - c. Valve Type.
  - d. Valve Size.
  - e. Pipe Size.
  - f. Configuration.
  - g. Flow Characteristics.
  - h. Capacity.
  - i. Valve CV.
  - j. Design Pressure Drop.
  - k. Pressure Drop at Design Flow.
  - l. Fail Position.
  - m. Close-off Pressure.
  - n. Valve and Actuator Model Number and Type.
  
11. Airflow Measuring Station Schedule:
  - a. The manufacturer's authorized representative shall prepare the airflow measuring station submittal, or review and approve in writing the submittal prepared by the TCC prior to submission to the Architect/Engineer and prior to installation. The representative shall review air handling equipment submittals and duct fabrication drawings to ensure that all AFMS locations meet the appropriate parameters to achieve proper installation and the specified accuracy. Comply with all manufacturer's installation requirements including straight up and downstream duct lengths. Install airflow straighteners if required by the manufacturer based on installation constraints. The Architect/Engineer shall be notified for approval of any deviations.
  - b. Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.

- c. Submit installation, operation, and maintenance documentation.
12. Product Data Sheets: Required for each component that includes: unique identification tag that is consistent throughout the submittal, manufacturer's description, technical data, performance curves, installation/maintenance instructions, and other relevant items. When manufacturer's literature applies to a product series rather than a specific product, the data specifically applicable to the project shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cutsheets to fulfill submittal requirements.
13. Provide PICS files indicating the BACnet@functionality and configuration of each device.
14. Provide documentation of submitted products that have been tested and listed by the BACnet Testing Laboratory (BTL), or provide a letter on the manufacturer's company letterhead indicating the anticipated date by which testing is expected to be completed. If, for any reason, BTL testing and listing has not been completed, a written commitment to upgrade installed controls to a version that meets BTL testing and listing requirements if problems are found during BTL testing is required.
15. Graphic Display: Include a sample graphic of each system and component identified in the points list with a flowchart (site map) indicating how the graphics are to be linked to each other for system navigation. Graphics are completed on the WebSuper per Rockford Public Schools Contractor
16. Software: A list of operating system software, operator interface software, color graphic software, and third-party software. Graphics are completed on the WebSuper per Rockford Public Schools Contractor.
17. Control System Demonstration and Acceptance: Provide a description of the proposed process, along with all reports and checklists to be used.
18. Clearly identify work by others in the submittal.
19. Quantities of items submitted may be reviewed but are the responsibility of the Contractor to verify.

C. Operation and Maintenance Manual:

1. In addition to the requirements of Section 23 05 00, submit an electronic copy of the O&M manuals in PDF format.
2. Provide three complete sets of manuals.
3. Each O&M manual shall include:
  - a. Table of contents with indexed tabs dividing information as outlined below.
  - b. Definitions: List of all abbreviations and technical terms with definitions.
  - c. Warranty Contacts: Names, addresses, and 24-hour telephone numbers of contractors installing equipment and controls and service representatives of each.
  - d. Licenses, Guarantees, and Warranties: Provide documentation for all equipment and systems.
  - e. System Components: Alphabetical list of all system components, with the name, address, and telephone number of the vendor.
  - f. Operating Procedures: Include procedures for operating the control systems; logging on/off; enabling, assigning, and reporting alarms; generating reports; collection, displaying, and archiving of trended data; overriding computer control; event scheduling; backing up software and data files; and changing setpoints and other variables.

- g. Programming: Description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point database creation and modification, program creation and modification, and use of the editor.
- h. Engineering, Installation, and Maintenance: Explain how to design and install new points, panels, and other hardware; recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions; how to debug hardware problems; and how to repair or replace hardware. A list of recommended spare parts.
- i. Original Software: Complete original issue CDs for all software provided, including operating systems, programming language, operator workstation software, and graphics software.
- j. Software: One set of CDs containing an executable copy of all custom software created using the programming language, including the setpoints, tuning parameters, and object database.
- k. Graphics: A glossary or icon symbol library detailing the function of each graphic icon and graphics creation and modification. One set of CDs containing files of all color graphic screens created for the project. Graphics are completed on the WebSuper per Rockford Public Schools contractor.

D. Training Manual:

- 1. Provide a course outline and training manuals for each training class.

E. Record Documents:

- 1. Submit record documentation per Section 23 05 00.
- 2. Provide a complete set of "as-built" drawings and application software on CDs. Provide drawings as AutoCAD or Visio compatible files. Provide two copies of the "as-built" drawings with revisions clearly indicated in addition to the documents on compact disk. All as-built drawings shall also be installed on the FMCS server in a dedicated directory. Provide all product data sheets in PDF format.
- 3. Submit two hard copies and one electronic copy of as-built versions of the shop drawings, including product data and record drawings with revisions clearly indicated. Provide floor plans showing actual locations of control components including panels, thermostats, sensors, and hardware.
- 4. Provide all completed testing and commissioning reports and checklists, along with all trend logs for each system identified in the points lists.
- 5. Submit printouts of all graphic screens with current values (temperatures, pressures, etc.) to the A/E verifying completion and proper operation of all points.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Provide factory-shipping cartons for each piece of equipment and control device. Maintain cartons through shipping, storage, and handling as required to prevent equipment damage. Store equipment and materials inside and protected from weather.
- B. Factory-Mounted Components: Where control devices specified in this section are indicated to be factory mounted on equipment, arrange for shipping control devices to unit manufacturer.

1.5 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Control Valves.
- B. Flow Switches.
- C. Temperature Sensor Sockets.
- D. Gauge Taps.
- E. Automatic Dampers.
- F. Flow Meters.

1.6 AGENCY AND CODE APPROVALS

- A. All products shall have the following agency approvals. Provide verification that the approvals exist for all submitted products with the submittal package.
  - 1. UL-916; Energy Management Systems.
  - 2. C-UL listed to Canadian Standards Association C22.2 No. 205-M1983 "Signal Equipment."
  - 3. EMC Directive 89/336/EEC (European CE Mark).
  - 4. FCC, Part 15, Subpart J, Class A Computing Devices.

1.7 ACRONYMS

- A. Acronyms used in this specification are as follows:
  - 1. B-AAC BACnet Advanced Application Controller
  - 2. B-ASC BACnet Application Specific Controller
  - 3. BTL BACnet Testing Laboratories
  - 4. DDC Direct Digital Controls
  - 5. FMCS Facility Management and Control System
  - 6. GUI Graphic User Interface
  - 7. IBC Interoperable BACnet Controller
  - 8. IDC Interoperable Digital Controller
  - 9. LAN Local Area Network
  - 10. JACE (RPS specific) Network Controller
  - 11. ODBC Open DataBase Connectivity
  - 12. OOT Object Oriented Technology
  - 13. OPC Open Connectivity via Open Standards
  - 14. PICS Product Interoperability Compliance Statement
  - 15. PMI Power Measurement Interface
  - 16. POT Portable Operator's Terminal
  - 17. TCC Temperature Control Contractor
  - 18. TCS Temperature Control System
  - 19. WAN Wide Area Network
  - 20. WBI Web Browser Interface

## 1.8 SUMMARY

- A. Extend Existing System (compatible with Owner control system):
  - 1. Extend the existing Tridium FMCS for this project.
  - 2. All controllers and accessories shall interface with the existing Tridium FMCS.
- B. TCC shall furnish all labor, materials, equipment, and service necessary for a complete and operating Temperature Control System (TCS) and Facility Management and Control System (FMCS) using Direct Digital Controls as shown on the drawings and as described herein.
- C. All labor, material, equipment and software not specifically referred to herein or on the plans that is required to meet the intent of this specification shall be provided without additional cost to the Owner.
- D. The Owner shall be the named license holder of all software associated with any and all incremental work on the project.

## 1.9 SYSTEM DESCRIPTION

- A. The entire TCS shall be comprised of a network of interoperable, standalone digital controllers communicating via the following protocol to an NAC. Temperature Control System products shall be as specified below.
- B. The FMCS shall include Network Area Controller or Controllers (NAC) within each facility. The NAC shall connect to the Owner's local or wide area network, depending on configuration. Provide access to the system, either locally in each building or remotely from a central site or sites, through standard Web browsers, via the Internet, and/or via local area network.
- C. Provide materials and labor necessary to connect factory supplied control components.
- D. Provide central and remote hardware, software, and interconnecting wire and conduit.
- E. The FMCS shall include automated alarming software capable of calling e-mail compatible cellular telephones and pagers. The e-mail alarm paging system shall be able to segregate users, time schedules, and equipment and be capable of being programmed by the Owner.
- F. For the dedicated configuration tool provided, it is preferable that it be launched from within the applicable Network Management Software. If not, include any software required for controller configuration as a leave-behind tool with enough license capability to support the installation.
- G. For each operator workstation provided, furnish one legal copy of all software tools, configuration tools, management tools, and utilities used during system commissioning and installation. All tools shall be readily available in the market. Contractor shall convey to the Owner all software tools and their legal licenses at project closeout.

#### 1.10 SOFTWARE LICENSE AGREEMENT

- A. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive ownership of all job-specific configuration documentation, data files, configuration tools, and application-level software developed for the project. This shall include, but is not limited to, all custom, job-specific software code and documentation for all configuration and programming that is generated for a given project and/or configured for use with the NAC, FMCS Server(s), and any related LAN/WAN/intranet and/or Internet connected routers and devices. Provide the Owner with all required IDs and passwords for access to any component or software program. The Owner shall determine which organizations shall be named in the SI organization ID ("orgid") of all software licenses. Owner shall be free to direct the modification of the "orgid" in any software license, regardless of supplier.

#### 1.11 JOB CONDITIONS

- A. Cooperation with Other Trades: Coordinate the Work of this section with that of other sections to ensure that the Work will be carried out in an orderly fashion. It is this Contractor's responsibility to check the Contract Documents for possible conflicts between the Work of this section and that of other crafts in equipment location; pipe, duct and conduit runs; electrical outlets and fixtures; air diffusers; and structural and architectural features.

#### 1.12 WARRANTY

- A. Refer to Section 23 05 00 for warranty requirements.
- B. Within the warranty period, any defects in the work provided under this section due to faulty materials, methods of installation or workmanship shall be promptly (within 48 hours after receipt of notice) repaired or replaced by this Contractor at no expense to the Owner.
- C. Warranty requirements include furnishing and installing all FMCS software upgrades issued by the manufacturer during the one-year warranty period.
- D. Update all software and back-ups during warranty period and all user documentation on the Owner's archived software disks.

#### 1.13 WARRANTY ACCESS

- A. The Owner shall grant to this Contractor reasonable access to the TCS and FMCS during the warranty period.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. BACnet Protocol:
  - 1. Distech Controls- Tridium
  - 2. Alerton

3. Automated Logic: WebCTRL
4. Delta Controls: ORCA
5. Honeywell
6. Johnson Controls: Metasys Extended Architecture
7. KMC
8. Siemens Building Technologies: APOGEE
9. Schneider Electric - EcoStruxure Building Operation
10. Trane Tracer SC

## 2.2 SYSTEM ARCHITECTURE

### A. General:

1. The Temperature Control System (TCS) and Facility Management Control System (FMCS) shall consist of a network of interoperable, standalone digital controllers, a computer system, graphic user interface software, printers, network devices, valves, dampers, sensors, and other devices as specified herein.

### B. Open, Interoperable, Integrated Architectures:

1. All components and controllers supplied under this Division shall be true "peer-to-peer" communicating devices. Components or controllers requiring "polling" by a host to pass data are not acceptable.
2. The supplied system must be able to access all data using standard Web browsers without requiring proprietary operator interface and configuration programs. An Open DataBase Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on a supplier-installed server for all database access. Systems requiring proprietary database and user interface programs are not acceptable.
3. Hierarchical or "flat" topologies are required to have system response times as indicated below and to manage the flow and sharing of data without unduly burdening the customer's internal intranet network.
  - a. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
  - b. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote or dial-up connected user interfaces.

## 2.3 NETWORKS

A. The Local Area Network (LAN) shall be a 100 megabits/sec Ethernet network supporting BACnet, Java, XML, HTTP, and SOAP. Provide support for multiple Network Area Controllers (NACs), user workstations and, if specified, a local server.

### B. Local area network minimum physical and media access requirements:

1. Ethernet; IEEE Standard 802.3.
2. Cable; 100 Base-T, UTP-8 wire, Category 6.
3. Minimum throughput; 100 Mbps.

- C. Communication conduits shall not be installed closer than six feet from 110VAC or higher transformers or run parallel within six feet of electrical high-power cables. Route the cable as far from interference generating devices as possible. Where communication wire must cross 110VAC or higher wire, it must do so at right angles.
- D. Ground all shields (earth ground) at one point only to eliminate ground loops. Provide all shield grounding at the controller location, with the shield at the sensor/device end of the applicable wire being left long and "safed" off in an appropriate manner.
- E. There shall be no power wiring more than 30 VAC rms run in conduit with communications wiring. In cases where signal wiring is run in conduit with communication wiring, run all communication wiring and signal wiring using separate twisted pairs (24awg) in accordance with the manufacturer's wiring practices.

#### 2.4 NETWORK AREA CONTROLLER (JACE)

- A. The TCC shall supply one or more Network Area Controllers (NAC) as part of this contract. Number of NACs required depends on the type and quantity of devices provided under Divisions 23 and 26. The TCC shall determine the quantity and type of devices.
- B. Each NAC shall provide the interface between the LAN or WAN and the field control devices and shall provide global supervisory control functions over the control devices connected to the NAC. It shall execute application control programs to provide:
  - 1. Calendar functions.
  - 2. Scheduling.
  - 3. Trending.
  - 4. Alarm monitoring and routing.
  - 5. Time synchronization.
  - 6. Integration of all controller data.
  - 7. Network Management functions.
- C. The Network Area Controller shall provide the following hardware features as a minimum:
  - 1. One Ethernet Port - 10/100 Mbps.
  - 2. One RS-232 port.
  - 3. One LonWorks Interface Port - 78KB FTT-10A (for LonWorks systems only).
  - 4. One RS-485 port.
  - 5. Battery backup.
  - 6. Flash memory for long-term data backup. (If battery backup or flash memory is not supplied, the controller shall contain a hard disk with at least 1 gigabyte storage capacity.)
  - 7. The JACE must be capable of operation over a temperature range of 32°F to 122°F.
  - 8. The JACE must be capable of withstanding storage temperatures of between 0°F and 158°F.
  - 9. The JACE must be capable of operation over a humidity range of 5% RH to 95% RH, non-condensing.
- D. The JACE shall provide multiple user access to the system and support for ODBC or SQL. Databases resident on the JACE shall be ODBC-compliant or must provide an ODBC data access mechanism to read and write data stored within it.

- E. The JACE shall support standard Web browser access via the Internet or an intranet and a minimum of five (5) simultaneous users.
- F. Event Alarm Notification and Actions:
  - 1. The JACE shall provide alarm recognition, storage; routing, management, and analysis to supplement distributed capabilities of equipment or application specific controllers.
  - 2. The JACE shall be able to route any alarm condition to any defined user location whether connected to a LAN, remote via dial-up telephone connection, or WAN.
  - 3. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including, but not limited to:
    - a. Alarm
    - b. Normal
  - 4. Provide for the creation of a minimum of eight alarm classes with different routing and acknowledgement properties, e.g. security, HVAC, Fire, etc.
  - 5. Provide timed (scheduled) routing of alarms by class, object, group, or node.
  - 6. Provide alarm generation from binary object "runtime" and/or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control.
- G. Treat control equipment and network failures as alarms and annunciated.
- H. Annunciate alarms in any of the following manners as defined by the user:
  - 1. Screen message text.
  - 2. E-mail of the complete alarm message to multiple recipients. Provide the ability to route and e-mail alarms based on:
    - a. Day of week.
    - b. Time of day.
    - c. Recipient.
  - 3. Pagers via paging services that initiate a page on receipt of e-mail message.
  - 4. Graphic with flashing alarm object(s).
  - 5. Printed message, routed directly to a dedicated alarm printer.
- I. The FMCS shall record the following for each alarm:
  - 1. Time and date.
  - 2. Location (building, floor, zone, office number, etc.).
  - 3. Equipment tag.
  - 4. Acknowledge time, date, and user who issued acknowledgement.
  - 5. Number of occurrences since last acknowledgement.
- J. Give defined users proper access to acknowledge any alarm.
- K. A log of all alarms shall be maintained by the JACE and/or a server (if configured in the system) and shall be available for review by the user.

- L. Provide a "query" feature to allow review of specific alarms by user-defined parameters.
- M. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.
- N. An error log to record invalid property changes or commands shall be provided and available for review by the user.

## 2.5 BACNET FMCS

- A. The intent of this specification is to provide a peer-to-peer networked, standalone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135-2001 BACnet, MODBUS, OPC, and other open and proprietary communication protocols in one open, interoperable system.
- B. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices in the system. Adherence to industry standards including the latest ANSI/ASHRAE Standard 135 (BACnet) to assure interoperability between all system components is required. For each BACnet device, the device supplier must provide a PICS document showing the installed device's compliance level. Minimum compliance is Level 3; with the ability to support data read and write functionality. Physical connection of BACnet devices shall be via Ethernet (BACnet Ethernet/IP) and/or RS-485 (BACnet MSTP).
- C. Interoperable BACnet Controller (IBC):
  1. Controls shall be microprocessor based Interoperable BACnet Controllers (IBC) in accordance with the latest ANSI/ASHRAE Standard 135. Provide IBCs for unit ventilators, fan coils, heat pumps, terminal air boxes (TAB) and other applications. The application control program shall reside in the same enclosure as the input/output circuitry that translates the sensor signals. Provide a PICS document showing the installed system's compliance level to ANSI/ASHRAE Standard 135. Minimum compliance is Level 3.
  2. The IBCs shall be listed by the BACnet Testing Laboratory (BTL) as follows:
    - a. BACnet Building Controller(s) (B-BC).
    - b. BACnet Advanced Application Controller(s) (B-ACC).
    - c. BACnet Application Specific Controller(s) (B-ASC).
  3. The IBCs shall communicate with the NAC via an Ethernet connection at a baud rate of not less than 10 Mbps.
  4. Each IBC sensor shall connect directly to the IBC and shall not use any of the I/O points of the controller. The IBC Sensor shall provide a two-wire connection to the controller that is polarity and wire type insensitive. The IBC sensor shall provide a communications jack for connection to the BACnet communication trunk to which the IBC controller is connected. The IBC sensor, the connected controller, and all other devices on the BACnet bus shall be accessible by the POT.
  5. All IBCs shall be fully application programmable and shall at all times maintain their BACnet Level 3 compliance. Controllers offering application selection only (non-programmable) require a 10% spare point capacity to be provided for all applications. Store all control sequences within or programmed into the IBC in non-volatile memory that does not depend on a battery to be retained.

6. The Contractor supplying the IBCs shall provide documentation for each device, with the following information at a minimum:
  - a. BACnet Device; MAC address, name, type and instance number.
  - b. BACnet Objects; name, type and instance number.
7. It is the responsibility of the Contractor to ensure that the proper BACnet objects are provided in each IBC.

D. Object Libraries:

1. A standard library of objects shall be included for development and setup of application logic, user interface displays, system services, and communication networks.
2. The objects in this library shall be capable of being copied and pasted into the user's database and shall be organized according to their function. In addition, the user shall have the capability to group objects created in their application and store the new instances of these objects in a user-defined library.
3. In addition to the standard libraries specified here, the system supplier shall maintain an on-line accessible (over the Internet) library, available to all registered users, to provide new or updated objects and applications as they are developed.
4. All control objects shall conform to the control objects specified in the BACnet specification.
5. The library shall include applications or objects for the following functions, at a minimum:
  - a. Scheduling Object: The schedule must conform to the schedule object as defined in the BACnet specification, providing seven-day plus holiday and temporary scheduling features and a minimum of 10 on/off events per day. Data entry to be by graphic sliders to speed creation and selection of on-off events.
  - b. Calendar Object: The calendar must conform to the calendar object as defined in the BACnet specification, providing 12-month calendar features to allow for holiday or special event data entry. Data entry to be by graphic "point-and-click" selection. This object must be "linkable" to any or all scheduling objects for effective event control.
  - c. Override Object: Provide override object that is capable of restarting equipment turned off by other energy saving programs to maintain occupant comfort or for equipment protection.
  - d. Start-Stop Time Optimization Object: Provide a start-stop time optimization object to start equipment just early enough to bring space conditions to desired conditions by the scheduled occupancy time. Also, allow equipment to be stopped before the scheduled unoccupied time just far enough ahead to take advantage of the building's "flywheel" effect for energy savings. Provide automatic tuning of all start-stop time object properties based on historical performance.
  - e. Demand Limiting Object: Provide a demand-limiting object that is capable of controlling demand for any selected energy utility (electric, oil, gas, etc.). The object shall be able to monitor a demand value and predict (using a sliding window prediction algorithm) the demand at the end of the user-defined interval period (1 to 60 minutes). This object shall also accommodate a utility meter time sync pulse for fixed interval demand control. Upon a prediction that will exceed the user-defined demand limit (supply a minimum of 6 per day), the demand limiting object shall issue shed commands to either turn off user specified loads or modify

equipment setpoints to provide the desired energy reduction. If the list of sheddable equipment is not enough to reduce the demand to below the setpoint, display a message on the user's screen (as an alarm) instructing the user to take manual actions to maintain the desired demand. The shed lists are specified by the user and shall be selectable to be shed in either a fixed or rotating order to control which equipment is shed the most often. Upon suitable reductions in demand, the demand-limiting object shall restore the equipment that was shed in the reverse order in which it was shed. Each sheddable object shall have a minimum and maximum shed time property to provide both equipment protection and occupant comfort.

6. The library shall include control objects for the following functions:
  - a. Analog Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. Allow high, low and failure limits to be assigned for alarming. Also, provide a time delay filter property to prevent nuisance alarms caused by temporary excursions above or below the user defined alarm limits.
  - b. Analog Output Object: Minimum requirement is to comply with the BACnet standard for data sharing.
  - c. Binary Input Object: Minimum requirement is to comply with the BACnet standard for data sharing. The user must be able to specify either input condition for alarming. This object must also include the capability to record equipment runtime by counting the amount of time the hardware input is in an "on" condition. The user must be able to specify either input condition as the "on" condition.
  - d. Binary Output Object: Minimum requirement is to comply with the BACnet standard for data sharing. Properties to enable minimum on and off times for equipment protection as well as start-to-start delay must be provided. Incorporate the BACnet Command Prioritization priority scheme to allow multiple control applications to execute commands on this object with the highest priority command being invoked. Provide 16 levels of priority as a minimum. Systems not employing the BACnet method of contention resolution are not acceptable.
  - e. PID Control Loop Object: Minimum requirement is to comply with the BACnet standard for data sharing. Each individual property must be adjustable to allow proportional control only, or proportional with integral control, or proportional, integral and derivative control.
  - f. Comparison Object: Allow a minimum of two analog objects to be compared to select either the highest, lowest, or equality between the two linked inputs. Also, allow limits to be applied to the output value for alarm generation.
  - g. Math Object: Allow a minimum of four analog objects to be tested for the minimum or maximum, or the sum, difference, or average of linked objects. Also, allow limits to be applied to the output value for alarm generation.
  - h. Custom Programming Objects: Provide a blank object template for the creation of new custom objects to meet specific user application requirements. This object must provide a simple BASIC-like programming language that is used to define object behavior. Provide a library of functions including, but not limited to, math and logic functions and string manipulation. Also, provide a comprehensive on-line debug tool to allow complete testing of the new object. Allow new objects to be stored in the library for reuse.

- i. Interlock Object: Provide an interlock object that provides a means of coordination of objects within a piece of equipment, such as an air handler or other similar types of equipment. An example is to link the return fan to the supply fan such that, when the supply fan is started, the return fan object is also started automatically without the user having to issue separate commands or to link each object to a schedule object. In addition, the control loops, damper objects, and alarm monitoring (such as return air, supply air, and mixed air temperature objects) will be inhibited from alarming during a user-defined period after startup to allow for stabilization. When the air handler is stopped, the interlocked return fan is also stopped, the outside air damper is closed, and other related objects within the air handler unit are inhibited from alarming, thereby eliminating nuisance alarms during the off period.
  - j. Temperature Override Object: Provide an object whose purpose is to override a binary output to an "on" state in the event a user-specified high or low limit value is exceeded. Link this object to the desired binary output object as well as to an analog object for temperature monitoring to cause the override to be enabled. This object will execute a start command at the Temperature Override level of start/stop command priority, unless changed by the user.
  - k. Composite Object: Provide a container object that allows a collection of objects representing an application to be encapsulated to protect the application from tampering or to more easily represent large applications. This object must have the ability to allow the user to select the appropriate parameters of the "contained" application that are represented on the graphic shell of this container.
7. The object library shall include objects to support the integration of devices connected to the Network Controller (JACE). Provide the following as part of the standard library included with the programming software:
- a. For BACnet devices, provide the following objects:
    - 1) Analog In.
    - 2) Analog Out.
    - 3) Analog Value.
    - 4) Binary.
    - 5) Binary In.
    - 6) Binary Out.
    - 7) Binary Value.
    - 8) Multi-State In.
    - 9) Multi-State Out.
    - 10) Multi-State Value.
    - 11) Schedule Export.
    - 12) Calendar Export.
    - 13) Trend Export.
    - 14) Device.
  - b. For each BACnet object, provide the ability to assign the object a BACnet device and object instance number.
  - c. For BACnet devices, provide the following support at a minimum:
    - 1) Segmentation.
    - 2) Segmented Request.
    - 3) Segmented Response.

- 4) Application Services.
- 5) Read Property.
- 6) Read Property Multiple.
- 7) Write Property.
- 8) Write Property Multiple.
- 9) Confirmed Event Notification.
- 10) Unconfirmed Event Notification.
- 11) Acknowledge Alarm.
- 12) Get Alarm Summary.
- 13) Who-has.
- 14) I-have.
- 15) Who-is.
- 16) I-am.
- 17) Subscribe COV.
- 18) Confirmed COV notification.
- 19) Unconfirmed COV notification.
- 20) Media Types.
- 21) Ethernet.
- 22) BACnet IP Annex J.
- 23) MSTP.
- 24) BACnet Broadcast Management Device (BBMD) function.
- 25) Routing.

## 2.6 TERMINAL AIR BOX (TAB) CONTROLLERS

- A. FMCS Volume Controller: Electronic, furnished and installed by TCC. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Provide velocity and static sensor at box inlet for use by unit controller. Set boxes for maximum and minimum settings shown on the drawings. Refer to Section 23 36 00 for additional information.
- B. The controller shall support various digital and analog inputs and outputs as needed for damper control, control valves, electric coils, airflow sensors, remote heating, occupancy sensors, etc. and shall be capable of independent occupancy scheduling.
- C. Controller shall provide continuous zone temperature histories internal to device for up to 24 hours and perform its own limit and status monitoring and alarms to limit unnecessary communications.
- D. Operator interface to any ASC point data or programs shall be through network resident programs or portable operator's terminal connected to the specific controller.
- E. Store all system setpoints, proportional bands, control algorithms, and other programmable parameters such that a power failure of any duration does not necessitate reprogramming of the controller.
- F. BACnet TAB controllers shall either be B-AAC devices or B-ASC devices as required to meet the performance and BTL listing.

## 2.7 DATA COLLECTION AND STORAGE (TRENDING REQUIREMENTS)

- A. Shall be completed on WebSuper as referenced above
- B. The JACE shall be able to collect data for any property of any object and store resident in the JACE that shall have, at a minimum, the following configurable properties:
  - 1. Designating the log as interval or deviation.
  - 2. For interval logs, configure the object for time of day, day of week and the sample collection interval.
  - 3. For deviation logs, configure the object for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
  - 4. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full or rollover the data on a first-in, first-out basis.
- C. Store all log data in a relational database in the JACE that is accessible from a server (if the system is so configured) or a standard Web browser.
- D. All log data, when accessed from a server, shall be capable of being manipulated using standard SQL statements.
- E. All log data shall be available to the user in ALL the following data formats:
  - 1. HTML.
  - 2. XML.
  - 3. Plain text.
  - 4. Comma or tab separated values.
- F. The JACE shall archive its log data either locally (to itself) or remotely to a server or other JACE on the network. Provide the ability to configure the following archiving properties:
  - 1. Archive on time of day.
  - 2. Archive on user-defined number of data stores in the log (buffer size).
  - 3. Archive when log has reached its user-defined capacity of data stores.
  - 4. Provide ability to clear logs once archived.

## 2.8 AUDIT LOG

- A. Provide and maintain an audit log that tracks all activities performed on the NAC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the JACE), to another JACE on the network, or to a server. For each log entry, provide the following data:
  - 1. Time and date.
  - 2. User ID.
  - 3. Change or activity: i.e., change setpoint, add or delete objects, commands, etc.

## 2.9 DATABASE BACKUP AND STORAGE

- A. The JACE shall automatically backup its database on a user-defined time interval.
- B. Store copies of the current database and, at the most, the recently saved database in the JACE. The age of the most recently saved database shall depend on the user-defined database save interval.
- C. Store the JACE database in XML format to allow viewing and editing. Other formats are acceptable as long as XML format is supported.

## 2.10 GRAPHIC USER INTERFACE COMPUTER HARDWARE (LAPTOP COMPUTER)

- A. Provide an Intel i7 processor based laptop computer with 8 GB RAM and 750-gigabyte minimum hard drive. It shall include a CD/DVD+/-R optical drive. Laptop computer shall be equipped with minimum 15" screen.
- B. Connect to the FMCS network via a 10/100 Mbps Ethernet network interface card.
- C. Provide a color laser system printer with a minimum 600 x 600-dpi resolution and 12 ppm print speed.

## 2.11 UNINTERRUPTIBLE POWER SUPPLY (UPS)

- A. A UPS shall be provided for each of the following:
  - 1. FMCS workstations and servers.
  - 2. Network area controllers.
  - 3. Chiller plant manager.
  - 4. Boiler plant manager.
- B. Provide a 120-volt 60 Hz line-interactive uninterruptible power supply with backup battery capacity for 5 minutes at 100% load. UPS shall have hot swappable batteries, automatic battery self-test and start-on-battery capabilities. Batteries shall be valve regulated, sealed lead acid type. UPS shall have sine wave shape output waveform. UPS shall be UL 1778 list and comply with FCC Part 15, Class A.
- C. Manufacturers:
  - 1. Sola/Hevi-Duty
  - 2. Eaton Powerware
  - 3. APC

## 2.12 SYSTEM PROGRAMMING

- A. The GUI software shall perform system programming and graphic display engineering. Access to the GUI software shall be through password access as assigned by the system administrator.

- B. Provide a library of control, application, and graphic objects to enable creation of all applications and user interface screens. Applications shall be created by selecting the control objects from the library, dragging or pasting them on the screen, and linking them together using a built-in graphic connection tool. Completed applications may be stored in the library for future use. GUI screens shall be created in the same fashion. Data for the user displays shall be obtained by graphically linking the user display objects to the application objects to provide "real-time" data updates. Any real-time data value or object property may be connected to display its current value on a user display. Provide all software tools or processes to create applications and user interface displays.
- C. Programming Methods:
  - 1. Provide the capability to copy objects from the supplied libraries or from a user-defined library to the user's application. Link objects with a graphic linking scheme by dragging a link from one object to another. Object links will support one-to-one, many-to-one, or one-to-many relationships. Linked objects shall maintain their connections to other objects regardless of where they are positioned on the page and shall show link identification for links to objects on other pages for easy identification. Links will vary in color depending on the type of link; e.g., internal, external, hardware, etc.
  - 2. Configuration of each object shall be done through the object's property sheet using fill-in-the-blank fields, list boxes, and selection buttons. Use of custom programming, scripting language, or a manufacturer-specific procedural language for configuration is not acceptable.
  - 3. The software shall provide the ability to view the logic in a monitor mode. When on-line, the monitor mode shall provide the ability to view the logic in real time for easy diagnosis of the logic execution. When off-line (debug), the monitor mode shall allow the user to set values to inputs and monitor the logic for diagnosing execution before it is applied to the system.
  - 4. All programming shall be done in real time. Systems requiring the uploading, editing, and downloading of database objects are not allowed.
  - 5. The system shall support object duplication in a customer's database. An application, once configured, can be copied and pasted for easy reuse and duplication. All links, other than to the hardware, shall be maintained during duplication.

## 2.13 DDE DEVICE INTEGRATION

- A. The JACE shall support the integration of device data via Dynamic Data Exchange (DDE) over the Ethernet network. The JACE shall act as a DDE client to another software application that functions as a DDE server.
- B. Provide the required objects in the library included with the Graphic User Interface programming software to support the integration of these devices into the FMCS. Objects provided shall include, at a minimum:
  - 1. DDE Generic AI Object.
  - 2. DDE Generic AO Object.
  - 3. DDE Generic BO Object.
  - 4. DDE Generic BI Object.

## 2.14 CONTROL DAMPERS

### A. Rectangular Control Dampers - Standard Construction:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Hat-shaped channel, minimum 12 gauge extruded aluminum, and minimum 4" deep. Caulk or weld seams to prevent leakage.
4. Blades: Minimum 12 gauge extruded aluminum airfoil design, minimum 6" wide, and overlapping blades and blade seals (overlapping blade seals only is unacceptable).
5. Shaft: Non-cylindrical, solid aluminum or zinc plated steel with opening in blade to match profile of shaft. Shaft shall be securely fastened to the blade and of sufficient length to mount direct-coupled actuator. Damper manufacturer shall provide drive pin extensions and outboard bearing support brackets as required.
6. Bearings: Acetal (Delrin/Celcon) inner bearing fixed to an aluminum shaft, rotating within a polycarbonate outer bearing inserted in the frame. Provide thrust bearings for vertical damper applications.
7. Blade Seals: Extruded silicone gaskets secured in an integral slot within the blade.
8. Side Seals: Stainless steel compression type or extruded silicone gasket secured in an integral slot within the frame.
9. Linkage: Shall be concealed in the frame, constructed of aluminum or corrosion-resistant zinc plated steel, and securely fastened to shaft. Blades linked for opposed operation, unless noted otherwise on the drawings. Blades shall close evenly. Use one direct-coupled actuator per damper section. Jack-shafting is not acceptable.
10. Size Limits: 48" maximum horizontal blade length, 24 square foot maximum area per damper. Total cross-sectional area of dampers in ducts shall be at least as large as the duct without the use of blank-off sections.
11. Maximum Leakage: Class 1A at 1" w.c. pressure differential for a 24" x 24" damper.
12. Maximum Pressure Drop for Opposed Blade Damper: 0.15" for 8,000 cfm through a 24" x 24" damper (2000 fpm).
13. Maximum Pressure Drop for Parallel Blade Damper: 0.08" for 8,000 cfm through a 24" x 24" damper (2000 fpm).

### B. Thermally Insulated Control Damper:

1. Shall be licensed to bear the AMCA Certified Rating Seal.
2. Test leakage and pressure drop per AMCA 500.
3. Frame: Extruded aluminum, minimum 4" deep, 0.080" minimum thickness.

## 2.15 DAMPER ACTUATORS

### A. Damper Actuators - Electronic - Spring Return:

1. Damper actuators shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).

2. Following power interruption, spring return mechanism shall close the damper. Mechanical spring shall be rated for a minimum of 60,000 full cycles. Provide breathable membrane in actuator housing to compensate for pressure differential and allow for 95% non-condensing relative humidity in the airstream.
3. Mount actuators with motor outside of airstream whenever possible. Unit casings shall have housing with proper weather, corrosive, or explosion-proof construction as required by application.
4. Actuators shall be rated for 60,000 full cycles at rated torque with 2-year unconditional warranty. Size actuators per damper manufacturer's recommendations.
5. Provide end switches as required for the sequence of operation.
6. Provide analog feedback signal for positive position indication. Refer to FMCS points list.

## 2.16 HYDRONIC CONTROL VALVES

### A. General:

1. Size two-way modulating valves to provide a pressure drop at full flow of 1 to 4 psi, except boiler three-way and cooling tower bypass valves shall not have a pressure drop over 2 psi.
2. Two-way valves shall be 100% tight-closing. Three-way valves shall be 100% tight-closing in both extreme positions.
3. Modulating two-way valves shall have equal percentage flow characteristics.
4. Piping geometry correction factors for Cv ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.

### B. Modulating:

1. Globe 1/2" to 2":
  - a. Design Pressure: 250 psi
    - 1) Design Temperature: 212°F
    - 2) Design Flow Differential Pressure Rating: 35 psi
  - b. Bronze or brass body, trim and plug; stainless steel stem; stainless steel or bronze seat; EPDM or PTFE packing; threaded ends.
2. Globe 2-1/2" to 6":
  - a. Design Pressure: 125 psi
    - 1) Design Temperature: 250°F
    - 2) Design Flow Differential Pressure Rating: 25 psi
  - b. Cast iron body, bronze or brass trim and plug; stainless steel stem; bronze seat; EPDM or PTFE packing; flanged ends.
3. Ball 2" and under:
  - a. Design Pressure: 400 psi

- 1) Design Temperature: 212°F
  - 2) Design Flow Differential Pressure Rating: 35 psi
- b. Bronze or brass body, nickel plated brass or stainless steel stem, chrome plated brass or stainless steel ball, PTFE or RTFE seats and seals, screwed ends (solder ends are acceptable only if rated for soldering in line with 470°F melting point of 95-5 solder).
4. Ball 3" to 6":
- a. Design Pressure: 200 psi
    - 1) Design Temperature: 212°F
    - 2) Design Flow Differential Pressure Rating: 35 psi
  - b. Cast iron body, stainless steel stem, stainless steel full port ball, PTFE or RTFE seats and seals, flanged ends.
5. Butterfly 2-1/2" to 12":
- a. Design Pressure: 125 psi
    - 1) Design Temperature: -20°F to 212°F
    - 2) Design Flow Differential Pressure Rating: 50 psi
  - b. Cast iron body, stainless steel stem with extended neck, aluminum-bronze or nickel-plated iron disc, EPDM seats and seals, fully lugged ends.

## 2.17 STEAM CONTROL VALVES

### A. General:

1. Two-position valves shall have a maximum pressure drop equal to 10% of the inlet pressure.
2. Modulating control valves shall have modified linear characteristics.
3. Two modulating control valves in parallel shall have 1/3 - 2/3 capacities sequenced so that the smaller valve opens first.
4. The pressure drop through a modulating control valve with an inlet pressure less than or equal to 15 psig shall be equal to 80% of the inlet pressure. In no case shall the inlet pressure of the equipment after the valve be less than 2 psig, except for integral face and bypass coils where the inlet pressure after the valve shall not be less than 5 psig.
5. The pressure drop through modulating control valves with inlet pressures greater than 15 psig shall be required to provide outlet pressure of 1 psi above the scheduled or specified inlet pressure of the equipment served.
6. Piping geometry correction factors for Cv ratings shall be used and stated for ball valves, butterfly valves, or non-characterized valves.

## 2.18 VALVE ACTUATORS

### A. Valve Actuators - Electronic:

1. Actuator shall be UL listed and provided with NEMA housing for applicable environment, electronic overload protection to prevent actuator damage due to over-rotation, and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
2. Actuators shall be rated for 60,000 full stroke cycles at rated torque. Stall motor not acceptable.
3. Tri-state/floating actuators shall have auto-zeroing function for realigning valve position.
4. Proportional actuator position shall be proportional to analog or pulse width modulating signal from electronic control system.
5. Spring return actuators shall have an internal spring return mechanism. Non-mechanical forms of fail-safe operation are not acceptable.
6. Provide analog feedback signal for positive position indication as required by control diagrams.

## 2.19 CONTROL INSTRUMENTATION

### A. Temperature Measuring Devices:

1. Electric Thermostats:
  - a. Single Temperature - Line Voltage Electric: Integral manual ON/OFF/AUTO selector switch, minimum dead band of 5°F, concealed temperature adjustment, locking cover, rated for load, single or double pole as required.
2. Low Limit Switch:
  - a. Provide one foot of sensing element for each one square foot of coil area, maximum element length 25 feet, of the vapor tension type, so that any point along the entire length of measuring element can trigger the switch.
  - b. Provide 3" minimum radius capillary support clips at each turn.
  - c. Furnish each thermostat with one single pole, single throw normally-opened switch and one single pole, single throw normally-closed auxiliary switch.
  - d. Setpoint range shall be 15°F to 55°F with a permanent stop at 35°F.
  - e. Differential shall be fixed at approximately 5°F and supplied with manual reset.

### B. Temperature Sensors:

1. Room Temperature Sensor:
  - a. Per Rockford Public School District - Sensor Only: Two-piece construction, ventilated plastic enclosure, off-white color, thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range,  $\pm 0.50^\circ\text{F}$  accuracy, no setpoint adjustment or override button.

2. Duct Temperature Sensor:
    - a. Thermistor or RTD type. Pneumatic transmitters with transducers are not acceptable.
  3. Water Temperature Sensor:
    - a. Install in immersion wells. Separate thermometers as specified elsewhere, also of the immersion well type, shall be installed within 2 feet of each temperature sensor.
- C. Humidity Measuring Devices:
1. Humidity Sensors:
    - a. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be minimum of 2.0 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90-100 %RH humidity at temperatures from 50°F to 104°F.
    - b. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service. Accuracy shall be  $\pm 2\%$  of reading.
  2. Humidistats:
    - a. Room Humidistats: Wall-mounted, proportioning type, with adjustable 2% RH throttling range, operating range from 30% to 80% at temperatures up to 110°F, cover with concealed setpoint. Accuracy shall be minimum of 1.5 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90-100 %RH at temperatures from 50°F to 104°F.
    - b. Duct Humidistats: Proportioning insertion type, with adjustable 2% RH throttling range and operating range from 20% to 80% at temperatures up to 150°F. Accuracy shall be minimum of 1.5 %RH accuracy from 0-90 %RH and 2.5 %RH accuracy from 90-100 %RH at temperatures from 50°F to 104°F.
    - c. High Limit Duct Humidistat: 2-position insertion type, with differential maximum 2% RH.
- D. Combination Room Temperature/Humidity Sensors:
1. Wall-mounted two-piece construction, plastic enclosure, off-white color with temperature and humidity measurement, exposed single setpoint adjustment and occupant override. Large display with temperature and %RH readout display, occupied/unoccupied override button with LED.
  2. Temperature Component: Thermistor sensing element or resistance temperature device (RTD), 45°F to 90°F operating range,  $\pm 0.50^\circ\text{F}$  accuracy.
  3. Humidity Component: Proportioning type, with adjustable 2% RH throttling range, operating range from 0% to 90% at temperatures up to 110°F. Accuracy shall be minimum of 2.0 %RH accuracy from 0-90 %RH.
- E. Enthalpy Sensors: Duct-mounted enthalpy sensor shall include solid state temperature and humidity sensors with electronics that shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

F. Pressure Measuring Devices

1. Differential Pressure Switches:

a. Standard Pressure Switches:

- 1) Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig.
- 2) Accuracy shall be  $\pm 3\%$  of full scale maximum throughout entire range at 70°F.
- 3) Provide mounting brackets, probes, and shutoff valves required for proper installation.
- 4) The range and service shall be as required for application or as noted on the drawings.
- 5) Provide two (2) photo-transistor-activated circuits and two (2) DPDT relays for both high or low limit alarms or controls.
- 6) Provide latching relays that require manual reset once activated.
- 7) Acceptable Manufacturer: Dwyer Photohelic Series 3000.

b. High Pressure Switches (Manual Reset):

- 1) Differential pressure switch with single pole, double-throw snap switch and enclosure.
- 2) Rated for pressure specified in sequence of control.
- 3) Electrical rating shall be 15 amps at 120-480 volts.
- 4) Setpoint adjustment shall be screw type located inside enclosure.
- 5) Provide optional manual reset for overpressure protection with all tubing, brackets, and adapters.
- 6) Repeatability:  $\pm 3\%$ .

2. Pressure Transmitters/Transducer:

a. Air-to-Air:

- 1) Provide transducer having the following minimum performance for measuring duct static pressure for VFD control or measuring differential pressure across filter banks:
  - a) Accuracy:  $\pm 1.0\%$  FS
  - b) Non-Linearity, BFSL:  $\pm 0.96\%$  FS
  - c) Hysteresis: 0.10% full scale
  - d) Non-Repeatability: 0.05% full scale
  - e) Thermal Effects (compensated range): 0°F to +150°F
  - f) Maximum Line Pressure: 10 PSI
  - g) Zero/Span Shift: 0.033%FS/°F
  - h) Long Term Stability: 0.5%FS/1year
- 2) Provide transducer with the following minimum performance for measuring differential pressure across piezometer fan inlet airflow measuring stations:
  - a) Unit shall come factory equipped with static tube attached.

- b) Unit shall include: (1) LCD shall display differential pressure on face of sensor enclosure over the entire operational range, and (2) IPCC-rated polycarbonate enclosure with short circuit proof outputs and reverse polarity protected inputs.
  - c) Accuracy at 72°F:  $\pm 0.25\%$  FS
  - d) Stability:  $\pm 0.25\%$  full scale per year
  - e) Temperature Error: (1) Zero:  $\pm 0.025\%$  full scale per °C, (2) Span: Maximum  $\pm 0.03\%$  full scale per °C
  - f) Environmental Operating Range: 32°F to 140°F.
  - g) Overpressure: Proof: (1) 2 psi, (2) Burst: 3 psi
  - h) Humidity: 0% to 95% RH non-condensing.
- b. Wet-to-Wet (uses include measuring hydronic system differential pressure for VFD control):
- 1) Unidirectional pressure range selected for appropriate range based on the application.
  - 2) Provide transducer with minimum 250 psi high side proof pressure and minimum 60 psi low side proof pressure.
  - 3) Case shall be constructed of stainless steel/aluminum and shall be equipped with 1/4" threaded connections. Wetted parts shall be constructed of 300 series stainless steel. Provide transducer with Viton and silicone O-rings for solutions containing water and/or glycol. Provide transducer with Buna-N O-rings for hydrocarbon solutions.
  - 4) Provide transducer with factory assembled 3-valve manifold assembly to allow for field calibration of transducer.
  - 5) Performance shall be as follows:
    - a) Accuracy:  $\pm 0.25\%$  F.S.
    - b) Non-Linearity:  $\pm 0.20\%$  F.S.
    - c) Hysteresis: 0.10% F.S.
    - d) Non-Repeatability: 0.05% F.S.
    - e) Compensated Temp Range: +30°F to +150°F
    - f) Long Term Stability: 0.5% F.S./year

G. Flow Measuring Devices:

- 1. Flow Switches:
  - a. Suitable for the intended application (water or air system).
  - b. Vane Operated Flow Switch: Vane motion shall activate a single pole, double throw snap switch.
- 2. Inline Electromagnetic Flow Meters:
  - a. General:
    - 1) Each flow meter shall be of the electromagnetic type.

- b. Service:
  - 1) Chilled Water: Rated for 32°F through 140°F service.
  - 2) Condensate and Heating Water: Rated for minimum of 240°F service.
  
- c. Electromagnetic Flow Tube:
  - 1) Each meter shall be rated for system pressure and shall have adequate structural integrity for a flow rate equal to 150% of the scheduled maximum initial or future flow rate, whichever is greater.
  - 2) Each meter shall have flanged connections to match piping pressure class, an outer body constructed of 316 stainless steel, a full line-size 304 stainless steel flow tube, 316 stainless steel electrodes, and a liner that is fully compatible with the chemical content of the flow media.
  
- d. Transmitter:
  - 1) Each meter shall incorporate an integral programmable transmitter that incorporates a digital display.
  - 2) Each transmitter shall calculate and display flow rate and net totalized flow, along with associated engineering units (e.g., GPM and Gal.).
  - 3) Each transmitter shall produce an analog output signal that is directly proportional to volumetric flow rate. This signal shall be scalable to indicate flow rate in either direction. In lieu of such bidirectional scalability, two separate pulsed outputs shall be provided. One shall indicate incremental flow in one direction, while the other indicates incremental flow in the opposite direction such that net totalized flow can be calculated remotely.
  - 4) Unless scheduled or otherwise indicated, the initial span adjustment of each transmitter shall be 0-120% of the scheduled maximum flow rate.
  - 5) Each transmitter shall incorporate self-diagnostics and test functions to permit internal checks of all outputs and displays, and to verify the accuracy of the unit and the integrity of the current loop without any external equipment.
  
- e. Accuracy:
  - 1) Non-billing Purposes: The accuracy of each meter/transmitter assembly shall be  $\pm 0.5\%$  of flow rate reading over a range of 3-15 feet/second fluid velocity, with a repeatability of 0.1%. Accuracy at 1 foot/second shall be  $\pm 0.75\%$ .
  
- f. Display Unit:
  - 1) Pair with Display Unit described below.
  
- g. BTU Meter:
  - 1) Pair with BTU Meter described below.

- h. Calibration:
    - 1) Each meter shall be calibrated on an NIST traceable flow stand at 1, 8, and 15 feet/second. Provide written documentation of calibration.
  - i. Installation and Startup:
    - 1) Each meter assembly shall include detailed installation and operation instructions, including piping straight run requirements.
  - j. Warranty:
    - 1) Each meter assembly shall carry a performance warranty of at least two years from the date of installation and startup. This warranty shall cover parts and labor for repair or replacement of the meter assembly. Performance during the warranty period shall satisfy the above-stated requirements for accuracy and repeatability.
  - k. Manufacturers:
    - 1) ABB
    - 2) Yokogawa
    - 3) Rosemount
    - 4) Onicon
    - 5) Badger.
3. Airflow Measuring Stations:
- a. In accordance with the requirements of LEED EQc1: Outdoor Air Delivery Monitoring, any AFMS used to measure outside air CFM shall have an accuracy of  $\pm 15\%$  of the design minimum outdoor air flow rate (or better). The AFMS accuracy shall also comply with requirements outlined in the following paragraphs of this specification.
  - b. Duct Mounted Airflow Measuring Stations (AFMS) - Thermal Dispersion:
    - 1) Provide airflow/temperature measurement devices where indicated on the plans.
    - 2) Each AFMS shall consist of one or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.
      - a) Each sensor assembly shall contain two individually wired, hermetically sealed bead-in-glass thermistors.
      - b) Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.
      - c) Devices using chip-in-glass or diode-case chip thermistors are not acceptable.
      - d) Devices using less than two thermistors in each sensor assembly are not acceptable.
      - e) Devices using platinum wire RTDs are not acceptable.

- f) Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.
- g) Pitot tubes and arrays are not acceptable.
- h) Vortex shedding devices are not acceptable.

3) All Sensor Probes:

- a) Each sensor assembly shall independently determine the velocity and temperature at its measurement point.
- b) Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).
- c) Airflow measuring station assembly accuracy shall be  $\pm 2\%$  of Reading over the entire operating airflow range. Temperature accuracy shall be  $\pm 0.15^\circ \text{F}$  between  $-20^\circ \text{F}$  and  $160^\circ \text{F}$ .
- d) The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).
- e) Each sensor probe shall have an integral, UL listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.
- f) The number of probes shall be as recommended by the manufacturer to achieve the specified accuracy.

4) Duct and Plenum Probes:

- a) Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.
- b) Probe assembly mounting brackets shall be constructed of 304 stainless steel.

5) Sensor Density:

Area (sq.ft.)	Total # of Sensors Required
Less than 2	4
2 to less than 4	6
4 to less than 8	8
8 to less than 16	12
$\geq 16$	16

6) Transmitters:

- a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
- b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
- c) The operating temperature range for the transmitter shall be  $-20^\circ \text{F}$  to  $120^\circ \text{F}$ .

- d) The transmitter shall be capable of communicating with other devices using one of the following interface options:
  - e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
  - f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
  - g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.
- c. Fan Inlet Airflow Measuring Stations (AFMS) - Thermal Dispersion:
- 1) Sensor assemblies shall be mounted on 304 stainless steel housings.
  - 2) Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
  - 3) Mounting feet shall be constructed of 304 stainless steel and securely riveted in place to prevent loosening over time due to vibration.
  - 4) The operating airflow range shall be 0 to 10,000 FPM unless otherwise indicated on the plans.
  - 5) Transmitters
    - a) The transmitter shall have an integral 16-character alphanumeric LCD display capable of simultaneously displaying individual airflow and temperature.
    - b) The transmitter shall be capable of field configuration and diagnostics using an on-board interface and LCD display.
    - c) The operating temperature range for the transmitter shall be -20° F to 120° F.
    - d) The transmitter shall be capable of communicating with other devices using one of the following interface options:
    - e) Option 1: Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10VDC/4-20mA (4-wire)
    - f) Option 2: RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus. BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.
    - g) Option 3: 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP. Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.
    - h) Option 4: LonWorks Free Topology
  - 6) The AFMS shall be UL listed as an entire assembly.

H. Current Measuring Devices:

1. Current Switches for Constant Speed Motors:

- a. Digital device rated for amperage load of motor or device with split core design, adjustable high and low trip points, 600 VAC rms isolation, induced power from the monitored load, LED indicator lamps for output status and sensor power. The device shall sense overloading, belt-loss, and power failure with a single signal.

2. Current Switches for Motors Controlled by VFD:

- a. Digital device rated for amperage load of motor or device with split core design, factory programmed to detect motor undercurrent conditions on variable or constant volume loads, self-calibrating, positive status indication, LED indicator lamps, 600 VAC rms isolation, induced power from the monitored load with NO output. The current sensor shall store the motor current operating parameters in non-volatile memory and have a pushbutton reset to clear the memory if the operating parameters change or the sensor is moved to another load. The device shall sense overloading, belt-loss, and power failure with a single signal. The sensor shall be mounted on the load side of variable frequency drives.

I. Carbon Monoxide Sensors:

1. Solid-state gas sensor/transmitter, NEMA 1 gasketed enclosure, normal operating temperature 0-120°F, normal relative humidity operation 5-95%,  $\pm 5\%$  accuracy, and detection range of 0-200 ppm.
2. Provide 4-20 mA output from the sensor to the FMCS system.
3. Provide local alarm whenever carbon monoxide level exceeds 100 ppm.
4. Install in accordance with OSHA requirements.
5. Unit shall be factory calibrated and shall be re-calibrated after installation per manufacturer's recommendations.

J. Miscellaneous Devices:

1. Application Specific Controller Power Supply:

- a. For use with terminal air box or fan coil unit.
- b. Provide multiple enclosures with the following accessories and components as required to provide 24VAC power to terminal air boxes, differential pressure monitors, damper actuators, valve actuators, and other components and devices as required.
- c. NEMA-1 steel enclosures (12"x12"x6") with separate high and low voltage compartments and separate access covers.
- d. Either one 300 VA power supply with three 100 VA Class 2 outputs, or one 500 VA power supply with five 100 VA Class 2 outputs.
- e. Primary side shall receive 480/277/240/120 input to 24 VAC ungrounded, isolated output on the secondary side.
- f. Each secondary output shall include a 4 amp breaker, on/off switch, and LED indicator. Terminal blocks shall accept 16-22 AWG wire.

- g. Acceptable Manufacturer:
  - 1) RIB Functional Devices Model MSH300A-LVC or PSH500A-LVC
- 2. Control Relays:
  - a. Form "C" contacts rated for the application with "push-to-test" contact transfer feature and an integral LED to indicate coil energization.
  - b. Mount all relays and power supplies in a NEMA 1 enclosure beside the FMCS panel or controlled device and clearly label their functions.
- 3. Thermostat and Sensor Enclosures:
  - a. Heavy Duty Enclosure:
    - 1) Usage: Gym, Pool
    - 2) Perforated steel, tamperproof locking thermostat and control device enclosure.
    - 3) Box shall be nominally 8"x6"x2" deep or sized as required to fit devices to be enclosed.
    - 4) Perforated cover shall be 16 gauge steel with maximum 3/16" perforations on maximum 1/4" staggered centers for a 55% free area.
    - 5) Secure to wall from inside of box. Cover shall be secured by tamperproof screws to frame.
    - 6) Color shall match electrical devices. Verify color with the Electrical Contractor.

K. Outdoor Weather Station:

- 1. Outdoor rated ventilated plastic enclosure, off-white color, radiation shield including the following parameters.
- 2. Measured Parameters:
  - a. Temperature Sensor: Thermistor sensing element or resistance temperature device (RTD).
    - 1) Operating Range: -40°F to 140°F
    - 2) Accuracy:  $\pm 0.54^\circ\text{F}$  at 68°F
  - b. Humidity Sensors: Fully electronic with no moving parts or parts requiring periodic service.
    - 1) Measurement Range: 0-100% RH
    - 2) Accuracy:
      - a)  $\pm 3\%$  of reading from 0%-90% RH at 50°F to 86°F
- 3. Calculated Parameters:
  - a. Dew Point Temperature in °F
  - b. Wet Bulb Temperature in °F

- c. Enthalpy. Enthalpy sensor shall output a 4-20 ma signal input to the controller upon a varying enthalpy (total heat) to enable economizer modes of operation when outside air enthalpy is suitable for free cooling.

## 2.20 CONDUIT AND BOXES

- A. Conduit and Boxes: Refer to Electrical Section 26 05 33 for materials, sizing, and other requirements
- B. Conduit and Box Identification (Color and Labeling):
  - 1. Refer to the Temperature Control Contractor notes located on the temperature controls cover sheet for raceway and box color requirements.
  - 2. Refer to Electrical Section 26 05 53 for raceway and box labeling requirements.

## 2.21 WIRE AND CABLE

- A. Wire and Cable: Refer to Electrical Section 26 05 13 for wire and cable materials.
  - 1. Wire and Cable Color: Refer to the Temperature Control Contractor notes located on the temperature controls cover sheet for wire and cable color requirements.

## PART 3 - EXECUTION

### 3.1 GENERAL INSTALLATION

- A. Verify that systems are ready to receive work. Beginning of installation means installer accepts existing conditions.
- B. Install system and materials in accordance with manufacturer's instructions.
- C. Drawings of the TCS and FMCS network are diagrammatic only. Any apparatus not shown but required to meet the intent of the project documents shall be furnished and installed without additional cost.
- D. Install all operators, sensors, and control devices where accessible for service, adjustment, calibration, and repair. Do not install devices where blocked by piping or ductwork. Devices with manual reset or limit adjustments shall be installed below 6'-0" if practical to allow inspection without using a ladder.
- E. Verify locations of wall-mounted devices (such as thermostats, temperature and humidity sensors, and other exposed sensors) with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Maximum height above finished floor shall not exceed ADA mounting requirements.
- F. Provide valves over 3/4" size with position indicators and pilot positioners where sequenced with other controls.

- G. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room.
- H. After completion of installation, test and adjust control equipment.
- I. Check calibration of instruments. Recalibrate or replace.
- J. Furnish and install conduit, wire, and cable per the National Electric Code, unless noted otherwise in this section.
- K. All controls associated with the proper operation of air handling units, pumps, or other mechanical equipment served by emergency power shall be connected to the emergency power system. Control components shall be powered from the optional standby branch of emergency power. In no instance shall panel be connected to the life safety branch of the emergency power system. Panels may be connected to a common 20 amp, 120 volt circuit provided the total load on the circuit does not exceed 16 amps. Circuit conductors shall be sized per the table below. All power connections to the control panels shall be performed by a licensed electrician at the cost of this Contractor. Submit circuit information (total amperage on circuit, conductors length, and panel) for control panels to the Architect/Engineer for approval.

Circuit Load (Amps)	Circuit Max Length	Feeder Size
≤ 5	≤ 200ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 10	≤ 100ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 16	≤ 75ft	2#12 & 1#12 ground in 3/4" conduit.
≤ 200	≤ 325ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 100	≤ 160ft	2#10 & 1#10 ground in 3/4" conduit.
≤ 75	≤ 100ft	2#10 & 1#10 ground in 3/4" conduit.

- L. All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational FMCS system, but not shown on the electrical drawings, are the responsibility of the TCC.
- M. Remodeling:
  - 1. All room devices as indicated on the drawings shall be removed by this Contractor. The Contractor shall also prepare the wall for finishes. Preparing the wall shall include patching old anchor holes (after the anchoring device has been removed) and sanding the wall to remove old paint outlines remaining from original devices. The wall shall be painted to match the existing wall prior to the installation of the new room device. If wall covering requires patching, the Contractor shall furnish new wall covering to match existing. If new wall covering is not available to match existing, the Contractor shall furnish a white acrylic or Plexiglas plate, 1/4" thick and sized to cover the void.

N. Labels For Control Devices:

1. Provide labels indicating service of all control devices in panels and other locations.
2. Labels may be made with permanent marking pen in the control panels if clearly legible.
3. Use engraved labels for items outside panel such as outside air thermostats.
4. Labels are not required for room thermostats, damper actuators and other items where their function is obvious.

O. VFDs:

1. This project includes several variable frequency drives to control the flow of fans and/or pumps based on a control variable.
2. Verify output signal required, 4-20 mA or 0-10V dc, with the EC.
3. If VFD has a bypass feature, auxiliary contacts on the drive may not be used for motor status. A separate relay must be used to indicate motor rotation in either hand or auto positions.
4. If a separate current transmitter or switch is indicated for status, install this device between the VFD and the motor. In this case, the drive status may be connected to the auxiliary contacts in the VFD.
5. Some devices, such as low limits and fire alarm shutdown relays, must be hardwired to the fan motor. Make connections such that fan will shut down whether in hand or auto position if the unit has a bypass feature.

P. Airflow Stations:

1. The transmitter shall be installed at a location that is protected from weather, water, and vibration.
2. Mount transmitter where they can easily be read (36" to 66" above floor). Do not fasten transmitters directly to ductwork or compromise duct insulation.
3. The manufacturer's authorized representative shall visit the project site during construction prior to station installations to confirm all submitted sizes, mounting requirements and locations. Size adjustments shall be made at no additional cost. The representative shall meet on site with the TCC to support and train them on proper installation procedures and calibration.
4. Install labels at each sensor and transmitter identifying its service.

### 3.2 GRAPHIC DISPLAY

- A. Create a customized graphic for each piece of equipment indicated on the itemized points list.
- B. Components shall be arranged on graphic as installed in the field.
- C. Include each graphic point listed in the itemized points list using real time data.
- D. Provide a graphic representation of the following:
  1. Where there are multiple buildings, color code the campus map by the systems serving that building. The building graphic shall be linked to the graphic for that building's systems.
  2. Where there are multiple floors, provide color codes/designations for the areas served by each AHU and TAB by floor.

3. Where multiple AHUs serve one floor, color code the areas served by each AHU. The area shall be linked to the graphic for that area's AHU.
  4. Provide an overall floor plan of each floor of the building color coded by zone linked to the TAB for that zone. The zone shall be linked to the graphic for that zone's TAB graphic.
  5. Show the location of each thermostat on the floor plan.
  6. Provide separate graphics showing the chilled and heating water system flow diagram. Show temperatures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
  7. Provide a graphic showing the steam system flow diagram. Show pressures and flows on the flow diagram. Each piece of equipment shown on the flow diagram shall be linked to the graphic for that piece of equipment.
- E. The FMCS shall include full graphic operator interface to display the following graphics as a minimum:
1. Home page to include a minimum of six critical points: Outside Air Temperature, Outside Air Relative Humidity, Enthalpy, KWH, KW, etc.
  2. Graphic floor plans accurately depicting rooms, walls, hallways, and showing accurate locations of space sensors and major mechanical equipment.
  3. Detailed graphics for each mechanical system including AHUs, ERUs, EFs, chillers, as a minimum.
  4. Access corresponding system drawings, technical literature, and sequences of operations directly from each system graphic.
- F. The FMCS shall include individual graphical buttons to access the following data stored in PDF format:
1. Project control as-built documentation including all TCS drawings, diagrams and sequences of operation.
  2. TCS Bill of Material for each system, e.g. AHU, RTU, FCU, boiler, etc.
  3. Technical literature specification data sheets for all components listed in the TCS Bill of Material.
- ### 3.3 CONDUIT AND BOXES INSTALLATION
- A. Conduit and Box Installation: Refer to Electrical Section 26 05 33 for execution and installation.
- B. Conduit and Box Identification (color and labeling) installation. Refer to Electrical Section 26 05 53 for raceway and box identification installation.
- C. Outlet Box Schedule: Thermostat/temperature sensor:
1. Dry Interior Locations: Provide 4" square galvanized steel with raised cover to fit flush with finished wall line. When located in concrete block walls, provide square edge title cover of sufficient depth to extend out to face of block or masonry boxes.
  2. Other Conditions: Refer to Electrical Section 26 05 33 for requirements.

### 3.4 WIRE AND CABLE INSTALLATION

- A. Wire and Cable Installation: Refer to Electrical Section 26 05 13 for execution and installation.
- B. Field Quality Control:
  - 1. Inspect wire and cable for physical damage and proper connection.
  - 2. Torque test conductor connections and terminations to manufacturer's recommended values.
  - 3. Perform continuity test on all conductors.
  - 4. Protection of cable from foreign materials:
    - a. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited, to overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid or compound that could come in contact with the cable, cable jacket or cable termination components.
    - b. Overspray of paint on any cable, cable jacket or cable termination component will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed. This requirement is regardless of the PASS/FAIL test results of the cable containing overspray. Should the manufacturer and warrantor of the structured cabling system desire to physically inspect the installed condition and certify the validity of the structured cabling system (via a signed and dated statement by an authorized representative of the structured cabling manufacturer), the Owner may, at their sole discretion, agree to accept said warranty in lieu of having the affected cables replaced. In the case of plenum cabling, in addition to the statement from the manufacturer, the Contractor shall also present to the Owner a letter from the local Authority Having Jurisdiction stating that they consider the plenum rating of the cable to be intact and acceptable.
- C. Installation Schedule:
  - 1. Conduit terminations to all devices installed in applications with rotating equipment, expansion/contraction or vibration shall be made with flexible metallic conduit, unless noted otherwise. Final terminations to exterior devices installed in damp or wet locations shall be made with liquidtight flexible metallic conduit. Terminations in hazardous areas, as defined in the National Electrical Code, shall be made with flexible conduit rated for the environment.

### 3.5 FMCS INSTALLATION

- A. Coordinate voltage and ampacity of all contacts, relays, and terminal connections of equipment being monitored or controlled. Voltage and ampacity shall be compatible with equipment voltage and be rated for full ampacity of wiring or overcurrent protection of circuit controlled.
- B. Naming Conventions: Coordinate all point naming conventions with Owner standards. In the absence of Owner standards, naming conventions shall use equipment designations shown on plans.

### 3.6 PREPARATION FOR BALANCING

- A. Verify that all dampers are in the position indicated by the controller (e.g., open, closed or modulating).
- B. Check the calibration and setpoints of all controllers.
- C. Check the locations of all thermostats and humidistats for potential erratic operation from outside influences such as sunlight, drafts, or cold walls.
- D. Check that all sequences operate as specified. Verify that no simultaneous heating and cooling occurs, unless specified. Observe that heating cannot begin at TAB reheat terminals until the unit is at the minimum cfm.
- E. Verify the operation of all interlock systems.

### 3.7 TEST AND BALANCE COORDINATION

- A. The Contractor shall furnish a single set of all tools necessary to interface to the control system for test and balance purposes.
- B. The Contractor shall provide a minimum of four (4) hours training for the Balancing Contractor in the use of these tools.
- C. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process until the first 20 terminal units are balanced.
- D. The tools used during the test and balance process shall be returned at the completion of the testing and balancing.

### 3.8 DEMONSTRATION AND ACCEPTANCE

- A. At completion of installation, provide two days minimum instruction for operators. Demonstrate operation of all controls and systems. Describe the normal operation of all equipment.

### 3.9 TRAINING

- A. On-Site:
  - 1. After completion of commissioning, the manufacturer shall provide 16 hours of training on consecutive days for 4 Owner's representatives. The training course shall enable the Owner's representatives to perform Day-to-Day Operations as defined herein. A factory-trained instructor with experience in presenting the training material and the system programmer for this project shall perform the training.

### 3.10 INSTALLATION OF SENSORS

- A. Install sensors in accordance with the manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for the environment within which the sensor operates.

- C. Room temperature sensors shall be installed on concealed junction boxes properly supported by the wall framing.
- D. All wires attached to sensors shall be air sealed in their raceways or in the wall to stop air transmitted from other areas affecting sensor readings.
- E. Averaging sensors and low limits shall be installed at the top of the assembly with the element on a slight downward incline away from the sensor making a serpentine pattern over the cross-sectional area with elements spaced not over 12" apart and within 6" of the top and bottom of the area.
- F. All pipe-mounted temperature sensors shall be installed in immersion wells. Install all liquid temperature sensors with heat-conducting fluid in thermal wells.
- G. Install outdoor air temperature sensors on exterior of north wall, complete with sun shield at designated location approved by Architect/Engineer. TCC shall prime and paint the device enclosure. Color selection by Architect.
- H. Install all wall-mounted CO2 sensors between 3 feet and 6 feet above the floor.

### 3.11 INSTALLATION OF FLOW METERS

- A. Provide manufacturer's recommended lengths of straight piping upstream and downstream of the flow meter. Up to 30 diameters upstream of the flow meter may be required depending on the piping arrangement and flow meter type.
- B. Maintain adequate pull/service space.

END OF SECTION 23 09 00

## SECTION 23 09 13 - INSTRUMENTATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pressure Gauge.
- B. Pressure Gauge Accessories.
- C. Thermometers.
- D. Test Plugs.
- E. Static and Differential Airflow Pressure Gauges.

### PART 2 - PRODUCTS

#### 2.1 PRESSURE GAUGES

- A. Gauges shall be 4-1/2" diameter with aluminum or stainless steel case with phosphor bronze bourdon tube, brass socket for air, steam, water or oil application, 1/4" or 1/2" bottom connection. Gauges shall be 1% full scale accurate with bronze brushed brass movement and adjustable pointer. Standard ranges to be either pressure or pressure and vacuum as required of application.
- B. Manufacturers:
  - 1. Ashcroft
  - 2. Marsh
  - 3. Marshalltown
  - 4. Miljoco
  - 5. Trerice
  - 6. U.S. Gauge Figure 1901
  - 7. Weiss
  - 8. Weksler
  - 9. Wika.
- C. Select gauge range for normal reading near center of gauge.

#### 2.2 PRESSURE GAUGE ACCESSORIES

- A. All pressure gauges shall have valves and pressure snubbers. All pressure gauges on steam shall have pigtail syphon.
- B. Shutoff Valve: 1/4" ball valve as specified for each piping system.
- C. Pressure snubber, brass with 1/4" connections, porous metal type.

## 2.3 THERMOMETERS

### A. Dial Type:

1. 4-1/2" diameter, hermetically sealed case. Stainless steel case and stem. Accuracy of 1% full scale with external recalibrator.
2. Select thermometers for appropriate temperature range. Adjustable elbow joint with locking device to allow rotation of thermometer to any angle.
3. Stem lengths as required for application with minimum insertion of 2-1/2" .
4. Thermometers for water, steam, or oil shall have brass or steel separable socket. Thermometer wells shall be stainless steel, pressure rated to match piping system design pressure; with 2 inch extension for insulated piping and threaded cap nut with chain permanently fastened to well and cap. Thermometers for air shall have an aluminum or brass duct flange.
5. Manufacturer:
  - a. Ashcroft
  - b. Marsh
  - c. Marshalltown
  - d. Miljoco
  - e. Tel-Tru
  - f. Trerice
  - g. U.S. Gauge
  - h. Weiss
  - i. Weksler, Wika.

### B. Select scales to cover expected range of temperatures.

## 2.4 TEST PLUGS

- A. Test Plug: 1/4" or 1/2" brass fitting and cap, with Nordel core for temperatures up to 275°F, for receiving 1/8" outside diameter pressure or temperature probe. Plugs shall be rated for zero leakage from vacuum to 500 psi.
- B. Provide extended units for all plugs installed in insulated piping.
- C. Test Kit: Carrying case, internally padded and fitted containing one 3-1/2" diameter pressure gauge with 0-100 psi range, one gauge adapter with 1/8" probes, two 1-1/2" dial thermometers with 0° to 220°F and -25°F to 125°F ranges and 5" stems.
  1. Manufacturers:
    - a. Sisco
    - b. Flow Design
    - c. Peterson Equipment
    - d. MG Piping Products Co.
    - e. Miljoco, Trerice
    - f. Watts Regulator.

## 2.5 STATIC AND DIFFERENTIAL AIRFLOW PRESSURE GAUGES

- A. Diaphragm-activated gauge with 4-3/4" dial, cast aluminum case, sealed interior, designed to resist shock and vibration, and rated for 15 psig .
- B. Accuracy shall be  $\pm 3\%$  of full scale maximum throughout entire range at 70°F .
- C. Provide mounting brackets, probes, and shutoff valves required for proper installation.
- D. The range and service shall be as required for application or as noted on the drawings.
- E. Manufacturers:
  - 1. Dwyer Magnehelic Series 2000
  - 2. Marshalltown Instrument Series 85C.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General Installation Requirements:
  - 1. Install per manufacturer's instructions.
  - 2. Coil and conceal excess capillary on remote element instruments.
  - 3. Install gauges and thermometers in locations where they are easily read from normal operating level.
  - 4. Do not install instrumentation when areas are under construction, except for required rough-in, taps, supports and test plugs.
- B. Pressure Gauges:
  - 1. Connect pressure gauges to suction and discharge side of all pumps.
  - 2. Provide snubber for each pressure gauge.
  - 3. Provide coil syphon for each pressure gauge connected to steam piping.
- C. Thermometers:
  - 1. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2" for installation of thermometer sockets.
  - 2. Install thermometer sockets adjacent to control system thermostat, transmitter and sensor sockets.
  - 3. Locate duct thermometers minimum 10 feet downstream of mixing dampers, coils, or other devices causing air turbulence.

END OF SECTION 23 09 13

## SECTION 23 21 00 - HYDRONIC PIPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings
- B. Valves
- C. Check Valves
- D. Strainers
- E. System Piping Schedule

#### 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

#### 1.4 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 23 05 00 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

### PART 2 - PRODUCTS

#### 2.1 STEEL PIPE (ABOVE GRADE) 4" and larger

- A. Design Pressure 125 psig, Maximum Design Temperature 225°F (230°F for grooved couplings).
- B. Black Steel; Standard Weight; Mechanically Coupled Grooved Joints:
  - 1. Pipe: Standard weight black steel, grooved ends, ASTM A53, Type E or S, Grade B.

2. Joints: Grooved type, with Grade E EPDM molded pressure-responsive gaskets suited for 32°F to 230°F per ASTM D2000.
  - a. Rigid Type: Housings cast with offsetting, angle-pattern, bolt pads to provide system rigidity and support. Design Basis: Victaulic 107N.
    - 1) Usage: All locations unless noted elsewhere.
  - b. Flexible Type: Housing cast with horizontal, angle-pattern bolt pads to provide vibration attenuation and stress relief. Design Basis: Victaulic 177N.
    - 1) Usage: first three joints adjacent to vibrating equipment (e.g., chillers, pumps, air handling equipment, etc.).
3. Fittings: ASTM A536 Grade 65-45-12 ductile or A47 malleable iron, grooved type.
4. Flanges: Grooved end, flanged adapter.

## 2.2 COPPER PIPE (ABOVE GRADE) 3" and smaller

- A. Design Pressure 125 psig. Maximum Design Temperature 225°F.
- B. Copper Pipe; Type L; Soldered Joints:
  1. Tubing: Type L drawn temper seamless copper tube, ASTM B88.
  2. Joints: Solder with Type 95-5 solder. 50-50 solder is not acceptable.
  3. Fittings: Wrought copper solder joint, ASME B16.22.
- C. Copper Pipe; Type L; Mechanical Press Connection: Tubing: Type L hard drawn seamless copper tube, ASTM B88.
  2. Joints: Mechanical press connection.
  3. Fittings: Copper, ANSI B-16.22, with embedded EPDM O-ring, NSF-61.
  4. Manufacturers:
    - a. Viega ProPress.
    - b. Elkhart Xpress.
    - c. NIBCO Press System Fittings and Valves.
    - d. Mueller Streamline PRS.

## 2.3 VALVES

- A. Shutoff Valves:
  1. For pipe systems where mechanical press connections are allowed, shutoff valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
  2. Ball Valves:
    - a. BA-1 (Steel and Copper): 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals.

- 1) Manufacturers:
  - a) Apollo #77C-140
  - b) Stockham #S-206 BR1-R
  - c) Milwaukee #BA-400
  - d) Watts
  - e) Nibco #585-70-66
  - f) National Utilities Co.
  - g) RUB.
- 2) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.
- 3) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

b. BA-1A (Steel): 2-1/2" and 3", 125 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals.

- 1) Manufacturers:
  - a) Apollo #88A-100
  - b) Nibco #F510-CS/66
  - c) Milwaukee #F90.
- 2) Provide extended shaft with operating handle of non-thermal conductive material and protective sleeve that allows operation of valve, adjustment of the packing, and adjustment of the memory stop without breaking the vapor seal or disturbing the insulation for all valves in insulated piping.
- 3) Provide lock out trim for all valves opening to atmosphere installed in domestic water piping over 120°F, heating water piping over 120°F, steam, condensate, boiler feed water piping, compressed air piping and gasoline/kerosene piping, and as indicated on the drawings. Solid extended shaft is not required on valves with lock out trim.

### 3. Butterfly Valves:

a. BF-1:

- 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 225°F continuous and 250°F intermittent at 125 psig, fully lugged end, ductile or cast iron body (not in contact with fluid); bronze, aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body

(for pipe extension without draining system), 10 position locking operator up to 6" size. Cv of at least 1580 in 6" size.

- 2) Manufacturers:
  - a) Center Line Series 200
  - b) Keystone #222
  - c) Watts #DBF-03-121-1P
  - d) Nibco N200 Series or LD2000 Series
  - e) Milwaukee CL series
  - f) Hammond 5200 series.
- 3) 8" thru 12", 175 psi CWP, elastomers for 20°F to 225°F at 130 psi, fully lugged end, ductile or cast iron body (not in contact with fluid), bronze, EPDM coated ductile iron or aluminum-bronze disc, EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to the centerline of the valve body (to permit pipe extension without draining system), weatherproof gear operator.
- 4) Manufacturers:
  - a) Center Line Series 225
  - b) Watts #DBF-03-121-1G
  - c) Nibco N200 Series or LD2000 Series
  - d) Milwaukee CL series, Hammond 5200 series.
- 5) Mechanically coupled grooved end valves are acceptable if they have the temperature ratings, pressure ratings, and features listed above.
- 6) Manufacturers:
  - a) Victaulic #300
  - b) Nibco GD4765.

## 2.4 THROTTLING VALVES

### A. Throttling Valves (Steel):

1. For pipe systems where mechanical press connections are allowed, throttling valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
2. Globe Valves (Steel Pipe):
  - a. GL-1: 3" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze.
    - 1) Manufacturers:
      - a) Crane #7TF
      - b) Stockham #B22T
      - c) Walworth #95
      - d) Milwaukee #590
      - e) Hammond #IB413T
      - f) Watts #B-4010-T

- g) or NIBCO #T-235.
  - b. GL-2: 4" thru 10", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted.
    - 1) Manufacturers:
      - a) Crane #351
      - b) Hammond #IR116
      - c) Stockham #G-512
      - d) Walworth #906F
      - e) Milwaukee #F2981
      - f) Watts #F-501
      - g) or NIBCO #F-718.
- 3. Globe Valves (Copper Pipe):
  - a. GL-5: 2" and under, 125 psi saturated steam, 300 psi WOG, solder, bronze.
    - 1) Manufacturers:
      - a) Hammond #IB423
      - b) Stockham #B24T
      - c) Milwaukee #1590
      - d) Watts #B-4011-T
      - e) NIBCO #S-235.
- 4. Ball Valves (Steel and/or Copper):
  - a. BA-9: 2" and under, 125 psi saturated steam, 600 psi WOG, standard port, screwed (solder ends are acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body and ball of copper alloy containing less than 15% zinc, chrome plated or stainless steel ball, Teflon seats and seals with memory stop.
    - 1) Manufacturers:
      - a) Apollo #70-120
      - b) Stockham #S-216BR-R
      - c) Milwaukee #BA-100
      - d) Watts #B-6000
      - e) Hammond #8501
      - f) Nibco #580-70.
- 5. Butterfly Valves:
  - a. BF-4:
    - 1) 2-1/2" thru 6", 175 psi CWP, elastomers rated for 20°F to 225°F continuous and 250°F intermittent at 125 psig, fully lugged or grooved end, ductile or cast iron body (not in contact with fluid); bronze,

aluminum-bronze or EPDM coated ductile iron disc; EPDM seat, stainless steel stem, extended neck, 175 psi bubble-tight, bi-directional dead-end shutoff without backing flange or nuts and with cap screws extending to centerline of valve body (for pipe extension without draining system), infinite position locking operator with memory stop up to 6" size. Cv of at least 1580 in 6" size.

- 2) Manufacturers:
  - a) Victaulic #300
  - b) Center Line Series 200
  - c) Keystone #222
  - d) Watts #DBF-03-121-1P
  - e) NIBCO LD2000 Series
  - f) Milwaukee CL series
  - g) Hammond 5200 series.

## 2.5 LOCK OUT TRIM

- A. Provide lock out trim for all quarter turn valves opening to atmosphere installed in heating water piping over 120°F and as indicated on the drawings.

## 2.6 CHECK VALVES

- A. For pipe systems where mechanical press connections are allowed, check valves with mechanical press connections are acceptable subject to the requirements in the paragraphs below.
- B. CK-1: Check Valves (Steel Pipe); 2" and under, 125 psi S @ 353°F, 200 psi WOG @ 150°F, screwed, bronze, horizontal swing.

### 1. Manufacturers:

- a. Crane #37
- b. Hammond #IB904
- c. Stockham #B319
- d. Walworth #406
- e. Milwaukee #509
- f. Watts #B-5000
- g. or NIBCO #T-413.

- C. CK-13: Check Valves (Steel Pipe); 2-1/2" thru 12", 200# WOG, double disc wafer type, iron body, bronze or aluminum-bronze discs, 316SS shaft and spring, Viton, EPDM or BUNA-N, Cv of at least 700 in 6" size.

### 1. Manufacturers:

- a. Mueller Steam Specialty Co. #71-AHB-6-H
- b. Stockham #WG-961
- c. NIBCO W-920-W
- d. Crane
- e. Victaulic #716/716H/779.

D. CK-4: Check Valves (Copper Pipe); 2" and under, 200 psi WOG @ 150°F, solder, bronze, horizontal swing.

1. Manufacturers:

- a. Crane #1342
- b. Hammond #IB912
- c. Stockham #B309
- d. Walworth #406SJ
- e. Milwaukee #1509
- f. Watts #B-5001
- g. NIBCO #S-413.

## 2.7 STRAINERS

A. For pipe systems where mechanical press connections are allowed, strainers with mechanical press connections are acceptable subject to the requirements in the paragraphs below.

B. ST-1: Bronze body, screwed ends, screwed cover, 125 psi S @ 353°F, 200 psi WOG @ 150°F

C. ST-2: Cast iron body, 125 lb. flanged ends, bolted cover, 125 psi S @ 353°F, 175 psi WOG @ 150°F.

1. Manufacturers:

- a. Armstrong #A1FL
- b. Metraflex #TF
- c. Mueller Steam Specialty Co.#758
- d. Sarco #CI-125
- e. Watts #77F-D
- f. Victaulic #732 or #W732
- g. NIBCO F-721-A.

D. Unless otherwise indicated, strainers shall be Y-pattern and have stainless steel screens with perforations as follows

1. Pipe Size:

- a. 1/4" - 2": 1/32" screen
- b. 2-1/2" - 8": 1/16" screen

E. Furnish pipe nipple with ball valve, threaded hose connection, and cap to blow down all strainer screens.

F. Use bronze body strainers in copper piping and iron body strainers in ferrous piping.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.
- D. Connect to all equipment with flanges or unions.
- E. After completion, fill, clean, and treat systems. Refer to Section 23 25 00 for treatment.

### 3.2 SYSTEMS, PIPING, AND VALVE SCHEDULE

- A. Heating Water (Above Grade - maximum 140°F):
  - 1. Copper Pipe; Type L; Soldered Joints: 3" and Under
  - 2. Black Steel; Standard Weight; Grooved Joints: 4:and Over
  - 3. Copper Pipe; Type L; Mechanical Press Connection: " and Under
  - 4. Shutoff Valves: GA-1, BA-1, BF-1, BF-5
  - 5. Throttling Valves: GL-1, GL-2
  - 6. Check Valves: CK-4, CK-13
  - 7. Strainers: ST-1, ST-2
- B. Chilled Water (Above Grade):
  - 1. Copper Pipe; Type L; Soldered Joints: 3" and Under
  - 2. Copper Pipe; Type L; Mechanical Press Connection: 3" and Under
  - 3. Black Steel; Standard Weight; Grooved Joints: 2-1/2" and Over
  - 4. Shutoff Valves: GA-1, BA-1, BF-5
  - 5. Throttling Valves: GL-1, GL-2
  - 6. Check Valves: CK-1, CK-4
  - 7. Strainers: ST-1, ST-2

### 3.3 TESTING PIPING

- A. Test pipes underground or in chases and walls before piping is concealed.
- B. Complete testing before insulation is applied. If insulation is applied before pipe is tested and a leak ruins the insulation, replace all damaged insulation.
- C. Test the pipe with water at 1.5 times the design pressure but not less than 100 psig pressure. Hold pressure for at least two hours.
- D. Test to be witnessed by the Architect/Engineer or their representative, if requested by the Architect/Engineer.

### 3.4 CLEANING PIPING

#### A. Assembly:

1. Prior to assembly of pipe and piping components, remove all loose dirt, scale, oil and other foreign matter on internal or external surfaces by means consistent with good piping practice subject to approval of the Architect/Engineer. Blow chips and burrs out of pipe before assembly. Wipe cutting oil from internal and external surfaces.
2. During fabrication and assembly, remove slag and weld spatter from both internal and external joints by peening, chipping and wire brushing to the degree consistent with good piping practices.
3. Notify the Architect/Engineer prior to starting any post erection cleaning operation in time to allow witnessing the operation. Properly dispose of cleaning and flushing fluids.
4. Prior to blowing or flushing erected piping systems, disconnect all instrumentation and equipment, open wide all valves, control valves, and balance valves, and verify all strainer screens are in place.

#### B. Chemical Cleaning:

1. Flush pipe and components with clean water until all discharge from system is clean. Maintain minimum velocities at all points of 5 feet/second for 30 minutes. Flow shall be in same direction as when system is in normal operation. Discharge shall be from low points of pipes, ends of headers and as otherwise needed to flush entire system. After flushing, all residual water shall be drained and/or blown out.
2. Add 2 pounds of trisodium phosphate per 100 gallons of system capacity. Use an alternate chemical if discharge of trisodium phosphate is not permitted. Maintain 150°F in the system if possible. If heat is not available, use 3 pounds per 100 gallons.
3. Drain the system after circulating the chemical cleaner for six hours at 150°F, or 12 hours at a lower temperature. Refill. Test a water sample. Drain and fill again if excessive cleaning chemicals remain and until water appears clear.
4. After each system has been cleaned and thoroughly flushed of pretreatment chemicals, it shall be immediately refilled with water and treated with chemical treatment as specified in Section 23 25 00. The system shall not be allowed to sit empty for any length of time.
5. When system water is clear, remove, clean and replace all strainers.
6. Water samples may be taken by the Architect/Engineer to verify a clean system. If system is not clean, the entire process, including chemical treatment specified in Section 23 25 00, shall be repeated at the Contractor's expense.
7. Chemical cleaning applies to the following systems:
  - a. Heating Water
  - b. Chilled Water

### 3.5 INSTALLATION

#### A. General Installation Requirements:

1. Route piping in orderly manner, straight, plumb, with consistent pitch, parallel to building structure, with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and needed flexibility in pipe system.
2. Install piping to conserve building space, and not interfere with other work.
3. Group piping whenever practical at common elevations.

4. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
5. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it. Where pipe sizes are not shown, the larger size in either direction shall continue through the fitting nearest to the indication of a smaller pipe size.
6. Install bell and spigot pipe with bells upstream.
7. Seal pipes passing through exterior walls with a wall seal per Section 23 05 29. Provide Schedule 40 galvanized sleeve at least 2 pipe sizes larger than the pipe.
8. Branch takeoffs shall be from the top side (if branch is two sizes smaller than main), or any angle from the horizontal plane to the top of piping.

B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment plus its required clearance space.

3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories prior to installation. Immediately reject and remove from the job any items which are unsuitable, cracked or otherwise defective.
- B. All pipe, fittings, valves, equipment and accessories shall have factory-applied markings, stampings, or nameplates sufficient to determine their conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any unclean item.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed at all times except when actual work is being performed on that item. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. 2-1/2" and larger fittings shall be long radius type, unless otherwise shown on the drawings or specified. Construct welded elbows of angles not available as standard fittings by cutting and welding standard elbows to form smooth, long radius fittings.
- F. Use full and double lengths of pipe wherever possible.
- G. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size being made only at control valve or pump.
- H. Cut all pipe to exact measurement and install without springing or forcing except in the case of expansion loops where cold springing is indicated on the drawings.

- I. Do not create, even temporarily, undue loads, forces or strains on valves, equipment or building elements.

### 3.7 DRAINING AND VENTING

- A. Unless otherwise indicated on the drawings, all horizontal pipes, including branches, shall pitch 1" in 40 feet to low points for complete drainage, removal of condensate, and venting.
- B. Provide drain valves at all low points of water piping systems or where indicated on drawings for complete or sectionalized draining. Drain valves are defined above.
- C. Use eccentric reducing fittings on horizontal runs when changing size for proper drainage and venting. Install all liquid lines with top of pipe and eccentric reducers in a continuous line.
- D. Provide air vents at all high points and wherever else required for elimination of air in all water piping systems. Do not use automatic air vents in glycol systems unless they are piped to the fill tank.
- E. Air vents shall be in accessible locations. If needed to trap and vent air in a remote location, a 1/8" pipe shall connect the tapping location to a venting device in an accessible location.
- F. All vent and drain piping shall be of same materials and construction as the service involved.

### 3.8 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise specified herein or detailed on the drawings.
- B. At the option of the Contractor, branch connections from headers and mains may be cut into black steel pipe using forged weld-on fittings.

### 3.9 JOINING OF PIPE

- A. Solder Joints (Copper Pipe):
  1. Make up joints with 95% tin and 5% antimony (95-5) solder conforming to ASTM B32 Grade 95TA. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt and grease just prior to soldering. Apply flux evenly, but sparingly, to all surfaces to be joined. Heat joints uniformly to proper soldering temperature so solder flows to all mated surfaces. Wipe excess solder, leaving a uniform fillet around cup of fitting.
  2. Flux shall be non-acid type conforming to ASTM B813.
  3. Solder end valves may be installed directly in the piping system if the entire valve is suitable for use with 470°F melting point solder. Remove composition discs and all seals during soldering if not suitable for 470°F.

B. Mechanically Coupled Grooved Joints (Steel):

1. Grooved connections shall mechanically engage, lock and seal the grooved pipe ends in a positive couple. Each coupling shall have malleable iron housing clamps, steel bolts and nuts, and sealing gasket designed so internal pressure increases the tightness of the seal. Couplings must be installation-ready style for quick installation and no more than two-piece housings.
2. All work, including pipe grooving, shall be accomplished in accordance with manufacturer's published instructions.
3. Final tightening of bolts shall be with a torque wrench to ensure equal tension in all bolts.
4. All fittings shall be provided by one manufacturer. Mixing grooved components is not acceptable.
5. Product Warranty:
  - a. Standard: One-year product warranty. A factory-trained manufacturer's representative shall visit the site for contractor training and installation observation.
    - 1) On-site Training: Manufacturer's factory trained representative shall provide training of contractor's field personnel in use of grooving tools and installation of product. Documentation of installing contractor training with manufacturer's representative shall be submitted to the Architect/Engineer.
    - 2) Job Site Visitation: Manufacturer's representative shall periodically visit job site to ensure manufacturer's installation practices are being followed.
6. Acceptable Manufacturers: Victaulic, Gruvlok, or Star Fittings.

C. Mechanical Press Connection (Copper):

1. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
2. Fully insert tubing into the fitting and mark tubing.
3. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
4. Joint shall be pressed with a tool approved by the manufacturer. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

END OF SECTION 23 21 00

## SECTION 23 21 16 - HYDRONIC SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Air Vents
- B. Basket Strainers
- C. Makeup Water Accessories
- D. Safety Relief Valves
- E. Suction Diffusers
- F. Balancing Valves
- G. Combination Piping Packages
- H. Expansion Tank
- I. Sidestream Filters
- J. Drain Valves and Blowdown Valves

#### 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.
- B. Welding Materials, Procedures, and Operators: Conform to ASME Section 9, ANSI/AWS D1.1, and applicable state labor regulations.

#### 1.3 SUBMITTALS

- A. Submit product data under provisions of Section 23 05 00. Include data on pipe materials, fittings, valves, and accessories. Include manufacturers' support spacing requirements for plastic piping.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent entrance of foreign matter into pipe and to prevent exterior corrosion.
- B. Deliver and store valves in shipping containers with labeling in place.

## 1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 23 05 00 for required hydronic systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

## PART 2 - PRODUCTS

### 2.1 AIR VENTS

- A. At end of main and other points where large volume of air may be trapped, use 1/4" globe valve, angle type, 125 psi, Crane #89, attached to coupling in top of main, 1/4" discharge pipe turned down with cap.
- B. On branch lines and small heating units, use coin-operated air vent equal to B&G #4V, attached to 1/8" coupling in top of pipe. Install air vents on all coils and terminal heating units.

### 2.2 AUTOMATIC AIR VENTS (only where specifically noted on drawings)

- A. Low capacity automatic air vent (for bladder tank anti-thermosyphon loops). Maximum operating pressure and temperature of at least 240°F and 125 psi, 1/2" or 3/4" inlet.

- 1. Manufacturers:

- a. B&G #87
- b. Armstrong
- c. Spirotherm
- d. Taco
- e. Watts

### 2.3 BASKET STRAINERS

- A. Cast iron body, 125 lb. flanged ends, quick release bolted, rated for 125 psi @ 350°F, 175 psi WOG @ 150°F. Strainer to have 1/8" perforated basket or equivalent. Pressure drop not to exceed 5 ft. head maximum.
- B. Basket strainer shall be supported from floor. Hanging strainer from pipes will NOT be acceptable.
- C. Furnish pipe nipple with ball valve, threaded hose connection, and cap to blow down all strainer screens.
- D. Furnish hinged cover for strainers below 6" in size. Furnish lifting lug and lifting device to remove cover of strainers 8" and larger. Provide O-ring gaskets on all covers.
- E. Furnish ASTM stamped 126-B or A216 grade WCB.
- F. Manufacturers:

- 1. Keckley GFV

2. Mueller 125F-CI
3. SureFlow BFC 125C
4. Watts 97FB-CIB
5. Metraflex B-1-TC

## 2.4 MAKEUP WATER ACCESSORIES

### A. Pressure Reducing Valve:

1. For water fill lines to hydronic systems.
2. Removable strainer, field adjustable discharge pressure, brass body, disc and seat, union with 1/2" or 3/4" NPT sweat connection, 125 psig maximum working pressure, 225°F maximum temperature.
3. Manufacturers:
  - a. Armstrong
  - b. Bell & Gossett
  - c. Conbraco
  - d. Thrush
  - e. Watts

### B. Relief Valve:

1. For water fill lines to hydronic systems.
2. Manufacturers:
  - a. Armstrong
  - b. Bell & Gossett
  - c. Conbraco
  - d. Taco
  - e. Watts

### C. Backflow Preventer:

1. Reduced pressure type as scheduled on the drawings.
2. Provide an air gap fitting and piping to drain.
3. If not indicated on the drawings, unit shall be same size as pipe.
4. Field test and tag units per manufacturer's instructions by a certified tester before initial operation.

## 2.5 SAFETY RELIEF VALVES

A. SRV-1 (Hydronic Heating Systems): Spring-loaded disc type with cast iron or bronze body, bronze or stainless steel disc, side outlet and lifting lever for maximum service of 125 psig at 250°F. For relieving water during pressure fluctuations and in case of control failure. Capacities shall be ASME Section IV certified and labeled.

### B. Manufacturers:

1. Kunkle # 537
2. B&G

3. Conbraco
4. McDonnell & Miller
5. Watts

## 2.6 SUCTION DIFFUSER

- A. Furnish and install on base-mounted pumps with inlet size same as pipe size shown on the drawing.
- B. In no case shall pressure drop exceed 3.0 psi.
- C. Suction diffuser shall consist of angle body with inlet vanes and combination diffuser-strainer-orifice cylinder with 3/16" diameter openings for pump protection, gauge tappings, and blowdown connection. Orifice cylinder, with bronze or stainless steel strainer with free area at least 5 times cross section area of pump suction opening. Furnish adjustable foot to support weight of suction piping. Connect drain valve to blowdown connection. Provide 16 mesh bronze startup strainer. The startup strainer shall be removed after the system has been started, cleaned, and is operating under normal conditions, but before the system is turned over to the Owner. Hang the startup strainer on the piping near the pump after it is removed.
- D. Manufacturers:
  1. Amtrol
  2. Armstrong
  3. Bell & Gossett
  4. Patterson
  5. Taco
  6. Wheatley
  7. Victaulic

## 2.7 BALANCING VALVE

- A. Rated for 125 psi working pressure and 250°F operating temperature, taps for determining flow with a portable meter, positive shutoff valves for each meter connection, memory feature, tight shutoff, and a permanent pressure drop between 1' and 2' water column at full flow with valve 100% open. Furnish with molded, removable insulation covers.
- B. Provide a nomograph to determine flow from meter reading (and valve position on units that sense pressure across a valve). Graph shall extend below the specified minimum flow.
- C. Furnish one meter kit equivalent to Bell & Gossett Model RO-5 meeting the following requirements:
  1. Carrying case with handle.
  2. Pressure gauge with 0-25 feet of head scale with 3.0% full scale accuracy.
  3. High and low side hoses with 5 feet length and 250 psig pressure rating, equipped with shutoff valves, vent valves, and probes for insertion into pressure and temperature plugs.
- D. Valves in copper piping shall be brass or bronze.
  1. Multi-Turn Style (Brass or Bronze):

- a. Manufacturers:
  - 1) Tour&Anderson (STAD)
  - 2) Armstrong "CBV"
  - 3) Victaulic 786
  - 4) Macon STVL/STV
  - 5) MEPCO MBV
  - 6) Wheatly GS
  - 7) NIBCO 1710

E. Valves in ferrous piping 2" or smaller shall have threaded ends and steel, brass or bronze construction. Option to balancing valves noted above are flow sensors specified in Section 23 09 00 with a specified throttling valve.

1. Multi-Turn Style (Ferrous Piping ä? 2"):

- a. Manufacturers:
  - 1) TA Hydronics "786-789"
  - 2) Armstrong "CBV"
  - 3) Victaulic 787
  - 4) Macon STVL/STV
  - 5) MEPCO MBV
  - 6) Wheatly GSNIBCO 1710 (T1710L)

F. Balancing valves in ferrous piping over 2 size shall have flanged or grooved ends and steel or cast iron construction. Option to balancing valves noted above are flow sensor specified in Section 23 09 00 with a specified throttling valve.

1. Multi-Turn Style (Ferrous Piping Greater Than 2"):

- a. Manufacturers:
  - 1) Armstrong "CVB-II"
  - 2) Tour&Anderson (STAF, STAG)
  - 3) Victaulic 788/789
  - 4) Macon STVA
  - 5) MEPCO MBV
  - 6) NIBCO 737

G. Manufacturer shall size balancing valves for the scheduled flow rate. Flow rate shall be measurable on manufacturer's standard meters.

## 2.8 COMBINATION PIPING PACKAGES

A. Combination piping packages are allowed at unitary equipment only (1" pipe size and smaller) in lieu of individual components specified for hydronic coils and devices containing hydronic coils. Configuration of combination pieces shall match layouts on the drawings. Each component of the combination piping packages shall meet these specifications for the individual components being combined. Coil connections shall be rigid. Combination piping packages shall include:

1. Shutoff valves
2. Wye strainers , with 1/4 turn strainer blowdown valves with hose thread and cap
3. Manual balancing valves with memory stop. Automatic flow control devices are not allowed.
4. Test plugs
5. Manual air vents
6. Unions

B. Manufacturers:

1. FDI Flowset
2. Griswold
3. Hays Fluid Controls
4. HCI Terminator
5. Nexus Coil Pak
6. NIBCO, Victaulic

2.9 EXPANSION TANK

A. Bladder Type:

1. Tank shall be welded steel, ASME construction and stamped.
2. Tank shall be complete with heavy-duty replaceable butyl bladder, charging valve, lifting ring, drain tapping, and system connection.
3. 125 psig working pressure and 240°F maximum operating temperature.
4. Manufacturers:
  - a. Thrush
  - b. Taco
  - c. Bell & Gossett
  - d. Armstrong
  - e. Watts
  - f. Wessels
  - g. Wheatley
  - h. Amtrol
  - i. Patterson
  - j. Grundfos

2.10 COALESCING TYPE COMBINATION AIR ELIMINATOR AND DIRT SEPARATOR

- A. Coalescing type air eliminator and dirt separator shall be fabricated from steel and ASME constructed and certified for 125 psi working pressure rated for 150 psig working pressure. Designed and constructed in accordance with ASME with ASME stamp, with two equal chambers above and below the inlet / outlet nozzles. Flanges to be Class 150, raised face, weld neck. and 270°F operating temperature. Units 2-1/2 inches and smaller shall have threaded connections. Units 3 inches and larger shall have flanged connections.

- B. Unit shall include internally structured coalescing media elements uniformly filling the entire vessel to suppress turbulence and provide air elimination efficiency of less than 99.5% free and entrained air, and 99.6% dissolved air at the installed location. Dirt separation efficiency shall be a minimum of 80% of all particles 30 micron and larger within 100 passes. Units capable of 5 micron dirt removal.
- C. Air elimination and dirt separation shall be by coalescing action by copper tubes with continuous wound, permanently attached copper wire and followed by a separate continuous wound permanently affixed copper wire.
- D. Provide unit with factory mounted air vent at the top of the air elimination chamber.
- E. Provide brass flushing cock on the separator side to facilitate system fast-fill and to blow down impurities from the water surface within the separator.
- F. Provide factory-mounted blowdown valve on the unit bottom to allow for draining and cleaning. Coalescing separators shall be equipped with removable cover to allow for removal, inspection, and cleaning of the internal coalescing media. Unit shall be manufactured with a removable lower head for internal inspection.
- G. Units shall be painted. Units with a primer finish are not acceptable.
- H. Warranty: Three-year.
- I. Coalescing separator shall be as sized on the construction drawings, but in no case shall it have less than line size connections nor shall entering velocity exceed 10 feet per second. Pressure drop shall not exceed 5psi at design flow. Include on submittal the pressure drop of each unit at its design flow rate.
- J. Manufacturers:
  - 1. Spirotherm
  - 2. Wessels WVA
  - 3. Thrush

2.11 DRAIN VALVES AND BLOWDOWN VALVES

- A. Drain valve and blowdown valve shall mean a shutoff valve as specified for the intended service with added 3/4" male hose thread outlet, cap, and retaining chain.

2.12 CONNECTIONS BETWEEN DISSIMILAR METALS

- A. Connections between dissimilar metals shall be insulating dielectric types that provide a water gap between the connected metals, and that either allow no metal path for electron transfer or that provide a wide water gap lined with a non-conductive material to impede electron transfer through the water path.
- B. Joints shall be rated for the temperature, pressure, and other characteristics of the service in which they are used, including testing procedure.

- C. Aluminum, iron, steel, brass, copper, bronze, galvanized steel, and stainless steel are commonly used and require isolation from each other with the following exceptions:
1. Iron and steel connected to each other.
  2. Brass, copper, and bronze connected to each other.
  3. Brass or bronze valves and specialties connected in closed systems with steel, iron, or stainless steel on both sides of the brass or bronze valves and specialties. Where two or more brass or bronze items occur together, they shall be connected with brass nipples. Brass or bronze valves and specialties cannot be used as a dielectric separation between pipe materials.
- D. Dielectric protection is required at connections to equipment of a material different than the piping.
- E. Screwed Joints (acceptable up to 2" size):
1. Dielectric waterway rated for 300 psi CWP and 225°F.
  2. Manufacturers:
    - a. Elster Group ClearFlow fittings
    - b. Victaulic Series 647
    - c. Grinnell Series 407
    - d. Matco-Norca
- F. Flanged Joints (any size):
1. Use 1/8" minimum thickness, non-conductive, full-face gaskets.
  2. Employ one-piece molded sleeve-washer combinations to break the electrical path through the bolts.
  3. Sleeve-washers are required on one side only, with sleeves minimum 1/32" thick and washers minimum 1/8" thick.
  4. Install steel washers on both sides of flanges to prevent damage to the sleeve-washer.
  5. Separate sleeves and washers may be used only if the sleeves are manufactured to exact lengths and installed carefully so the sleeves must extend partially past each steel washer when tightened.
  6. Manufacturers:
    - a. EPCO
    - b. Central Plastics
    - c. Pipeline Seal and Insulator
    - d. F.H. Maloney
    - e. Calpico

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. Valves/Fittings and Accessories:

1. Where a manual balance valve is shown to be installed in series with a service (isolation) valve, separate balance and service (isolation) valves shall be installed.
2. Install balancing valves with the manufacturer's recommended straight upstream and downstream diameters of pipe.
3. Prepare accessories for finish painting.
4. Install accessories with stems upright or horizontal, not inverted, except install manual quarter turn valves in radiation cabinets and all butterfly valves with stems horizontal.
5. Provide shutoff valves and flanges or unions at all connections to equipment, traps, and items that require servicing.
6. Provide flanges or unions at all final connections to equipment, traps and valves.
7. Arrange piping and piping connections so equipment may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.

END OF SECTION 23 21 16

## SECTION 23 21 23 - HVAC PUMPS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. All pumps except where integral with a manufactured piece of equipment.
- B. Pump controls where self-contained.

#### 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 05 00.
- B. Submit certified pump performance curves with pump and system operating point plotted. Include NPSH curve when applicable.
- C. Submit motor data indicating compliance with Section 23 05 13.

### PART 2 - PRODUCTS

#### 2.1 PUMPS - GENERAL

- A. Statically and dynamically balance rotating parts.
- B. Construction shall permit complete servicing without breaking piping or motor connections.
- C. Pumps shall operate at 1750 rpm unless specified otherwise.
- D. Pump connections shall be flanged, whenever available.
- E. Heating pumps shall be suitable for 225°F water.
- F. Motors shall comply with Section 23 05 13.
- G. Pump impellers shall not have smaller diameters than those scheduled. The inlet and discharge pipe sizes shall also meet or exceed the scheduled pump.
- H. Pumps specified in this section operating in clean water with a flow greater than 25 GPM and less than 459 feet head shall have a maximum Pump Energy Index (PEI) as scheduled on the drawings. In no case shall the PEI exceed 1.0.

#### 2.2 BASE MOUNTED END SUCTION PUMPS

- A. Type: Centrifugal, single stage.
- B. Casing: Cast iron, single suction, rated for greater of 150 psi or 1.25 times actual working discharge pressure, flanged suction and discharge with gauge ports.
- C. Impeller: Bronze, fully enclosed, keyed to shaft.

- D. Shaft: High grade alloy steel with copper, bronze or stainless steel shaft sleeves.
- E. Bearings: Grease lubricated roller or ball bearings with grease fittings. If pump will be insulated, grease fittings shall be extended 3" with rigid pipe to clear the insulation.
- F. Drive: Flexible coupling with OSHA-approved guard.
- G. Seals: Mechanical type with internal flushing rated for -20 to 225°F with Buna elastomer, carbon primary ring, and ceramic stationary ring.
- H. Baseplate: Heat treated cast iron or reinforced heavy steel.
- I. Manufacturers:
  - 1. Bell & Gossett
  - 2. Taco
  - 3. Aurora
  - 4. Armstrong
  - 5. Grundfos/Peerless/PACO
  - 6. Patterson
  - 7. Weinman/Crane

### 2.3 IN-LINE PUMP

- A. Type: Centrifugal, single stage, close coupled in-line, back pullout design, suitable for horizontal or vertical operation.
- B. Casing: Cast iron, rated for greater of 125 psi or 1.5 times actual working discharge pressure, flanged suction and discharge with gauge ports.
- C. Impeller: Bronze or stainless steel, fully enclosed, dynamically balanced, keyed to shaft and secured with locknut.
- D. Shaft: Steel or stainless steel.
- E. Seals: Mechanical type with internal flushing rated for -20 to 225°F and comprised of Buna elastomer, carbon primary ring, and ceramic stationary ring.
- F. Manufacturers:
  - 1. Bell & Gossett
  - 2. Taco
  - 3. Aurora
  - 4. Armstrong
  - 5. Grundfos/Peerless/PACO
  - 6. Patterson
  - 7. Weinman/Crane

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General Installation Requirements:

1. Install all products per manufacturer's recommendations.
2. Support piping adjacent to pumps so that no weight is carried by pump casings. Provide supports under elbows on 4" and larger pump suction and discharge pipes. Allow a minimum of 18" clearance for removal of suction diffuser.
3. Ensure pumps operate at specified fluid temperatures without vapor binding or cavitation, are non-overloading in parallel or individual operation, and operate within 25% of midpoint of published maximum efficiency curve.
4. Install on vibration isolators as scheduled on drawings.

#### B. In-Line Pumps:

1. Support in-line pumps individually so there is no strain on the piping. Install with a minimum of five diameters of straight pipe on pump suction and discharge.
2. Pump orientation shall be in accordance with the manufacturer<sup>TM</sup>s recommendations.

#### C. Base-Mounted Pumps:

1. Base-mounted pump shall be aligned in accordance with the pump manufacturer<sup>TM</sup>s recommendations. A factory-trained representative shall laser align the pump to meet the manufacturer<sup>TM</sup>s requirements and tolerances. An alignment report shall be provided as part of the project closeout documents.
2. Unless otherwise shown on the drawings, mount all base mounted pumps on 4" high concrete pads and anchor frames to pads with cast-in-place anchors.
3. All base-mounted pumps shall be grouted-in. Follow manufacturer's instructions for grouting.

END OF SECTION 23 21 23

## SECTION 23 22 00 - STEAM AND STEAM CONDENSATE PIPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings.
- B. Valves.
- C. Steam Piping System.
- D. Condensate Piping System.

#### 1.2 QUALITY ASSURANCE

- A. Valves: Manufacturer's name and pressure rating marked on valve body. Remanufactured valves are not acceptable.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect piping to prevent corrosion and entrance of foreign matter.
- B. Deliver and store valves in shipping containers with labeling in place.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/ASME B31.9 for the following pipe systems:
  - 1. Boiler external pipe systems that operate up to 15 psi.
  - 2. Non-boiler external pipe systems that operate up to 150 psi.
- B. Conform to ANSI/ASME B31.1 for boiler external pipe systems that operate above 15 psi.
- C. Refer to ANSI/ASME B31.1 and ANSI/ASME B31.9 for "boiler external piping" and "non-boiler external piping" definitions.

#### 1.5 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 23 05 00 for required steam and steam condensate piping systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.

## PART 2 - PRODUCTS

### 2.1 STEEL PIPING (0 TO 125 PSIG)

#### A. Steel Pipe; 0 to 125psig; Standard Weight; Threaded Joints:

1. Design Pressure: 125 psig. Maximum Design Temperature: 353°F.
2. Pipe: Standard weight black steel, threaded and coupled, ASTM A53.
3. Joints: Screwed.
4. Fittings: 125 psi S - 175 psi. WOG, cast iron, ASTM A126, ANSI B16.4.
5. Unions: 250 psi S - 500 psi. WOG, black malleable iron, ground joint with brass seat.

#### B. Steel Pipe; 0 to 125psig; Standard Weight; Flanged Joints or Welded Joints:

1. Design Pressure: 125 psig. Maximum Design Temperature: 353°F.
2. Pipe: Standard weight black steel, beveled ends, ASTM A53.
3. Joints: Butt welded or flanged.
4. Fittings: Standard weight seamless steel, butt welded type, ASTM A234, Grade WPB, ANSI B16.9.
5. Flanges: 150 lb. forged steel, welding neck or slip-on, ASTM A181, Grade I, ANSI B16.5. Flange face seal weld (backweld) is required for slip-on flanges.

### 2.2 VALVES

#### A. Shutoff Valves:

1. BA-1: 3" and under, 125 psi saturated steam, 600 psi WOG, full port, screwed or solder ends (acceptable only if rated for soldering in line with 470°F melting point of lead-free solder), bronze body of a copper alloy containing less than 15% zinc, stainless steel ball and trim, Teflon seats and seals. Apollo #77C-140, Stockham #S-206 BR1-R, Milwaukee #BA-400, Watts, Nibco #585-70-66, National Utilities Co., RUB.
2. BA-1A (0 to 125 psig): 2-1/2" and 3", 150 psi saturated steam, 275 psi WOG ANSI Class, 150 psi standard port, carbon steel body stainless steel ball and trim, Teflon seats and seals. Apollo #88A-100, Nibco #F510-CS/66, Milwaukee #F90.

#### B. Throttling/Shutoff Valves:

1. Globe Valves (0 to 125 psig):
  - a. GL-1 (0 to 125 psig): 2" and under, 125 psi saturated steam, 300 psi WOG, screwed, bronze. Crane #7TF, Stockham #B22T, Walworth #3095, Milwaukee #590, Hammond #IB413, Watts #B-4010-T, NIBCO T-235-Y.
  - b. GL-2 (0 to 125 psig): 2-1/2" thru 10", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, iron body, bronze mounted. Crane #351, Hammond #IR116, Stockham #G-512, Walworth #8906F, Milwaukee #F2981, Watts #F-501, NIBCO F-718-B.

## 2.3 CHECK VALVES

- A. CK-1 (0 to 125 psig): 2" and under, 125 psi S @ 353°F, 200 psi WOG @ 150°F, screwed, bronze, horizontal swing. Crane #37, Hammond #IB904, Stockham #B319, Walworth #3406, Milwaukee #509, Watts #B-5000, NIBCO T-413-Y.
- B. CK-6 (0 to 125 psig): 2-1/2" thru 12", 125 psi S @ 353°F, 200 psi WOG @ 150°F, flanged, all iron, horizontal swing. Crane #373-1/2, Hammond #IR1126, Stockham #G933, Walworth #8928-1/2F, Milwaukee #F2971, Watts #F-511-R, NIBCO F-918-Ng.

## 2.4 STRAINERS

- A. ST-1 (0 to 125 psig): Cast iron body, screwed ends, screwed cover, 250# steam @ 406°F, 400# WOG @ 150°F. Armstrong #CA1SC, Metraflex #TS, Mueller Steam Specialty Co. #11M, Sarco #IT, Watts #77S, NIBCO T-751. Bronze body strainer 125# may be used as contractor option.
- B. Unless otherwise indicated, strainers shall have stainless steel screens with perforations as follows:
  - 1. Steam All Sizes: 1/32"
  - 2. Condensate All Sizes: 3/64"
- C. Furnish pipe nipple with gate valve and threaded cap to blow down all strainer screens.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Ream pipe and tube ends, remove burrs, bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories .
- D. Make connections to equipment with flanges or unions.
- E. After completion, fill, clean, and treat systems.

### 3.2 PIPING SCHEDULE

- A. Steam (0 to 125 psig):
  - 1. Steel Pipe; 0 to 125 psig; Standard Weight; Threaded Joints: 2" and Under
  - 2. Steel Pipe; 0 to 125 psig; Standard Weight; Flanged Joints or Welded Joints: 2-1/2" and Over
  - 3. Shutoff Valves: BA-1, BA-1A
  - 4. Throttling: GL-1, GL-2

5. Check Valves: CK-1, CK-6
6. Strainers: ST-1

B. Condensate Piping (0 to 125 psig):

1. Shutoff Valves: BA-1, BA-1A
2. Throttling: GL-1, GL-2
3. Check Valves: CK-1, CK-6
4. Strainers: ST-1

C. Boiler Feedwater (0 to 125 psig):

1. Steel Pipe; 0 to 125 psig; Extra Strong; Threaded Joints: 2" and Under
2. Shutoff Valves: BA-1, BA-1A
3. Throttling: GL-1, GL-2
4. Check Valves: CK-1, CK-6
5. Strainers: ST-1

### 3.3 TESTING PIPING

- A. Complete all testing of pipes underground, or in chases and walls, before piping is concealed.
- B. Complete all testing before insulation is applied, or if insulation is applied before the pipe is tested and a leak develops which ruins the insulation, the pipe installing contractor shall arrange and pay for replacing the damaged insulation.
- C. Test piping with water at 150% of the maximum operating pressure.
- D. Hold pressure for at least two hours.
- E. Test to be witnessed by the Architect/Engineer or their representative, if requested by the Architect/Engineer.

### 3.4 CLEANING PIPING

- A. Assembly:
  1. Prior to assembly of pipe and piping components, all loose dirt, scale, oil and other foreign matter on internal or external surfaces shall be removed by means consistent with good piping practice subject to the approval of the Architect/Engineer's representative. Chips and burrs from machinery or thread cutting operation shall be blown out of pipe before assembly. Cutting oil shall be wiped from internal and external surfaces.
  2. During fabrication and assembly, remove slag and weld spatter from both internal and external pipe joints by peening, chipping and wire brushing.
  3. Notify the Architect/Engineer's representative prior to starting any post erection cleaning operation in sufficient time to allow witnessing the operation. Consult with and obtain approval from the Architect/Engineer's representative regarding specific procedures and scheduling. Arrange for proper disposal of cleaning and flushing fluids.

4. When the system is started up for the first time, discharge the condensate to drain per the boiler manufacturer's recommendations or for 24 hours, whichever is more restrictive. Add domestic cold water to the drain at a sufficient rate to reduce the condensate temperature to a maximum of 140°F.

### 3.5 INSTALLATION

#### A. General Installation Requirements:

1. Route piping in orderly manner, plumb and parallel to building structure, and maintain gradient.
2. Install piping to conserve building space and not interfere with use of space, other work, or equipment.
3. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
4. Slope steam piping 0.25" in 10 feet in direction of flow. Use eccentric reducers to maintain bottom of pipe level.
5. Slope steam condensate piping 0.5" in 10 feet.
6. Where pipe supports are welded to structural building framing, scrape, brush clean, and apply zinc rich primer to welds.

#### B. Installation Requirements in Electrical Rooms:

1. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.

#### C. Valves/Fittings and Accessories:

1. Provide clearance for installation of insulation and access to valves and fittings.
2. Provide access doors where valves and fittings are not exposed.
3. Provide drip trap assembly at low points and before control valves and pressure reducing valves.
4. Provide loop vents over trapped sections.
5. Prepare pipe, fittings, supports, and accessories for finish painting.
6. Provide drip legs as shown on the drawings, at low points, traps, and the base of all risers in steam, and condensate pipes. Unless otherwise shown, drip legs shall be full pipe size on pipes through 4" and at least 4", but not less than half line size over 4". Drip legs shall be 12" minimum length, with a reducer and a 3/4" shutoff valve.
7. Install valves with stems upright or horizontal, not inverted.
8. Provide shutoff valves in supply and return to all equipment.
9. Install strainers in steam piping with the "wye" of the strainer to the side of the pipe in the horizontal plane to avoid pooling of condensate.

### 3.6 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.

- B. All pipe, fittings, valves, equipment and accessories shall have factory applied identification sufficient to determine conformance with specified requirements.
- C. Exercise care at every stage of storage, handling, laying and erecting to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item of system. Use plugs, caps, blind flanges or other items designed for this purpose.
- E. Run pipe straight and true, parallel to building lines with minimum use of offsets and couplings. Provide only offsets required for needed headroom or clearance and to provide needed flexibility in piping.
- F. Change direction of pipes only with fittings or pipe bends. Change size only with fittings. Do not use miter fittings, face or flush bushings, or street elbows. All fittings shall be long radius type, unless otherwise noted.
- G. Provide flanges or unions at all connections to equipment traps and valves to facilitate dismantling.
- H. Arrange piping and connections so equipment served may be serviced or totally removed without disturbing piping beyond final connections and associated shutoff valves.
- I. Use full and double lengths of pipe wherever possible.
- J. Unless otherwise indicated, install all inlet and outlet piping, including shutoff valves and strainers, to coils, pumps and other equipment at line size with reduction in size made only at control valve, pump, or trap.
- K. Cut all pipe to exact measurement and install without springing or forcing.
- L. Avoid creating, even temporarily, undue loads, forces or strains on valves, equipment or building elements with piping connections or supports.
- M. Unless otherwise indicated, branch takeoffs shall be from top of mains or headers at either a 45° or 90° angle from the horizontal plane for steam pipes.
- N. Branch takeoffs shall be from the top, side (if branch is two sizes smaller than main), or any angle from the horizontal plane to the top of piping for liquids.

### 3.7 BRANCH CONNECTIONS

- A. Make branch connections with standard tee or cross fittings of the type required for the service unless otherwise indicated.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Branch connections from mains may be cut into black steel pipe using forged weld-on fittings:

1. Steam.
2. Condensate.
3. Boiler Feedwater.

D. Use of forged weld-on fittings is further limited as follows:

1. Must have at least same pressure rating as the main.
2. Header or main must be 2-1/2" or over.
3. Branch pipe is at least two sizes under main size.

### 3.8 JOINING OF PIPE

A. Threaded Joints (Steel Pipe):

1. Screw threads shall conform to ANSI B2.1 "Pipe Threads".
2. Ream pipe ends and remove all burrs and chips formed in cutting and threading.
3. Protect plated pipe and valve bodies from wrench marks.
4. Apply high temperature, anti-seize thread lubricant to male threads.

B. Welded Joints (Steel Pipe):

1. Welding of all pipe joints, both as to procedures and qualification of welders, shall be in accordance with Section IX, ASME "Boiler & Pressure Vessel Code" unless local codes take precedence.
2. Furnish to the Owner's Representative prior to start of work certificates qualifying each welder.
3. The Owner's Representative reserves the right to require qualifying demonstration, at the Contractor's expense, of any welders assigned to the job.
4. Ends of pipe and fittings to be joined by butt welding shall be beveled, cleaned to bare metal and internal diameters aligned before tack welding.

END OF SECTION 23 22 00

## SECTION 23 22 18 - STEAM AND STEAM CONDENSATE SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Steam Traps
- B. Condensate Return Units
- C. Safety Valves

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: For each product specified, provide components by same manufacturer throughout.
- B. Traps: Remanufactured traps are not acceptable.

#### 1.3 SUBMITTALS

- A. Submit product data under provisions of Section 23 05 00. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes.
- B. Submit schedule indicating manufacturer, model number, size, location, rated capacity, and features for each specialty.
- C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- D. Submit manufacturer's installation instructions.
- E. Submit operation and maintenance data.

### PART 2 - PRODUCTS

#### 2.1 STEAM TRAPS

- A. Furnish traps as scheduled on the drawings.
- B. Type T-1: Inverted bucket type with thermic vent, 250 psig rated, cast iron body, side inlet and outlet, and all internal components constructed of stainless steel and renewable in-line.
  - 1. Manufacturers (0-250 psig):
    - a. Armstrong Machine Works Series 800T
    - b. Spirax/Sacro Co., Inc. Type B
    - c. Hoffman Industrial Specialties Co. Series 600 T
    - d. Clark-Reliance Series 120

C. Type T-3: Float and thermostatic type, 125 psig rated, cast iron body; balanced pressure thermostatic air vent; stainless steel valve seat, float, brass valve mechanism, and side inlet and outlet.

1. Manufacturers: (0-125 psig):

- a. Armstrong Machine Works Type A
- b. Hoffman Industrial Specialties Co. Series H, C, or X
- c. Spirax/Sacro Co., Inc. Type FT
- d. Clark-Reliance Type FT

## 2.2 LOW PRESSURE CONDENSATE RETURN UNITS (212°F-210°F, ATMOSPHERIC VENTED, FLOOR MOUNTED TANK)

- A. Contractor note: Does not apply to Flinn Middle School. Existing vacuum pump is being reused. Does not apply to Lincoln, elevate new steam heat exchangers high enough for condensate to drain by gravity to existing condensate return system. Provide new condensate return unit for Washington if the existing underground condensate return piping is found to be in poor condition.
- B. Units: Consist of factory assembled packaged receiver, pumps, float switches, control panel and accessories, for duplex operation.
- C. Receiver: Floor mounted, 3/16" welded steel,, suitable for 212°F condensate, with inlets, outlets, vent, overflow, and drain connections, and lifting eye bolts.
- D. Pumps: Centrifugal or vertical regenerative turbine type, rated to pump 212°F condensate, with two (2)-foot NPSHR. Cast iron case, renewable liners, bronze impeller, inducer impeller in addition to the centrifugal, stainless steel shaft, carbide/carbon mechanical seals rated for 250°F, with grease lubricated, sealed ball bearings, coupled to motor, 1750 RPM, and mounted on top or side of receiver. Refer to Section 23 05 13 for additional motor information.
- E. Controls: Mechanical alternator shall be two pole; float switch shall start and stop pump. Provide control transformer for alternator if required for three-phase power.
- F. Control Cabinet: Single point electrical connection, NEMA 1 or 2 enclosure, UL listed components, with hinged door, combination fused disconnect magnetic starters with overload relays, terminal strip, fusible control circuit transformer, and mechanical alternator. 'Hand-Off-Auto' switch, selector 'lead-off-lag' switches, test buttons, level alarm light, dry contacts for high level alarm, acknowledge button and alarm horn.
- G. Control Sequence: Each pump control circuit shall be completely independent of the other. Operate pumps on high level, alternating after each cycle; operate second pump upon failure of first pump and alarm.
- H. Accessories: , dial thermometer, pressure gauge on each pump discharge, isolation valves, double pole float switches, drain valve. Provide safety vapor release on receiver.
- I. Manufacturer:
  1. Roth Pump - Bulletin 1H99 Pg. 10 & 11

2. Domestic CB with "B" pumps 210°F
3. Shipco - ECC

### 2.3 VACUUM BREAKER

- A. Spring loaded type selected or adjusted for the minimum possible opening pressure, but never over 11" water gauge.
- B. Rated for 150 psig and 366°F.
- C. Manufacturers:
  1. Johnson VB8
  2. Sarco VB14
  3. B&G 26

## PART 3 - EXECUTION

### 3.1 INSTALLATION AND APPLICATION

- A. General Installation Requirements:
  1. Install specialties in accordance with manufacturer's instructions.
  2. Size traps to handle minimum of two and one-half times maximum condensate load of apparatus served, unless noted otherwise.
  3. All traps shall be minimum 3/4" size.
  4. Install traps with unions or flanges at both ends.
  5. Provide shutoff valve and strainer at inlet, and check valve and shutoff valve at discharge of traps.
  6. Provide minimum 14" long dirt pocket of same size as apparatus return connection between apparatus and trap, unless noted otherwise on drawings.
7. Remove thermostatic elements from traps during temporary and trial usage, and until system has been operated and dirt pockets cleaned of sediment and scale.
- B. Condensate Return Unit: (Contractor note: does not apply to Flinn or Lincoln)
  1. Install full-sized P-traps in the overflow drain piping from condensate return units and extend piping to nearest floor drain.
- C. Safety Valve:
  1. Rate safety valves for maximum capacity of largest available trim for pressure reducing valve(s) or maximum capacity of bypass valve(s), whichever is larger, at maximum possible pressure upstream of pressure reducing valve. Set at maximum 20 percent above reduced pressure.
  2. Terminate safety valves outdoors. Provide drip pan elbow with drain connection to nearest floor drain.

END OF SECTION 23 22 18

## SECTION 23 23 00 - REFRIGERATION PIPING AND SPECIALTIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Piping and Pipe Fittings
- B. Moisture and Liquid Indicators
- C. Check Valves
- D. Pressure Relief Valves
- E. Filter-Driers
- F. Suction Filters
- G. Solenoid Valves
- H. Expansion Valves
- I. Receivers
- J. Suction Accumulators

#### 1.2 QUALITY ASSURANCE

- A. Remanufactured specialties are not acceptable.

#### 1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 05 00.
- B. Submit layout of entire piping system including equipment, critical dimensions, and all pipe sizes, traps, valves, and accessories. Layout shall be a custom drawing for this job, not a standard detail. The refrigeration equipment supplier shall stamp the approval on layout drawings.
- C. Submit product data for specialties, including manufacturers catalog information.
- D. Submit manufacturer's installation instructions.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labels in place.
- B. Protect piping and specialties from entry of foreign material by leaving caps and plugs in place until installation.

## PART 2 - PRODUCTS

### 2.1 PIPING

- A. Design Pressure: 450 psig.
  - 1. Maximum Design Temperature: 250°F.
- B. Piping - 4" and under; Brazed Joint:
  - 1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
  - 2. Joints: Brazed with silver solder.
  - 3. Fittings: Wrought copper solder joint, ANSI B16.22.
  - 4. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.

### 2.2 MOISTURE AND LIQUID INDICATORS

- A. UL listed, with copper, brass, or copper-plated steel body, flared or solder ends, extended fittings in units up to at least 1-1/8" to allow brazing without removing the cartridge, sight glass, color coded paper moisture indicator that is replaceable without breaking piping connections for units up to 1-1/8" size, and plastic cap; maximum working pressure of 500 psi, and maximum temperature of 200°F.
  - 1. Manufacturers:
    - a. Sporlan
    - b. Henry Valve Company
    - c. Alco Valve

### 2.3 VALVES

- A. BA-14: Refrigerant Ball Valve: 3/8" thru 3-1/8", 500 psi, -40°F to +300°F, full-port up to 2-1/8" size, blow-out proof, PTFE seals, brass ball with equalizing orifice, visible position indication, seal cap, extended copper connections, replaceable stem seals, compatible with all CFC, HCFC, and HFC refrigerants.
  - 1. Manufacturers:
    - a. Henry Valve Company
    - b. Superior Valve
    - c. Alco Valve

### 2.4 CHECK VALVES

- A. CK-10: 1/4" thru 3-5/8", 500 psi, globe or angle pattern, brazed, brass body, cleaned-dried-plugged and tagged at factory for refrigerant service.

1. Manufacturers:
  - a. Henry Valve Company
  - b. Mueller
  - c. Wolf-Linde

## 2.5 PRESSURE RELIEF VALVES

- A. RV-5: Straight Thru or Angle Type: Brass body and disc, Teflon seat, factory sealed and stamped with ASME UV and National Board Certification NB; selected to ANSI/ASHRAE 15.

## 2.6 FILTER-DRIERS

- A. Replaceable Cartridge Angle Type: ANSI/AHRI 710, UL listed, brass or epoxy-coated steel shell, molded desiccant high-water capacity filter core(s); maximum working pressure of 500 psi; maximum temperature of 275°F; maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.
- B. Permanent Straight Thru Type: ANSI/AHRI 710, UL listed, steel shell with molded desiccant filter core, maximum working pressure of 500 psi, maximum pressure drop of 3 psi with R410a or 1.5 psi with R134a at system flow rate.

## 2.7 SUCTION FILTERS

- A. Replaceable Cartridge Angle Type: UL listed for 500 psi up to 2-18" size, and 400 psi for larger sizes, steel shell that passes 1000-hour salt spray test with copper fittings, replaceable pleated filter element(s); maximum pressure drops of 3 psi with R410a or 2 psi with R134a at system flow rate, capable of accepting molded desiccant core for cleanup after compressor burnout, access valve in the removable end plate. Install with side refrigerant inlet.

## 2.8 SOLENOID VALVES

- A. Valve: AHRI 760; pilot operated; copper or brass body and internal parts; synthetic seat; stainless steel stem and plunger assembly; extended solder ends to permit installation without disassembly; maximum working pressure of 500 psi; normally closed. Maximum pressure drop at system flow of 5 psi for R410a and 3 psi for R134a.
- B. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, surge protector and color-coded lead wires, integral junction box, Class F temperature rated, ANSI/UL 429.

## 2.9 EXPANSION VALVES

- A. Angle or Straight Thru Type: ANSI/AHRI 750; materials suitable for system refrigerant, external equalizer, adjustable super heat setting, balanced port design, suitable for horizontal or vertical installation, with replaceable capillary tube and remote sensing bulb.
- B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10°F super heat. Select to avoid being undersized at full load or excessively oversized at part load.

## 2.10 RECEIVERS

- A. All receivers shall have capacity to hold the entire refrigerant charge when 90% full at 90°F per ASHRAE 15-78.
- B. 6" and Smaller Internal Diameter: ANSI/AHRI 495, UL listed, steel or copper, brazed; 450 psi working pressure, with tappings for inlet, outlet, and relief valve or fusible plug.

## 2.11 SUCTION ACCUMULATORS

- A. All accumulators shall have capacity to hold 50% of the refrigerant charge when 90% full at 90°F per ASHRAE 15-78, pressure drop equivalent to under 0.5°F at peak capacity, a finish that survives a 500-hour salt spray test, vertical design with dip tube and screened oil inlet orifice, and a hot gas boil-out coil to evaporate liquid refrigerant.
- B. 6" and Smaller Internal Diameter: ANSI/AHRI 495, UL listed, steel or copper, brazed; 400 psi pressure rating, with tappings for inlet, outlet, and pressure relief valve or fusible plug.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Remove all scale, rust, dirt, oils, stickers and thoroughly clean exterior of all bare metal exposed piping, hangers, and accessories in preparation to be painted.

### 3.2 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Reducers are generally not shown. Where pipe sizes change at tee, the tee shall be the size of the largest pipe shown connecting to it.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and not interfere with use of space.
- E. Do not install piping or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the equipment.
- F. Group piping whenever practical at common elevations and locations. Slope piping 1% in direction of oil return.
- G. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

- H. Provide clearance for installation of insulation and access to valves and fittings.
- I. Where pipe support members are welded to structural building frame, brush clean, and apply zinc rich primer to welding.
- J. Insulate piping and equipment; per Section 23 07 19 and Section 23 07 16.
- K. Provide external equalizer piping on expansion valves, and locate expansion valve sensing bulb immediately downstream of evaporator on suction line. Connect distributor to expansion valve outlet.
- L. Install flexible connectors parallel to the shafts of compressors.
- M. Fully charge system with refrigerant after testing.

### 3.3 PIPE ERECTION AND LAYING

- A. Carefully inspect all pipe, fittings, valves, equipment and accessories before installation. Any items that are unsuitable, cracked or otherwise defective shall be rejected and removed from the job immediately.
- B. All pipe, fittings, valves, equipment and accessories shall have factory applied identification sufficient to determine their conformance with specified requirements.
- C. Exercise care at all times to prevent entry of foreign matter into piping, fittings, valves, equipment and accessories. Do not erect or install any item that is not clean.
- D. During construction, until system is fully operational, keep all openings in piping and equipment closed except when actual work is being performed on that item or system. Closures shall be plugs, caps, blind flanges or other items designed for this purpose.
- E. Change direction of pipes only with fittings or pipe bends. Change size only with fittings.
- F. Cut all pipe to exact measurement and install without springing or forcing.

### 3.4 APPLICATION

- A. Provide solenoid valves in liquid lines of systems, in oil bleeder lines to stop flow of oil and refrigerant into the suction line when system shuts down, and in hot gas bypass lines, as applicable.
- B. Provide refrigerant charging valve connections.
- C. Provide replaceable cartridge filter-driers, with three-valve bypass assembly and suction filters without bypass assembly.

### 3.5 JOINING OF PIPE

#### A. Brazed Joints:

1. Make up joints with brazing filler metal conforming to ANSI/AWS A5.8. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt, and grease just prior to brazing. Apply flux evenly, but sparingly, to all surfaces to be joined. Brazing filler metal with a flux coating may also be used. Heat joints uniformly to proper brazing temperature so braze filler metal flows to all mated surfaces. Wipe excess braze filler metal, leaving a uniform fillet around cup of fitting.
2. Flux shall conform to ANSI/AWS A5.31.
3. Remove composition discs and all seals during brazing if not suitable for a minimum of 840°F or greater than the melting temperature of the brazing filler metal, whichever is greater.

### 3.6 FIELD QUALITY CONTROL

- A. Test piping system with nitrogen at 300 psig for at least 8 hours without loss of pressure.
- B. Comply with ASHRAE Standard 147 for refrigerant system integrity testing.
- C. After pressure testing, evacuate all refrigerant piping to at least 28" of mercury for 24 hours without loss of vacuum. Ensure moisture does not enter the piping prior to and during the tests.

END OF SECTION 23 23 00

## SECTION 23 25 00 - CHEMICAL (WATER) TREATMENT

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Treatment for Closed Systems (Water).
- B. Chemical Feed Equipment.

#### 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 05 00.
- B. Include system schematics, equipment locations, and controls schematics.
- C. Submit product data indicating chemicals and equipment.
- D. Submit manufacturer's installation instructions.
- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit reports indicating start-up of treatment systems is completed and operating properly. Include reports indicating analysis of system water after cleaning and after treatment.

#### 1.3 EXTRA STOCK

- A. Provide clean cartridges or bags in all bypass (pot) feeders with filters and sidestream filters.
- B. Provide two complete sets of replacement cartridges or filters for each bypass (pot) feeder with filters and sidestream filter installed. Deliver to Owner at job site.

#### 1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include data on pumps and other equipment including spare parts lists, procedures, and treatment programs.
- C. Include step-by-step instructions on test procedures including target concentrations and test frequencies.
- D. Include list of treatment chemicals and associated SDS.

## 1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this section with minimum five years documented experience. Company shall have local representatives with water analysis laboratories and full-time service personnel.

## 1.6 REGULATORY REQUIREMENTS

- A. Conform to all applicable codes and regulations for addition of non-potable chemicals to building mechanical systems, and for discharge to public sewage systems.
- B. Provide only chemicals approved for use and disposal by local authorities. Contact the Architect/Engineer if any specified chemicals are prohibited.

## 1.7 MAINTENANCE SERVICE

- A. Provide the following services to assist the owner in setting up and maintaining chemical treatment systems for one year from Date of Substantial Completion:
  - 1. Provide technical service visits to perform field inspections and make water analysis on site. Visits shall be twice annually for closed systems and monthly for steam and cooling tower systems. For cooling tower systems, monthly testing shall have dipslide culture counts, and quarterly water samples shall be sent to a CDC Elite lab for culturing to establish baseline total organism and Legionella counts. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit copies of the field service report after each visit to the Owner and to the Mechanical Contractor. Any problems related to the operation of the chemical treatment program shall be reported to the Architect/Engineer.
  - 2. Provide laboratory and technical assistance services for warranty period.
  - 3. Include 2 hour training course for operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Arrange course at start-up of systems.
  - 4. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.
  - 5. Provide sufficient chemicals for treatment and testing during warranty period.
- B. The Chemical Treatment Subcontractor shall be responsible for assisting the Mechanical Contractor by adding the chemical solutions required for cleaning each piping system. During the remainder of the warranty period, the Chemical Treatment Subcontractor will be responsible for adding chemicals and doing other work related to the operation of system such as boiler blowdown. The Chemical Treatment Contractor shall make periodic tests of the chemical treatment program as called for above and recommend changes to Owner when needed.

## 1.8 WATER ANALYSIS

- A. Sample feedwater to determine appropriate chemical treatment. Contact the Architect/Engineer if test indicates treatment required is different than that specified.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. America's Best Water Treaters
- B. Betz
- C. Butler Chemical Company
- D. H-O-H Chemicals Inc.
- E. Watertech of America

### 2.2 MATERIALS

- A. Closed System Treatment (Water):
  - 1. Provide one bypass feeder on each system. Install inlet, outlet and drain valves, and necessary piping.
  - 2. Provide a 3/4" water meter in the domestic cold water line that provides makeup water to hydronic systems with electronic pulse output to building automation system.
  - 3. Provide coupon rack around main system pumps for all systems
  - 4. Proprietary blend containing the following items:
    - a. Corrosion Inhibitors for Chilled Water Systems and Heating Systems operating at  $\leq 145^{\circ}\text{F}$ : Sodium molybdate with added inhibitors such as mercaptobenzothiazole, sodium tolytriazole, or phenyltriazole to protect copper and brass and minimize dielectric pitting of steel. Maintain 50 ppm molybdate. Adjust borax content to keep correct pH for type of system (mainly steel or mainly copper).
    - b. Scale Inhibitor: Organic phosphonates such as aminomethylene-phosphonate; phosphonates such as hydroxyethylidenediphosphonate or polyamino-substituted phosphonates; or synthetic polymers such as low-molecular-weight polyacrylates, poly-methacrylates and polyacrylanides. Inorganic phosphates are not acceptable. Maintain residual concentration as recommended by the manufacturer.

### 2.3 EQUIPMENT

- A. Bypass (Pot) Feeder: 5.0 gal; quick-opening cap with 3-1/2" minimum diameter opening and opening wrench, legs to raise fill cap to 30" to 36", drain valve, air cock, working pressure of 200 psig at 200°F, 20 to 25-micron cartridge or bag filter.
  - 1. Acceptable Manufacturers:
    - a. Griswold
    - b. Vector Industries
    - c. J.L. Wingert
    - d. Neptune
- B. Water Meter: Positive displacement type meter with bronze housing. 3/4" meter size. Meter to handle 1/2 - 30 GPM.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install bypass (pot) feeder with top approximately 36" above the floor.
- C. Coordinate with Contractor to provide temporary metering capabilities during system fill to determine overall system volume. Notify Architect/Engineer of overall system volume so that expansion tank sizing can be confirmed.

3.2 CLOSED-LOOP HYDRONIC SYSTEM WATER QUALITY STANDARDS

- A. Review equipment manufacturer's water quality standard to ensure water quality is sufficient to meet their warranty requirements as well as to ensure peak heat transfer efficiency. Contractor shall maintain hydronic systems within the more stringent of either the equipment manufacturer's requirements or those listed below:

Measured Value	Multi-Metal Systems with Aluminum	Multi-Metal Systems with Stainless Steel	Multi-Metal Systems with Copper
pH Range	8.5	8.5	9.0
Alkalinity as CaCO <sub>3</sub>	100 - 500 mg/l	100 - 500 mg/l	100 - 500 mg/l
Hardness as CaCO <sub>3</sub> *	100 - 500 mg/l	100 - 500 mg/l	100 - 500 mg/l
Suspended Solids	less than 10 mg/l	less than 10 mg/l	less than 10 mg/l
Dissolved Solids	less than 1,000 mg/l	less than 1,000 mg/l	less than 1,000 mg/l
Chlorides	less than 150 mg/l	less than 150 mg/l	less than 150 mg/l
Iron	less than 5.0 mg/l	less than 5.0 mg/l	less than 5.0 mg/l
Manganese	less than 0.4 mg/l	less than 0.4 mg/l	less than 0.4 mg/l
Nitrate	less than 100 mg/l	less than 100 mg/l	less than 100 mg/l
Sulfate	less than 200 mg/l	less than 200 mg/l	less than 200 mg/l
Ammonia	less than 5.0 mg/l	less than 5.0 mg/l	less than 5.0 mg/l
Free Copper	less than 0.10 mg/l	less than 0.10 mg/l	less than 0.10 mg/l

\* Minimum hardness only applies to softened water. If water from rivers or lakes is below 100 mg/l, remineralizing is not required.

- B. Submit an independent third-party test report for each chemically treated closed-loop system showing compliance with all measured values shown in the above table as part of project closeout documentation.
- C. Circulate water and verify proper chemical and especially biocide levels for six (6) hours prior to starting fans if system has been out of service.
- D. Lockout all feed and bleed operations when there is no flow to cooling towers.

END OF SECTION 23 25 00

## SECTION 23 31 00 - DUCTWORK

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Galvanized Ductwork
- B. Aluminum Ductwork
- C. Ductwork Reinforcement
- D. Ductwork Sealants
- E. Rectangular Ductwork
- F. Round and Flat Oval Ductwork
- G. Exposed Ductwork (Rectangular, Round, or Oval)
- H. Flexible Duct
- I. Fabric Ductwork (Textile Air Dispersion)
- J. Ductwork Penetrations
- K. Painting

#### 1.2 QUALITY ASSURANCE

- A. Building Codes and Standards:
  - 1. Product must be classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and UL 2518.
  - 2. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.
- B. Design and Quality Control:
  - 1. Manufacturer must have documented design support information including duct sizing; vent, orifice, and/or nozzle location; vent, orifice, and/or nozzle sizing; length.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00.
- B. The Architect/Engineer may require field verification of sheet metal gauges and reinforcing to verify compliance with these specifications. At the request of the Architect/Engineer, the contractor shall remove a sample of the duct for verification. The contractor shall repair as needed.

- C. Duct Layout Drawings: Submit detailed duct layout drawings at 1/4" minimum scale complete with the following information:
1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
  2. Differentiate ducts that are wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
  3. Room names and numbers, ceiling types, and ceiling heights.
  4. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
  5. Verify clearances and interferences with other trades prior to preparing drawings. IMEG will provide electronic copies of ventilation drawings for contractor's use if the contractor signs and returns the "Electronic File Transfer" waiver. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for this submittal. Refer also to Section 23 05 00.
- D. Duct Leakage Test Summary Report: Upon completion of the pressure test described in Part 3, the Contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.

#### 1.4 WARRANTY (Fabric Ductwork)

- A. Manufacturer must provide a 15-year product warranty for products supplied for the fabric portion of this system as well as a design and performance warranty.

#### 1.5 DELIVERY, STORAGE AND HANDLING

1. Protect textile air dispersion systems from damage during shipping, storage and handling.
2. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

#### 1.6 DEFINITIONS

- A. Duct Sizes shown on drawings are inside clear dimensions. Maintain clear dimensions inside any lining.
- B. Transitions are generally not shown in single-line ductwork. Where sizes change at a divided flow fitting, the larger size shall continue through the fitting.
- C. Exterior Duct: Ductwork located outside the conditioned envelope including exposed ductwork above the roof, outside exterior walls, in attics above insulated ceilings, inside parking garages, and crawl spaces.
- D. Interior Duct: Ductwork located within the conditioned envelope including return air plenums and indirectly conditioned spaces.

## 1.7 COORDINATION DRAWINGS

- A. Reference Coordination Drawings article in Section 23 05 00 for required duct systems electronic CAD drawings to be provided to Coordinating Contractor for inclusion into composite coordination drawings.
- B. Duct drawings shall be at 1/4" minimum scale complete with the following information:
  - 1. Actual duct routing, ductwork fittings, actual sheet metal dimensions including insulation liner and wrap, duct hanger and support types, ductwork accessories, etc. with lengths and weights noted.
  - 2. Differentiate ducts that are lined or wrapped. Include insulation thickness, type of insulation, and acoustical lagging.
  - 3. Location and size of all duct access doors.
  - 4. Room names and numbers, ceiling types, and ceiling heights.
  - 5. Indicate location of all beams, bar joists, etc. along with bottom of steel elevations for each member.
  - 6. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings. Architectural plans will need to be obtained from the Architect.

## PART 2 - PRODUCTS

### 2.1 SHAPE

- A. Rectangular Duct - Single Wall:
  - 1. General Requirements:
    - a. All ductwork gauges and reinforcements shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space consuming reinforcement.
    - b. Transitions shall not exceed the angles in Figure 4-7.
  - 2. Exceptions and modifications to the 2005 HVAC Duct Construction Standards are:
    - a. All ducts shall be cross-broken or beaded.
    - b. Snap lock seams are not permitted.
    - c. Turning vanes shall be used in all 90° mitered elbows, unless clearly noted otherwise on the drawings. Vanes shall be as follows:
      - 1) Type 2:
        - a) Description: Double wall type with 3-1/4" blade spacing, 4-1/2" radius, 24-gauge minimum, and SMACNA Type 1 runners. C-value below 0.27.
        - b) Usage: No limits other than imposed by the manufacturer. Provide intermediate support for vanes over 48" long.

- d. Where smooth radius rectangular elbows are shown, they shall be constructed per SMACNA Figure 4-2. Type RE1 shall be constructed with a centerline duct radius R/W of 1.0. Where shown on drawings, Type RE3 elbows with 3 vanes shall be used with centerline duct radius R/W of 0.6 (SMACNA r/W=0.1). RE1 or RE3 elbows may be used where mitered elbows are shown if space permits. Mitered elbows (with or without turning vanes) may not be substituted for radius elbows. Do not make branch takeoffs within 4 duct diameters on the side of the duct downstream from the inside radius of radius elbows.
- e. Rectangular branch and tee connections in ducts over 1" pressure class shall be 45° entry type per Figs. 4-5 and 4-6. Rectangular straight taps are not acceptable above 1" pressure class.
- f. Bellmouth fittings shown on return duct inlets shall expand at a 60-degree total angle horizontally and vertically (space permitting) and have length of at least 25% of the smallest duct dimension.
- g. Round taps off rectangular unlined ducts shall be flanged conical or bellmouth type (equal to Buckley Bellmouth or Sheet Metal Connectors E-Z Tap), or 45° rectangular with transition to round (equal to Sheet Metal Connectors Inc. High Efficiency Takeoff). Straight taps are acceptable if pressure class is 1" or less, round duct is 12" diameter or less, and the tap is not located between fans and TAB devices.
- h. Duct offsets shall be constructed as shown on drawings. Additional offsets required in the field shall be formed of mitered elbows without turning vanes for offsets up to 30° maximum angle in accordance with SMACNA offset Type 2. Offsets of greater than 30° angle shall be formed of radius elbows with centerline radius R/W=1.0 or greater. SMACNA Type 1 offsets are not permitted.
- i. All lined duct shall utilize dovetail joints where round or conical taps occur. The dovetail joints shall extend past the liner before being folded over.
- j. Cushion heads are acceptable only downstream of TAB devices in ducts up to ± 2" pressure class, and must be less than 6" in length.
- k. Slide-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
  - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
  - 2) Manufacturers:
    - a) Ductmate Industries - 25/35/45
    - b) Nexus
    - c) Mez
    - d) WDCI
    - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.
- l. Formed-on flanged transverse joint systems are acceptable provided they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
  - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.

- 2) Flanges shall be 24-gauge minimum (not 26 gauge).
- 3) Manufacturers:
  - a) Lockformer TDC
  - b) TDF
  - c) United McGill
  - d) Sheet Metal Connectors
  - e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

B. Rectangular Duct - Double Wall:

1. All applicable portions of Rectangular Duct - Single Wall shall apply.
2. Furnish and install double-wall insulated airtight duct as shown on the drawings.
3. Duct Construction:
  - a. Galvanized steel exterior wall with solid galvanized steel interior wall.
  - b. Rectangular double wall duct shall be suitable for pressures listed in the ductwork application schedule.
  - c. All ductwork gauges and reinforcement shall be as listed in SMACNA Duct Construction Standards Chapter 2. Where necessary to fit in confined spaces, furnish heaviest duct gauge and least space-consuming reinforcement.
  - d. Ducts shall be 1-1/2" thick and completely metal enclosed with annular space completely filled with 1-1/2# density glass fiber insulation. Insulation shall have flame spread/smoke developed ratings of less than 25/50 per ASTM E84, NFPA 255, or UL 723.
  - e. Divided flow fittings may be separate fittings or factory installed taps with the following construction requirements:
    - 1) Airtight, continuous welds at intersection of fitting body and tap.
    - 2) Tap liner spot welded to inner liner with weld spacing not over 3".
    - 3) Insulation packed around the tap area for complete cavity filling.
    - 4) Carefully fit branch connections to cut-out openings in inner liner without spaces for air erosion of insulation or sharp projections for noise and airflow disturbance.
  - f. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
  - g. Support inner liner of ducts and fittings with metal spacers welded to maintain spacing and concentricity.
  - h. Formed-on flanged transverse joint systems are acceptable if they are a manufactured product that has been tested for conformance with Chapter 2 of the SMACNA HVAC Duct Construction Standards for sheet and joint deflection at the specified pressure class.
    - 1) Apply sealant to all inside corners. Holes at corners are not acceptable.
    - 2) Flanges shall be 24-gauge minimum (not 26 gauge).
    - 3) Manufacturers, Formed-on Flanged Joint Systems:

- a) Lockformer TDC
- b) TDF
- c) United McGill
- d) Sheet Metal Connectors
- e) Other manufacturers must submit test data and fabrication standards and receive Architect/Engineer's approval before any fabrication begins.

C. Round and Flat Oval Spiral Seam Ductwork - Single Wall:

1. Conform to applicable portions of Rectangular Duct Section. Round or flat oval ductwork may be substituted for rectangular ductwork where approved by the Architect/Engineer. The spiral seam ductwork shall meet the standards set forth in this specification. The ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
2. Flat oval duct in negative pressure applications shall have flat sides reinforced as required for rectangular ducts of the same gauge with dimensions equal to the flat span of the oval duct.
3. 90° elbows shall be smooth radius or have a minimum of five sections with mitered joints and R/D of at least 1.5.
4. Duct and fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA requirements for the specified pressure class. Ribbed and lightweight duct are not permitted.
5. Ductwork shall be suitable for velocities up to 5,000 fpm.
6. Divided flow fittings may be made as separate fittings or factory installed taps with sound, airtight, continuous welds at intersection of fitting body and tap.
7. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
8. Ducts with minor axis less than 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
9. Reinforce flat oval ducts with external angles. Internal tie rods are permitted only as indicated for rectangular ductwork.
10. Transverse Joint Connections:
  - a. Crimped joints are not permitted.
  - b. Ducts and fittings 36" in diameter and smaller shall have slip joint connections. Size fitting ends to slip inside mating duct sections with minimum 2-inch insertion length and a stop bead. Use inside slip couplings for duct-to-duct joints, and outside slip couplings for fitting-to-fitting joints.
  - c. Ducts and fittings larger than 36" shall have flanged connections.
  - d. Secure all joints with at least 3 sheet metal screws before sealing.
  - e. Manufacturers:
    - 1) Slide-on Flanges:
    - 2) Ductmate Industries - SpiralMate
    - 3) Accuflange
    - 4) Sheet Metal Connectors are acceptable.

D. Round and Flat Oval Spiral Seam Ductwork - Double Wall:

1. Conform to applicable portions of Rectangular Duct Section. Spiral seam round or flat oval double wall ductwork may be substituted for double wall rectangular ductwork where approved by the Architect/Engineer. Double wall spiral seam ductwork shall meet the standards set forth in this specification. Ductwork shall meet or exceed the specified cross-sectional area and insulation requirements. The substitution shall be coordinated with all other trades prior to installation.
2. Interior ducts shall have an airtight outer pressure shell, a 1" insulation layer, and a solid inner wall that completely covers the insulation.
3. Exterior ducts shall have an airtight outer pressure shell, a 2" insulation layer, and a solid inner wall that completely covers the insulation.
4. Insulation shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
5. 90° elbows shall be smooth radius or have a minimum of 5 mitered joints, and R/D of at least 1.5.
6. Duct and Fittings shall meet the required minimum gauges listed in chapter 3 of the SMACNA standards for the specified pressure class. Ribbed and lightweight duct are not permitted.
7. Ductwork shall be suitable for up to 5,000 fpm velocity.
8. Divided flow fittings may be separate fittings or factory installed taps with the following construction requirements:
  - a. Sound airtight, continuous welds at intersection of fitting body and tap.
  - b. Tap liner welded to inner liner with weld spacing not over 3".
  - c. Insulation packed around the tap area for complete cavity filling.
  - d. Carefully fit branch connections to cut-out openings in inner liner without spaces for air erosion of insulation or sharp projections for noise and airflow disturbance.
9. Spot weld and bond all fitting seams in the pressure shell. Coat galvanizing damaged by welding with corrosion resistant paint to match galvanized duct color.
10. Support inner liner of ducts and fittings with metal spacers welded to maintain spacing and concentricity.
11. Ducts with minor axis under 22" shall be spiral seam type. Larger ducts may be rolled, longitudinal welded seam type. SMACNA seams RL-2 and RL-3 are not permitted.
12. Transverse Joint Connections:
  - a. Crimped joints are not permitted.
  - b. Provide couplings to align the inner liners. Butt joints are not permitted for inner liners. Make alignment by extending the liner of the fitting into the duct or by using a double concentric coupling with the two couplings held by spacers for rigidity and wall spacing.
  - c. Above 34" ID provide a separate coupling for inner alignment with the pressure shells joined by angle ring flanged connections.
  - d. Use outside slip couplings for fitting-to-fitting joints.
  - e. Secure all joints with at least 3 sheet metal screws before sealing.
  - f. Manufacturers
    - 1) Slide-on Flanges:
    - 2) Ductmate Industries - SpiralMate

- 3) Accuflange
- 4) Sheet Metal Connectors

## 2.2 MATERIAL AND APPLICATION SPECIFIC

### A. Galvanized Steel:

#### 1. General Requirements:

- a. Duct and reinforcement materials shall conform to ASTM A653 and A924.
- b. Interior Ductwork and reinforcements: G60 galvanized (0.60 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise.
- c. Exterior Ductwork: G90 galvanized (0.90 ounces per square foot total zinc coating for two sides per ASTM A90) unless noted otherwise. G60 is not acceptable for exterior use.
- d. Ductwork reinforcement shall be of galvanized steel.

#### 2. Duct Hangers and Support:

- a. Ductwork supports shall be of galvanized or painted steel.
- b. Aircraft cable and slip cable hangers are acceptable for ducts up to 18"Ø. Protective sleeve tubing shall be used on the cable when supporting duct with exterior insulation. Corner saddles are required when supporting rectangular ductwork.

##### 1) Manufacturers; Supports:

- a) Gripple
- b) Ductmate
- c) Duro Dyne
- d) Architect/Engineer approved

### B. Aluminum Ductwork:

#### 1. General Requirements:

- a. Material: ASTM B209; aluminum sheet, Alloy 3003-H14. Aluminum connectors and bar stock: Alloy 6061-T6. Aluminum or stainless steel fasteners are acceptable.
- b. All duct gauges and reinforcement shall be as called for in Tables 2-50, 2-51, 2-52, and 3-14 of the SMACNA HVAC Duct Construction Standards.
- c. Ductwork reinforcement shall be of aluminum.

#### 2. Duct Hangers and Supports:

- a. Ductwork supports shall be of aluminum, galvanized steel or painted steel. Slip cable hangers are acceptable.

##### 1) Manufacturers, Supports:

- a) Gripple
- b) Ductmate

- c) Duro Dyne
- d) Architect/Engineer approved

b. All other requirements are as noted for galvanized rectangular sheet metal duct.

C. Fabric Ductwork (Textile Air Dispersion System):

1. Textile Construction: Filament/filament twill polyester treated with a machine washable anti-microbial agent by the fabric manufacturer, fire retardant in accordance with UL 2518. Non-linting filament yarn to meet the requirements of ISO Class 3 environment.

- a. Weight: 6.8 oz. /yd<sup>2</sup> per ASTM D3776
- b. Color: Coordinate with the Architect and Owner for custom color selection based on school team colors.
- c. Air Permeability: 2 (+2/-1) CFM/ft<sup>2</sup> per ASTM D737, Frazier

2. Systems Fabrication Requirements:

- a. Textile system to be constructed in modular lengths (zippered) with proper radial securing clips (inlets, endcaps) and top access zippers for tension lock attachments.
- b. Integrated air dispersion shall be specified and approved by manufacturer.

1) Linear Vents:

- a) Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on 0.5" SP), starting a 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
- b) Size of vent openings and location of linear vents to be specified and approved by manufacturer.

- c. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.
- d. Inlet connection includes zipper for easy removal / maintenance.
- e. Lengths to include required intermediate zippers as specified by manufacturer.
- f. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
- g. End cap includes zipper for easy maintenance.
- h. Each section of the textile shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.

3. Design Parameters:

- a. Textile air diffusers shall be designed from 0.25" water gauge minimum to 3.1" maximum, with 0.5" as the standard.

- b. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F.
4. Suspension Hardware:
- a. SkeleCore Pull-Tight System: Air diffusers shall be constructed with both internal retention and external tensioning.
    - 1) System shall consist of internal tensioning baskets with cable or track stops that externally tension the system off of the suspension system selected below along with 360 degree internal retention hoops that are spaced 5' on center between tensioning baskets.
    - 2) Tensioning baskets are designed to self-lock when tension is applied to the system.
    - 3) All straight sections utilize both internal retention hoops and external tensioning with the use of the tension baskets.
    - 4) Distance between consecutive tensioning baskets should not be more than 40'.
    - 5) System shall be installed with a one row suspension system located 1.5" above top-dead-center of the textile system.
    - 6) System attachment to cable shall be made using Gliders spaced no further than 12 inches apart.
      - a) Cable suspension hardware to include cable, eye bolts, thimbles, cable clamps, and turnbuckle(s) as required.
      - b) Galvanized steel cable: Support lengths available in 5 feet.
5. Acceptable Manufacturer:
- a. DuctSox Corporation.
    - 1) Sedona-Xm textile.
    - 2) SkeleCore Pull-Tight suspension system.
  - b. KE Fibertec
  - c. Nanosox

### 2.3 DUCTWORK REINFORCEMENT

- A. All reinforcement shall be external to the duct except that tie rods may be used with the following limitations.
  - 1. Ducts must be over 18" wide.
  - 2. Duct dimensions must be increased 2" in one dimension (h or w) for each row of tie rods installed.
  - 3. Tie rods must not exceed 1/2" diameter.
  - 4. Manufacturer of tie rod system must certify pressure classifications of various arrangements, and this must be in the shop drawings.

## 2.4 DUCTWORK SEALANTS

- A. One-part joint sealers shall be water-based mastic systems that meet the following requirements: maximum 48-hour cure time, service temperature of -20°F to +175°F, resistant to mold, mildew and water, flame spread rating below 25 and smoke-developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Mastic used to seal flexible ductwork shall be marked UL 181B-M. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30°F to +175°F and 2000-hour minimum UV resistance per ASTM G-53.
- B. Two-part joint sealers shall consist of a minimum 3" wide mineral-gypsum compound impregnated fiber tape and a liquid sealant. Sealant system shall meet the following requirements: maximum 48-hour cure time, service temperature of 0°F to 200°F, resistant to mold, mildew, and water, flame spread rating below 25 and smoke developed rating below 50 when tested in accordance with ASTM E84, suitable for all SMACNA seal classes and pressure classes. Joint sealers for use on exterior weather exposed ductwork shall be rated for -30°F to +175°F and 2000-hour minimum UV resistance per ASTM G-53.

## 2.5 FLEXIBLE DUCT

- A. Flexible duct shall be listed and labeled as UL 181 Class 1 Air Duct Material, and shall comply with NFPA 90A and 90B, and meet GSA, FHA and other U.S. Government agency standards. Flexible duct shall bear the ADC Seal of Certification.
- B. Flame Spread/Smoke Developed: Not over 25/50.
- C. Stretch all flexible duct to prevent sags and reduce air friction. Shorten and reinstall all sagging or loose flexible duct. Avoid sharp elbows. Elbows shall maintain 1.5 diameter centerline turning radius.
- D. Install per the SMACNA Flexible Duct Manual. Secure inner layer with draw band. Wrap with pressure sensitive tape for protection prior to installing draw band. Pressure sensitive tape alone is not acceptable.
- E. Acoustic:
  - 1. Flexible duct shall be acoustic rated in accordance with ASTM E477 and ADC Test Code FD 72-RI by ETL. Insertion loss values noted below are for flow velocities less than 2,500 fpm. Submittals shall include insertion losses ratings per sizes and lengths listed below regardless of sizes shown on the drawings.
  - 2. Flexible have corrosion-resistant wire helix, bonded to a nylon fabric core inner liner that prevents air from contacting the insulation, covered with minimum 1-1/2", 3/4 lb/cf density fiberglass insulation blanket, sheathed in a vapor barrier of metalized polyester film laminated to glass mesh. .
  - 3. Inner liner shall be airtight and suitable for 6" WC static pressure through 16" diameter. Outer jacket shall act as a vapor barrier only with permeance not over 0.1 perm per ASTM E96, Procedure A. "R" value shall not be less than 4.0 ft<sup>2</sup>\*F\*hr/Btuh. Temperature range of at least 0-180°F. Maximum velocity of 4,000 fpm.
  - 4. Minimum Acoustic Insertion Losses per octave band:

a. Straight Duct:

Dia	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" $\emptyset$	6 ft	4.0	13	15	15	16	17	16
6" $\emptyset$	3 ft	2.3	4.9	5.3	5.3	5.5	5.8	5.4
8" $\emptyset$	6 ft	5.7	14	13	15	16	18	16
8" $\emptyset$	3 ft	2.9	5.0	4.9	5.7	5.6	5.8	5.6
12" $\emptyset$	6 ft	5.5	13	12	15	15	18	13
12" $\emptyset$	3 ft	2.8	4.8	4.7	5.3	5.3	5.8	4.9

b. 90deg Elbow:

Dia	Length	63hz	125hz	250hz	500hz	1000hz	2000hz	4000hz
6" $\emptyset$	6 ft	10	15	16	17	18	17	18
6" $\emptyset$	3 ft	3.8	5.4	5.5	5.7	5.9	5.8	5.9
8" $\emptyset$	6 ft	10	15	16	17	16	18	18
8" $\emptyset$	3 ft	2.4	5.3	5.6	5.8	5.6	5.9	6.0
12" $\emptyset$	6 ft	11	14	15	16	15	16	15
12" $\emptyset$	3 ft	4.4	5.1	5.3	5.5	5.4	5.6	5.3

5. Usage:

- a. Take-offs from supply ducts to inlets of terminal air boxes. Do not exceed 36" in length.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide openings in ducts for thermometers and controllers.
- B. Locate ducts with space around equipment for normal operation and maintenance.
- C. Do not install ducts or other equipment above electrical switchboards or panelboards. This includes a dedicated space extending 25 feet from the floor to the structural ceiling with width and depth equal to the electrical equipment. Unless intended to serve these rooms, do not install any ductwork or equipment in electrical rooms, transformer rooms, electrical closets, telephone rooms or elevator machine rooms.
- D. Provide temporary closures of metal or taped polyethylene on open ducts to prevent dust from entering ductwork.
- E. Supply ductwork shall be free of construction debris, and shall comply with Level "B" of the SMACNA Duct Cleanliness for New Construction Guidelines.
- F. Repair all duct insulation and liner tears.

- G. Install manual volume dampers in branch supply ducts so all outlets can be adjusted. Do not install dampers at air terminal device or in outlets, unless specifically shown.
- H. Install flexible duct in accordance with the ADC Flexible Duct Performance and Installation Standards.
- I. Flexible duct shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required, to include, but not limited to, all connections to air inlets, air outlets, and terminal air boxes.
- J. Install all exterior ductwork per SMACNA Fig. 6-3. Where drawings do not indicate otherwise, ductwork seams and joints shall be sealed watertight and pitched to shed water.
- K. Support all duct systems in accordance with the SMACNA HVAC Duct Construction Standards: Metal and Flexible and the SMACNA Seismic Restraint Manual: Guidelines for Mechanical Systems, where applicable. Refer to Section 23 05 50 for seismic requirements.
- L. Adhesives, sealants, tapes, vapor retarders, films, and other supplementary materials added to ducts, plenums, housing panels, silencers, etc. shall have flame spread/smoke developed ratings of under 25/50 per ASTM E84, NFPA 255, or UL 723.
- M. All duct support shall extend directly to building structure. Do not support ductwork from pipe hangers unless coordinated with piping contractor prior to installation. Do not allow lighting or ceiling supports to be hung from ductwork or ductwork supports.
- N. Fabric Ductwork (Textile Air Dispersion Systems): Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with the product.

### 3.2 DUCTWORK APPLICATION SCHEDULE

#### A. General:

- 1. Seal Class is per SMACNA HVAC Air Duct Leakage Test Manual
- 2. Insulation:
  - a. Refer to Section 23 07 13 for insulation types.
  - b. Type A insulation (Flexible Fiberglass Wrap) R-values noted are based on installed values (25% compression).

**SPECIFIER:** This note is intended for DOAS systems where flows are typically small and small amounts of leakage can severely affect overall operation. This note can be left in for all systems if desired.

- 3. Note 1: Apply aluminum based adhesive sealant tape at non-flanged joints on ducts serving dedicated outside air supply (DOAS) and exhaust system in addition to Class A sealant.

#### B. Duct System Description: Interior Supply/Return (Lincoln DOAS-6L) - from unit connection to outlet/inlet:

- 1. Shape: Rectangular Duct - Single Wall

2. Material: Aluminum
  3. Pressure Class: +4"
  4. Seal Class: A
  5. Insulation: 1-1/2" thick Type A (R=4.5)
  6. Additional Requirements: None
- C. Duct System Description: Supply/Return (Flinn RTU-1, East HS RTU-3) - from unit connection to outlet/inlet:
1. Shape: Rectangular Duct - Double Wall
  2. Material: Aluminum
  3. Pressure Class: +4"
  4. Seal Class: A
  5. Insulation: 3" thick Type E (R=12.0)
  6. Additional Requirements: None
- D. Duct System Description: Exterior Supply/Return - Ductwork on roof (Flinn RTU-2 and RTU-3, Lincoln RTUs and DOASs, Washington RTUs and DOASs, East HS RTUs-1, 2, 4, 5, 6, 7, 8, 9, 10 and DOASs) - from unit connection to roof penetration:
1. Shape: Round or Rectangular Duct (as shown on plans) - Double Wall
  2. Material: Galvanized Steel
  3. Pressure Class: +4"
  4. Seal Class: A
  5. Insulation: IECC-2018: 3" thick Type E (R=12)
  6. Additional Requirements: None
- E. Duct System Description: Interior Supply, including internal to curb (Flinn RTU-2, East HS RTUs-5, 6, 7, 8, and 9) - from unit connection to outlet:
1. Shape: Round - Round and Flat Oval Spiral Seam Ductwork - Double Wall
  2. Material: Galvanized Steel
  3. Pressure Class: +4"
  4. Seal Class: A
  5. Insulation: 1-1/2" thick Type E (R=4.5)
  6. Additional Requirements: None
- F. Duct System Description: Interior Return (Flinn RTU-2, East HS RTU-1, 2, 4, 5, 6, 7, 8, 9) - from unit connection to bell mouth opening:
1. Shape: Rectangular - Rectangular - Double Wall
  2. Material: Galvanized Steel
  3. Pressure Class: +3"
  4. Seal Class: A
  5. Insulation: 1-1/2" thick Type E (R=4.5)
  6. Additional Requirements: None
- G. Duct System Description RTU-3 Supply/Return - Exterior on roof (Flinn) - from unit connection to roof penetration:
1. Shape: Rectangular Duct - Double Wall

2. Material: Galvanized Steel
  3. Pressure Class: +4"
  4. Seal Class: A
  5. Insulation: 3" thick Type E (R=12)
- H. Duct System Description Interior Supply/Return, including internal to curb (Flinn RTU-3, Lincoln RTUs, Washington RTUs, East HS RTU-10) - from unit connection to outlet:
1. Shape: Round or Rectangular Duct - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: +3" Supply, -2" Return
  4. Seal Class: A
  5. Insulation: 1-1/2" thick Type A (R=4.5)
  6. Additional Requirements: None
- I. Duct System Description Interior Room Neutral Temp Supply/Return/Exhaust (Flinn DOAS-1, 2, 3, 5, 6, 7, 8, Lincoln DOASs, Washington DOASs, East HS DOASs) - from unit or curb connection to outlet:
1. Shape: Round or Rectangular Duct (as shown on plans) - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: +3" Supply, -2" Return and Exhaust
  4. Seal Class: A
  5. Insulation: None - (room neutral temperature air)
  6. Additional Requirements: None
- J. Duct System Description Interior Outside Air/Exhaust Air (Flinn DOAS-4) - Mechanical Room only:
1. Shape: Rectangular Duct - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: Supply -3", Exhaust +3"
  4. Seal Class: A
  5. Insulation: 1-1/2" thick Type B (R=4.5)
  6. Additional Requirements: None
- K. Duct System Description Interior Supply/Exhaust (Flinn DOAS-4) - from unit connection to vertical riser in tunnel/plenum:
1. Shape: Rectangular Duct - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: +4" Supply, -4" Exhaust
  4. Seal Class: A
  5. Insulation: 1-1/2" thick Type A (R=4.5)
  6. Additional Requirements: None
- L. Duct System Description Interior Supply/Exhaust (Flinn MAU-1) - from unit connection to outlet:
1. Shape: Rectangular - Single Wall
  2. Material: Galvanized Steel

3. Pressure Class: +3" Supply
  4. Seal Class: A
  5. Insulation: 1-1/2" thick Type A (R=4.5)
  6. Additional Requirements: Supply duct shall be perforated as noted on plan. Coordinate with MAU manufacturer.
- M. Duct System Description Interior Ducted Units (Flinn BCU/FCU, Lincoln CFCUs, Washington CFCUs, ) - Supply/Return from unit connection to outlet:
1. Shape: Round or Rectangular Duct (as shown on plans) - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: +2" Supply, -2" Return
  4. Seal Class: A
  5. Insulation: 1-1/2" thick Type G (Round Duct) Liner (R=4.5)
  6. Insulation: 1 -1/2" thick Type I (Rectangular Duct) Liner (R=4.5)
  7. Additional Requirements: None
- N. Duct System Description Interior Fabric Ductwork (Lincoln Gym, Washington Gym, East HS RTUs-1, 2, 3, 4) - Supply ductwork where shown on plan:
1. Shape: Round Duct (as shown on plans) - Single Wall
  2. Material: Fabric
  3. Pressure Class: +2" Supply
  4. Seal Class: A
  5. Insulation: None
- O. General Exhaust Duct:
1. Shape:
    - a. Rectangular Duct - Single Wall
    - b. Round and Flat Oval Spiral Seam Ductwork - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: -1"
  4. Seal Class: A
  5. Insulation: None
  6. Additional Requirements: None
- P. Transfer Ducts:
1. Shape:
    - a. Rectangular Duct - Single Wall
  2. Material: Galvanized Steel
  3. Pressure Class: -1/2"
  4. Seal Class: A
  5. Insulation: 1" thick Type C (R=3.6)

Q. Ductwork Accessories (Fabric Flex Connectors, Equipment Flanges, etc.):

1. Insulation:

- a. ASHRAE 90.1-2019: 1-1/2" thick Type A (R=4.5)
- b. IECC-2018: 2" thick Type A (R=6.0)

R. All Terminal Air Box/ Reheat Coil Headers and Duct Mounted Coil Headers:

1. Insulation: 1-1/2" thick Type A (R=4.5)

S. Linear Diffuser Supply Plenum:

1. Insulation:

- a. ASHRAE 90.1-2019: 1/2" thick Type C (R=1.8)

### 3.3 DUCTWORK SEALING

A. General Requirements:

1. Openings, such as rotating shafts, shall be sealed with bushings or similar.
2. Pressure sensitive tape shall not be used as the primary sealant unless it has been certified to comply with UL-181A or UL-181B by an independent testing laboratory and the tape is used in accordance with that certification.
3. All connections shall be sealed including, but not limited to, taps, other branch connections, access doors, access panels, and duct connections to equipment. Sealing that would void product listings is not required. Spiral lock seams need not be sealed.
4. Mastic-based duct sealants shall be applied to joints and seams in minimum 3 inch wide by 20 mil thick bands using brush, putty knife, trowel, or spray, unless manufacturer's data sheet specifies other application methods or requirements.

B. All ducts systems, regardless of pressure class, shall be Seal Class A as defined by Section 5-1 of SMACNA HVAC Air Duct Leakage Test Manual per the Energy Code, unless specifically noted otherwise. Seal Class A shall include sealing of all transverse joints, longitudinal seams, and duct wall penetrations with welds, gaskets, mastics, or fabric-embedded mastic system. Joints are inclusive of, but not limited to, girth joints, branch and sub-branch intersections, duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

C. Double-wall ductwork: Install insulation end fittings at all transitions from double to single-wall construction.

### 3.4 TESTING

A. Interior Duct - Less than 3" WG (positive or negative):

1. Leak testing of these pressure classes is not normally required for interior ductwork (inside the building envelope). However, leak tests will be required if, in the opinion of the Architect/Engineer, the leakage appears excessive. All exterior ductwork shall be tested. If duct has outside wrap, testing shall be done before it is applied.

2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
  3. Seal ducts to bring the air leakage into compliance.
  4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.
- B. Interior Duct - 3" WG and Above (positive or negative):
1. A minimum of 25% of interior ductwork (inside the building envelope) shall be tested. The Owner or designated representative shall select the sections to be tested. If duct has outside wrap, testing shall be done before it is applied.
- C. Exterior Duct - 1/2" • • WG and Above (positive or negative):
1. All exterior ductwork (outside the building envelope) shall be completely pressure tested. If duct has outside wrap, testing shall be done before it is applied.
  2. Leak test shall be at the Contractor's expense and shall require capping and sealing all openings.
  3. Seal ducts to bring the air leakage into compliance.
  4. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing.
- D. Test Procedure:
1. Testing shall be as listed in the latest edition of the SMACNA HVAC Duct Leakage Manual, with the following additional requirements:
    - a. The required leakage class for Seal Class A, rectangular ducts, shall be 4; round shall be 2.
    - b. Test pressure shall be the specified duct pressure class. Testing at reduced pressures and converting the results mathematically is not acceptable. This is required to test the structural integrity of the duct system.
    - c. If any leak causes discernible noise at a distance of 3 feet, that leak shall be eliminated, regardless of whether that section of duct passed the leakage test.
    - d. All joints shall be felt by hand, and all discernible leaks shall be sealed.
    - e. Totaling leakage from several tested sections and comparing them to the allowable leakage for the entire system is not acceptable. Each section must pass the test individually.
    - f. Contractor shall notify the Architect/Engineer five business days prior to pressurizing ductwork for testing. Failure to notify the Architect/Engineer of pressure testing may require the contractor to repeat the duct pressure test after proper notification.
    - g. Upon completion of the pressure test, the contractor shall submit an air duct leakage test summary report as outlined in the SMACNA HVAC Duct Leakage Test Manual.
    - h. All access doors, taps to terminal air boxes, and other accessories and penetrations must be installed prior to testing. Including terminal air boxes in the test is not required.
    - i. Positive pressure leakage testing is acceptable for negative pressure ductwork.

### 3.5 DUCTWORK PENETRATIONS

- A. All duct penetrations of firewalls shall have fire or fire/smoke dampers where required by code.
- B. Dampers shall be compatible with fire rating of wall assembly. Verify actual rating of any wall being penetrated with Architect/Engineer.
- C. Seal all duct penetrations of walls that are not fire rated by caulking or packing with fiberglass. Install trim strip to cover vacant space and raw construction edges of all openings in finished rooms. Install escutcheon ring at all round duct openings in finished rooms. Trim strips and rings shall be same material and finish as exposed duct.

### 3.6 DUCTWORK CLEANING

- A. General: Applies to Vertical Area B Supply/Exhaust in chases and existing Auditorium duct that is to remain (Flinn)
  - 1. This section applies to the cleaning of ductwork and HVAC system components.
  - 2. The HVAC system cleaning contractor shall be a certified member of the National Air Duct Cleaners Association (NADCA) or shall maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.
  - 3. The HVAC system cleaning contractor shall furnish all necessary equipment, materials, and labor to adequately perform the specified services.
  - 4. The HVAC system cleaning contractor shall be capable of remediation of exposed damaged insulation in air handlers and/or ductwork requiring replacement.
  - 5. Regulatory Requirements:
    - a. Contractor shall submit to the Owner SDS for all chemical products proposed to be used in the cleaning process.
- B. Perform the services specified here in accordance with current NADCA standards.
- C. System Component Inspections and Site Preparations:
  - 1. Prior to beginning any cleaning work, perform a visual inspection of the HVAC system to determine appropriate methods, tools, and equipment needed. The cleanliness inspection should include air handling units, other air moving equipment, and ductwork. In systems with multiple air handling units, a representative sample of the units should be inspected.
  - 2. Coordinate any system shutdowns with the Owner a minimum of 24 hours in advance of any needed shutdowns.
  - 3. The cleanliness inspection shall be conducted without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification, or other debris. .
  - 4. Damaged system components found during the inspection shall be documented and brought to the attention of the Owner and Architect/Engineer.
  - 5. Conduct a site evaluation, and establish a specific, coordinated plan detailing how each area of the building will be protected during each phase of the project.

D. HVAC System Cleaning Requirements:

1. Collect debris removed during cleaning and take precautions to avoid dispersing debris from cleaning operations outside the HVAC system.
2. Use HEPA filters if particulate collection equipment exhausts inside the building.
3. When particulate collection equipment exhausts outside the building, precautions shall be taken to locate the equipment downwind and away from all air intakes and other points of entry into the building.
4. Cleaning operations shall be undertaken only with particulate collection equipment in place, including adequate filtration to contain debris removed from the HVAC system.
5. Take measures to control odors, mist, and vapors during the cleaning process.
6. All HVAC system components must be visibly clean as defined in the NADCA Standards.
7. Volume dampers, control dampers, and other mechanical devices inside the HVAC system must have their positions marked prior to cleaning and, upon completion, must be restored to their marked positions.
8. Service Openings:
  - a. Use existing service openings where possible.
  - b. Create openings where needed. Seal openings per the original duct pressure and leakage classification after use.
  - c. Closures must not significantly restrict or alter the system airflow.
  - d. Closures must be insulated to prevent heat transfer and condensation.
  - e. Openings must not compromise the structural integrity of the system.
  - f. Openings shall conform to applicable NFPA and SMACNA standards, and NADCA Standard 05.
  - g. Do not cut openings in flexible duct. Disconnect flexible duct at the ends as needed for proper cleaning and inspection.
  - h. Clearly mark all service openings that can be reopened and mark their locations in the final report.
9. Duct System Cleaning:
  - a. Create service openings as needed for cleaning inaccessible areas.
  - b. Mechanically clean all duct systems such that the systems are capable of passing NADCA cleaning verification tests.
  - c. Seal all openings, grilles, diffusers, etc. in the system to be cleaned.
  - d. Attach high-pressure vacuum unit to ductwork near fan. Do not exceed the negative pressure rating of ductwork.
  - e. From farthest opening, work dirt from duct back to extraction point using compressed air, brushes, and scrapers.
  - f. Do not damage lining or devices during cleaning. Replace any damaged material.

E. Cleaning Methods

1. Source Removal Cleaning Method:
  - a. Clean the HVAC system using source removal mechanical cleaning methods designed to extract contaminants from the HVAC system and safely remove contaminants from the facility. Select source removal methods that will render the HVAC system visibly clean and capable of passing cleaning verification and other

specified tests included in this section. No cleaning method or combination of methods shall be used that could potentially damage the HVAC system or negatively alter the system integrity.

- b. Operate vacuum collection devices continuously during cleaning. A vacuum device shall be connected to the downstream end of the section being cleaned. The vacuum collection device must maintain sufficient negative pressure in all areas being cleaned to contain debris and protect the indoor environment.
- c. All vacuum devices exhausting air inside the building shall be equipped with HEPA filters, including hand-held vacuums and wet vacuums.
- d. All vacuum devices exhausting outside the facility shall be equipped with particulate collection devices including a washable cloth filter bag to contain debris removed from the HVAC system. Such devices shall exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate any codes or regulations.
- e. All methods require mechanical agitation devices to dislodge debris adhered to interior HVAC system surfaces such that debris may be safely conveyed to vacuum collection devices. Acceptable methods include those that will not potentially damage the integrity of the ductwork nor damage porous surface materials, such as liners inside the ductwork, or system components.
- f. Exterior gas-fired vacuum collection equipment shall be located at least 20 feet away from the building.
- g. Where vacuum collection hoses run into the building, the Contractor shall seal the opening airtight so dust from the collection equipment cannot re-enter the building.
- h. Hoses for mechanical agitation devices should not enter the building in the same location as the vacuum hoses. Utilize a remote building opening for the tool entry location.

END OF SECTION 23 31 00

## SECTION 23 33 00 - DUCTWORK ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Manual Volume Dampers.
- B. Fire Dampers.
- C. Control/Fire/Smoke Dampers.
- D. Backdraft Dampers.
- E. Fabric Connectors.
- F. Drip Pans.
- G. Duct Access Doors.
- H. Duct Test Holes.
- I. Remote Volume Control Devices.

### PART 2 - PRODUCTS

#### 2.1 MANUAL VOLUME DAMPERS

- A. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.
- B. Fabricate single blade dampers for duct sizes to 9-1/2 x 30 inches.
- C. Fabricate multi-blade damper of opposed blade pattern with maximum blade sizes 12" x 72". Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
- D. Except in round ductwork 12 inches and smaller, provide end bearings. On multiple blade dampers, provide molded synthetic or oil-impregnated nylon or sintered bronze bearings.
- E. Provide locking quadrant regulators on single and multi-blade dampers.
- F. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.
- G. If blades are in open position and extend into the main duct, mount damper so blades are parallel to airflow.

## 2.2 DYNAMIC CURTAIN BLADE FIRE DAMPERS (FD)

- A. Furnish and install fire dampers in ducts, where shown on the drawings, at the point where they pass through a fire wall or a floor and in all other locations required by the local fire department, The National Fire Protection Association's Pamphlet No. 90A and all other applicable codes.
- B. Fire dampers shall be UL 555 listed for 1-1/2-hour fire resistance unless noted otherwise, dynamic rated with heated airflow at 2,000 fpm and 4" WC, and have all blades stacked out of the airstream (Type B).
- C. Where dampers are in aluminum or stainless steel duct, provide stainless steel dampers.
- D. Fire dampers shall be held open by a fusible link rated at 165°F unless otherwise called for on the drawings or by local codes.
- E. Dampers shall be installed in sleeves of sufficient thickness to comply with the UL555 Standard for Safety Fire Dampers listing of the damper. Where UL555 permits sleeve thickness to be the same as that of the duct gauge, such thickness shall not be less than that specified in NFPA 90A for breakaway style sleeves. If a breakaway style duct/sleeve connection is not used, the sleeve shall be a minimum of 16 gauge for dampers up to 36" wide by 24" high and 14 gauge for dampers exceeding 36" wide by 24" high. Damper sleeve shall not extend more than 6" beyond the firewall or partition unless damper is equipped with a factory installed access door. Sleeve may extend up to 16" beyond the firewall or partition on sides equipped with the factory installed access door.
- F. Maximum Curtain Damper Size (Multi-section) at less than 2,000 fpm:
  - 1. Vertical Installation – 72"w x 48"h or 48"w x 72"h or 120"w x 24"h.
  - 2. Horizontal Installation – 36"w x 48"h or 48"w x 36"h.
- G. Maximum Curtain Damper Size at greater than 2,000 fpm: Vertical or horizontal - 24"w x 24"h.
- H. Locate access door in the ductwork for visual inspection and on the latch side to replace link easily. Each access door shall have a label with letters at least 1/2" high, reading "FIRE DAMPER".

## 2.3 FIRE/SMOKE DAMPERS (FSD)

- A. General:
  - 1. Does not apply to Flinn Middle School.
  - 2. Furnish and install fire/smoke dampers in ducts, where shown on the drawings, at the point where they pass through a fire/smoke partition and in all other locations required by the local Fire Department, the National Fire Protection Association Pamphlet No. 90A, and all other applicable codes.
  - 3. Fire Resistance Rating: Assemblies shall be 1-1/2 hour rated under UL Standard 555 unless noted otherwise on drawings.
  - 4. Airflow Rating: Dynamic rated at 2,000 fpm and 4" WC.

5. Temperature Rating: Assemblies shall be UL 555S listed for use in smoke control system with a 250°F temperature rating.
6. Leakage Rating: Class II. Shall not leak over 20 cfm per square foot at 4" WC.
7. FSD dampers shall be furnished complete with factory-mounted actuators, and the damper/operator assemblies shall meet all requirements listed below.
8. Where dampers are located in aluminum or stainless steel duct, provide stainless steel dampers.
9. The complete assembly must be factory assembled, cycled and tested prior to shipment.
10. All operators shall be located with easy access for servicing.
11. Contractor to field verify actuator installation and clearance requirements prior to ordering. Actuator should not be taller than duct height. Rotate or turn over the actuator if this is the case.

B. Construction:

1. Frame: 5 inches x minimum 16 gauge roll formed, galvanized steel hat-shaped channel, reinforced at corners.
2. Sleeve: Dampers shall be installed in sleeves of sufficient thickness to comply with UL555 Standard for Safety Fire Dampers listing of the damper. Where UL555 permits sleeve thickness to be the same as that of the duct gauge, such thickness shall not be less than that specified in NFPA 90A for breakaway style sleeves. If a breakaway style duct/sleeve connection is not used, the sleeve shall be a minimum of 16 gauge for dampers up to 36" wide by 24" high and 14 gauge for dampers exceeding 36" wide by 24" high. Damper sleeve shall not extend more than 6" beyond the firewall or partition unless damper is equipped with an actuator or factory installed access door. Sleeve may extend up to 16" beyond the firewall or partition on sides equipped with the actuator or factory installed access door.
3. Blades: Opposed blade; airfoil-shaped, single piece, minimum 14 gauge double skin. Galvanized steel. Maximum 6" damper blades.
4. Seals: Blade seal shall be silicone fiberglass material to maintain smoke leakage rating to minimum of 450°F and galvanized steel for flame seal to 1,900°F. Seal to be mechanically attached to blade edge. Jam seal shall be stainless steel, flexible metal compression type.
5. Bearings: Self-lubricating stainless-steel sleeve, in extruded hole in frame.
6. Axle: Minimum 1/2" plated steel, hex shaped, mechanically attached to blade.

- C. Electric Actuator: Externally mounted, electric direct coupled. Actuator shall be 24VAC. Wiring by Mechanical Contractor. "Stall type" actuators are NOT acceptable. Actuator shall carry a manufacturer's 5 year warranty. Fail to closed position.

## 2.4 BACKDRAFT DAMPERS

- A. Gravity backdraft dampers, size 18 inches x 18 inches or smaller, furnished with air moving equipment, may be air moving equipment manufacturer's standard construction.
- B. Fabricate multi-blade, parallel action gravity balanced backdraft dampers of extruded aluminum, with blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90° stop, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

C. Models:

1. Ruskin CBD4
2. Arrow 655
3. Safe-Air/Dowco BRL
4. Greenheck EM.

2.5 FABRIC CONNECTORS

- A. Fabric connectors shall be installed between all fans or fan units and metal ducts or casings to prevent transfer of fan or motor vibration.
- B. The fabric connectors shall be completely flexible material which shall be in folds and not drawn tight.
- C. Fabric connectors shall be of glass fabric double coated with neoprene, with UL approval. Weight = 30 oz. per square yard minimum. Fabric shall not be affected by mildew and shall be absolutely waterproof, airtight and resistant to acids, alkalis, grease and gasoline, and shall be noncombustible.
- D. Fabric connections shall not exceed 6" in length on ductwork that has a positive pressure. On ductwork that has a negative pressure, the length shall not exceed 2" in length.
- E. All corners shall be folded, sealed with mastic and stapled on 1" centers.
- F. Fabric connectors shall not be painted.
- G. Unless otherwise shown on the drawings, the fabric connection at the inlet to centrifugal fans shall be at least one duct diameter from the fan to prevent inlet turbulence.
- H. Materials:
  1. Durodyne MFN-4-100
  2. Vent Fabrics, Inc.
  3. "Ventglas"
  4. Proflex PFC3NGA
- I. Fabric connectors exposed to sunlight and weather shall be as described above, except the coating shall be hypalon in lieu of neoprene.
- J. Materials:
  1. Durodyne "Duralon MFD-4-100"
  2. Vent Fabrics, Inc.
  3. "Ventlon"
  4. Proflex PFC3HGA

2.6 DRIP PANS

- A. Install drip pans under all rooftop exhaust fans, intake hoods, exhaust hoods and other roof penetrations that do not have ductwork below them to intercept dripping water.

- B. Drip pans shall be 22 gauge minimum cross-broken or reinforced sheet metal with 2" welded upturned lips.
- C. Pans shall extend 6" in all directions beyond the opening and shall have the top of the lip located 25% of the maximum throat dimension below the opening.
- D. Insulate interior of drip pan with 1" thick elastomeric foam insulation. Adhere foam to drip pan with standard foam adhesive.

## 2.7 DUCT ACCESS DOORS

- A. Fabricate per Fig. 7-2 and 7-3 of the SMACNA HVAC Duct Construction Standards and as indicated.
- B. Review locations prior to fabrication. Install access doors at fire dampers, smoke dampers, motorized dampers, fan bearings, filters, automatic controls, humidifiers, louvers, duct coils and other equipment requiring service inside the duct.
- C. Provide duct access door in all horizontal return ductwork at 20 foot intervals per NFPA 90A.
- D. Construction shall be suitable for the pressure class of the duct. Fabricate rigid, airtight, and close-fitting doors of materials identical to adjacent ductwork with sealing gaskets butt or piano hinges, and quick fastening locking devices. For insulated ductwork, install minimum one inch thick insulation with sheet metal cover.
- E. Access doors with sheet metal screw fasteners are not acceptable.
- F. Minimum size for access doors shall be 24" x 16" or full duct size, whichever is less.
- G. Provide quantity of access doors such that two hands can fit inside ductwork to manually reset fire dampers. This will typically require one access door on the bottom and one access door on an accessible side of the duct for sizes 12x12 and smaller.

## 2.8 DUCT TEST HOLES

- A. Cut or drill temporary test holes in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

## 2.9 REMOTE VOLUME CONTROL DEVICES - MANUAL

- A. Remote volume control balancing damper shall be supplied with either miter gears or right angle worm gears. Provide all damper shafts, gearboxes, couplings, U-joints, bearings, shafts, offsets, adapters, and adjustable concealed covers as required.
- B. When distances, angles, or offsets prevent installing solid rods, the mechanical cable control system may be utilized. Provide all damper shafts, rack and pinion gear operator, cables and sleeves, and adjustable ceiling mounting cups.

## 2.10 DUCTWORK ACCESSORY SEALANTS

- A. Ductwork accessory sealants and adhesives shall conform to Section 23 31 00.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General Installation Requirements:

1. Install accessories in accordance with manufacturer's instructions.
2. Where duct access doors are located above inaccessible ceilings, provide ceiling access doors. Coordinate location with the Architect/Engineer.
3. Coordinate and install access doors provided by others.
4. Provide access doors for all equipment requiring maintenance or adjustment above an inaccessible ceiling. Minimum size shall be 24" x 24".
5. Provide duct test holes where indicated and as required for testing and balancing purposes.

#### B. Manual Volume Damper:

1. Provide manual volume dampers at points on low pressure supply, return, and exhaust systems where branches are taken from larger ducts where indicated on drawings and as required for air balancing. Use splitter dampers only where indicated.
2. Provide ceiling access doors for manual volume dampers. When manual volume dampers are located above an inaccessible ceiling and an access door cannot be installed, provide a remote-controlled volume control device for operation of the damper. Coordinate location with the Architect/Engineer.

#### C. Fire Damper, Fire Smoke Damper:

1. Provide fire dampers, combination fire and smoke dampers, and smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by authorities having jurisdiction. Install with required perimeter mounting angles, sleeves and duct connections.
2. Provide ceiling access doors for smoke and/or fire dampers. Coordinate location with the Architect/Engineer.
3. Demonstrate resetting of fire dampers to authorities having jurisdiction and Owner's representative.
4. At fire dampers, combination fire smoke dampers where duct is:
  - a. Internally insulated, exterior duct wrap shall be installed from the wall out to 1 foot from the wall. All edges shall be taped.
  - b. Externally insulated, the exterior duct wrap shall extend up to the wall.

#### D. Drain Pan:

1. Drain pans shall be installed per ASHRAE 62.1.
  - a. All drain pans shall be field tested under normal operating conditions to ensure proper drainage.

- b. Field testing of drain pans is not required if units with factory installed drain pans have been certified (attested in writing) by the manufacturer for proper operation when installed as recommended.

END OF SECTION 23 33 00

## SECTION 23 34 23 - POWER VENTILATORS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Roof Exhaust Fan.
- B. Rooftop Fan Curbs.
- C. Micro-De-stratification Fan. (Applies to East High School only)

#### 1.2 QUALITY ASSURANCE

- A. Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- B. Sound Ratings: AMCA 301, tested to AMCA 300.
- C. Fabrication: Conform to AMCA 99.
- D. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00. Include data on all fans and accessories. Submit sound power levels for both fan inlet and outlet at rated capacity. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point (ceiling and HVLS fans are exempt from FEI submittal requirements).
- B. Submit manufacturer's installation instructions.
- C. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

### PART 2 - PRODUCTS

#### 2.1 ROOFTOP EXHAUST FAN - BELT DRIVEN (Lincoln Auditorium Only)

- A. Fan Wheel: Centrifugal type, aluminum hub and wheel with backward inclined blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.

- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.
- E. V-belt drive with adjustable pitch drive sheave and adjustable motor mountings for belt tensioning.
- F. Motor mounted outside of air stream and ventilated with outside air.
- G. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- H. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- I. Furnish normally closed, electric motorized damper. Provide step down transformer if required. Install and wire damper to open when fan runs.
- J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods. Leakage shall not exceed 4 cfm/sq.ft @ 1" SP (or shall be AMCA Class 1 certified).
- K. Mill aluminum finish.
- L. Permanently lubricated, permanently sealed, self-aligning ball bearings.
- M. Furnish permanently lubricated sealed ball type motor and drive shaft bearings sized for 200,000 hours life at specified operating conditions. Drives sized for 150% of rated motor horsepower. Drive assembly and wheel supported by vibration isolators.
- N. Manufacturers:
  - 1. Aerovent "FACX"
  - 2. Cook "ACE-B"
  - 3. Greenheck "GB"
  - 4. Carnes "VEB"
  - 5. PennBarry DX
  - 6. ACME PV
  - 7. ILG CRB
  - 8. Twin City BCRD

## 2.2 ROOFTOP EXHAUST FAN - DIRECT DRIVEN

- A. Fan Wheel: Centrifugal type, aluminum or composite with backward inclined or airfoil blades, statically and dynamically balanced.
- B. Housing: Removable, spun aluminum dome or rectangular top, with square, one piece, aluminum base and curb cap with Venturi inlet cone.
- C. Fan Shaft: Turned, ground and polished steel; keyed to wheel hub.
- D. All steel parts galvanized or epoxy coated. Non-corrosive fasteners.

- E. Direct drive, motor mounted outside of air stream and ventilated with outside air.
- F. Aluminum or brass bird screen. Plastic mesh will not be allowed.
- G. Furnish factory mounted and wired disconnect switch: Non-fusible type with thermal overload protection mounted inside fan housing, factory wired through an aluminum conduit.
- H. Furnish solid-state dial speed controller. Mount and wire inside fan unless shown otherwise on the drawings. Provide permanent marking at balanced point.
- I. Furnish normally closed, electric motorized damper. Provide step-down transformer if required. Install and wire damper to open when fan runs.
- J. Dampers shall be aluminum with brass bushings, blade seals and blade tie rods. Leakage shall not exceed 4 cfm/sq.ft @1" SP (or shall be AMCA Class 1 certified).
- K. Mill aluminum finish.
- L. Furnish permanently lubricated sealed ball type motor and drive shaft bearings. Motor and wheel supported by vibration isolators.
- M. Manufacturers:
  - 1. Aerovent "FACX"
  - 2. Cook "ACE-D"
  - 3. Greenheck
  - 4. ILG - CRD
  - 5. ACME PX
  - 6. PennBarry DX
  - 7. Carnes
  - 8. Twin City DCRU
  - 9. Soler-Palau

### 2.3 ROOFTOP FAN CURBS

- A. Furnish and install prefabricated roof curbs for all rooftop fans.
- B. Size curb to match the curb cap of fan.
- C. Roof Mounting Curb: Minimum 14 inches, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.
- D. Unitized construction, continuous arc welded corner seams. Insulated with 1-1/2" thick, 3 lb. density rigid fiberglass board. Damper support angle. Pressure treated wood nailer.
- E. If called for in the drawings, curbs shall be of the sound attenuation type. Sound attenuation curbs shall reduce the fan sone rating by at least 40% and not decrease fan cfm more than 8% (which is accounted for in the scheduled fan cfm). Baffles shall be removable for access to the dampers.
- F. 14-gauge aluminum construction.

G. Curb without cant.

H. Manufacturers:

1. Same manufacturer as the fan
2. Pate
3. RPS
4. Thy

#### 2.4 MICRO-DESTRATIFICATION FAN

A. Ceiling-mounted fan with enclosed motor and fan wheel and mounting accessories.

B. Housing: Double wall, UV-resistant plastic with intake grille.

C. Fan Wheel: Composite or plastic fan wheel. Statically and dynamically balanced. Sealed lifetime lubricated bearings.

D. Support: Mounting hardware with cable tether.

E. Color: White.

F. Accessories:

1. 6 foot 3-prong cord and plug.

G. Controls:

1. Automatic controller including minimum of two space temperature sensors.

H. Electrical: Disconnect provided by Electrical Contractor.

I. Acceptable Manufacturer:

1. ZOO Fan

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Secure roof exhausters with cadmium plated lag screws to roof curb.

C. If manufacturer has no recommendations, secure roof exhaust fans to curbs with 1/4" lag bolts on 8" maximum centers.

D. MC shall install and wire factory provided damper to open when the fan runs if the manufacturer does not provide an option to pre-wire the damper.

END OF SECTION 23 34 23

## SECTION 23 36 00 - AIR TERMINAL UNITS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Single Duct Variable Air Volume Terminal Box.

#### 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 05 00.
- B. Submit shop drawings indicating configuration, general assembly, and materials used in fabrication.
- C. Submit product data indicating configuration, general assembly, and materials used in fabrication. Include catalog performance ratings which indicate airflow, static pressure, and NC designation.
- D. Include schedules listing discharge and radiated sound power level for each of second through sixth octave bands at inlet static pressures of one to 4 inch WG.
- E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- F. Submit manufacturer's installation instructions.

#### 1.3 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts lists.
- C. Include directions for resetting constant volume regulators.

### PART 2 - PRODUCTS

#### 2.1 ACOUSTICAL CONSIDERATIONS (THIS APPLIES TO ALL UNITS)

- A. All units shall have noise data certified in accordance with AHRI Standard 885-98 with 5/8" 20-lb. density mineral fiber ceiling tile and shall not produce space noise values over NC-35 due to radiated and airborne noise combined. Acoustical considerations shall take priority over sizes noted in schedule. It is the manufacturer's responsibility to increase inlet size to meet acoustic levels scheduled. Noise in classrooms shall not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002.

## 2.2 SINGLE DUCT VARIABLE AIR VOLUME TERMINAL BOX

- A. Casing: Minimum 22 gauge galvanized steel.
  - 1. Fully insulated with 3/4" elastomeric closed cell insulation liner. Insulation shall be UL listed and meet NFPA 90A requirements.
- B. Damper Blade: Extruded aluminum or minimum 18 gauge galvanized steel. Nylon or bronze bushings on damper shafts. Dampers shall seal against gasketed stops. Leakage shall not exceed 4% of unit nominal cfm at 3.0 inches WG inlet static pressure.
- C. Inlet Flow Sensor: Provide "cross" □□ or "ring□□" style velocity and static sensor at inlet to box for use by unit controller.
- D. Damper Operators: Electronic. Furnish all mounting brackets, relays, and linkages. Provided and installed by the manufacturer.
  - 1. Operator shall be UL listed, electronic direct coupled with spring return to normal position for modulating or two-position control as noted in the sequence of control. Actuator shall be 24 VAC with proportional control, electronic overload protection to prevent actuator damage due to over-rotation and "V" bolt clamp with matching "V" toothed cradle (single bolt or setscrew fasteners not acceptable).
- E. Electronic Volume Regulator/Controller: Provided and installed by the manufacturer. Boxes shall have pressure independent control to maintain constant air volume regardless of duct pressure changes up to 6 inches w.c. and shall be accurate down to 0.004" velocity pressure. Set boxes for maximum and minimum settings shown on the drawings.
- F. Hot Water Coils: Copper tubes, aluminum fins, minimum 0.016" wall thickness, leak tested at 300 psig. Air pressure drop shall not exceed scheduled value. Provide access door or removable panel for access to the upstream side of the heating coil. Capacity shall be as scheduled on the drawings. Hot water control valve shall be by the TCC.
- G. Electric Heating Coil: Open nichrome type electric resistance coils, automatic reset thermal cutout primary safety device, manual reset thermal cutout secondary safety device, airflow switch interlock, disconnect switch on face of integral control panel, magnetic contactors, 24-volt control, control voltage transformer and fusing, SCR control. Capacity and voltage shall be as scheduled on the drawings.
- H. Boxes shall not exceed the static pressure drop and N.C. level scheduled on the drawings. It is the manufacturer's responsibility to increase inlet size to meet pressure drop and N.C. levels scheduled.
- I. Refer to control diagrams and notes on control drawings for complete sequence of control.
- J. Manufacturers:
  - 1. Carrier
  - 2. Titus
  - 3. Trane
  - 4. Krueger

5. Carnes
6. E.H. Price
7. Tuttle & Bailey
8. Nailor
9. Enviro-Tec
10. Johnson Controls Inc.
11. Metalaire.
12. Anemostat.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Maintain minimum working clear space for all electrical connections in accordance with NFPA 70, National Electrical Code.
- C. Provide ceiling access doors or locate units above easily removable ceiling components.
- D. Support units individually from structure. Do not support from adjacent ductwork.
- E. Where boxes are located adjacent to a wall or joist, the damper motors and control valves shall be located on the side of the box away from the wall or joist to permit easy access.
- F. Comb fins on coils to repair bent fins.
- G. Insulate terminal air box hydronic reheat coils to prevent condensation. Tape insulation tight to box. Do not insulate or interfere with actuator, access panel and control panel.

#### 3.2 ADJUSTING

- A. All boxes shall be set to the cfm shown on the drawings. TCC shall be responsible to field recalibrate all boxes that are not set correctly.

END OF SECTION 23 36 00

## SECTION 23 37 00 - AIR INLETS AND OUTLETS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Grilles And Registers.
- B. Architectural Square Panel Diffusers.
- C. Linear Diffusers.
- D. Linear Diffuser Supply Plenum.
- E. Louvers.

#### 1.2 QUALITY ASSURANCE

- A. Test and rate performance of air inlets and outlets per ASHRAE 70.
- B. Test and rate performance of louvers per AMCA 500L-99.
- C. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

#### 1.3 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A.
- B. Conform to ASHRAE 90.1.

#### 1.4 EXTRA STOCK

- A. Provide clean filters in all filter return grilles at time of installation.
- B. Provide one additional set of replacement filters for all filter return grilles. Deliver to Owner at job site.

### PART 2 - PRODUCTS

#### 2.1 AIR TERMINALS - GRILLES AND REGISTERS

- A. Reference to a grille means an air supply, exhaust or transfer device without a damper.
- B. Reference to a register means an air supply, exhaust or transfer device with a damper.
- C. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule and suitable for the intended use.

- D. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents shall be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.
- E. The capacity and size of the unit shall be as shown on the drawings.
- F. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10-12 watts with a 10 dB room effect. Noise in classrooms may not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002 and ASHRAE 70.
- G. Refer to the drawings for construction material, color and finish, margin style, deflection, and sizes of grilles and registers.
- H. Provide with 3/4" blade spacing. Blades shall have steel friction pivots to allow for blade adjustment, plastic pivots are not acceptable.
- I. Corners of steel grilles and registers shall be welded and ground smooth before painting. Aluminum grilles and registers shall have staked corners.
- J. Where specified to serve registers, provide opposed blade volume dampers operable from the face of the register.
- K. Screw holes for surface fasteners shall be countersunk for a neat appearance. Provide concealed fasteners for installation in lay-in ceilings and as specified on the drawings.
- L. Manufacturers:
  - 1. Tuttle & Bailey
  - 2. Titus
  - 3. Price
  - 4. Nailor
  - 5. Carnes
  - 6. Metalaire
  - 7. Krueger
  - 8. Anemostat
  - 9. Raymon Donco.

## 2.2 AIR TERMINALS - ARCHITECTURAL SQUARE PANEL DIFFUSERS

- A. Reference to a diffuser means an air supply device, ceiling mounted, that shall diffuse air uniformly throughout the conditioned space.
- B. The type of unit, margin, material, finish, etc., shall be as shown on the drawing schedule. Flat-oval inlets are not acceptable for connection to flexible ducts.
- C. All margins shall be compatible with ceiling types specified (including 'Thin-Line' T-bar lay-in grid system). Any discrepancies in contract documents should be brought to the attention of the Architect/Engineer, in writing, prior to Bid Date. Submission of Bid indicates ceiling and air inlet and outlet types have been coordinated.

- D. The capacity and size of the unit shall be as shown on the drawings.
- E. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10-12 watts with a 10 dB room effect. Noise in classrooms may not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002 and ASHRAE 70.
- F. Diffusers shall be architectural solid square panel and flush with ceiling.
- G. The exposed surface shall be smooth, flat and free of visible fasteners. The face panel shall be 22 gauge steel with a rolled edge or shall be 18 gauge with a smooth ground, uniform edge.
- H. The back pan shall be one piece 22 gauge stamped and shall include an integral inlet. (Welded inlets and corner joints are not acceptable).
- I. Diffusers with a 24x24 back pan shall have a minimum 18x18 face panel size. Diffusers with a 12x12 back pan shall have a minimum 9x9 face panel size.
- J. The face panel shall be mechanically fastened to the back panel with steel components. (Plastic fasteners are not acceptable.)
- K. Manufacturers:
  - 1. Tuttle & Bailey
  - 2. Titus
  - 3. Price
  - 4. Nailor
  - 5. Carnes
  - 6. Metalaire
  - 7. Krueger
  - 8. Anemostat
  - 9. Raymon Donco.

### 2.3 AIR TERMINALS - LINEAR DIFFUSERS

- A. Plenum Slot Diffusers (Lay-In):
  - 1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
  - 2. The capacity and size of the unit shall be as shown on the drawings.
  - 3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10-12 watts with a 10 dB room effect. Noise in classrooms may not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002 and ASHRAE 70.
  - 4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
  - 5. Linear diffusers and mounting frames shall be furnished as one piece up to 5' in length.
  - 6. Diffusers shall be furnished with factory installed adjustable gasket edged blade deflector.

7. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
8. Number and width of slots shall be as shown on the drawings.
9. Provide integral insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
10. Manufacturers:
  - a. Tuttle & Bailey ITPS
  - b. Carnes DA
  - c. Price TBD
  - d. Krueger PTBS
  - e. Nailor 5800
  - f. Titus TBD
  - g. Metalaire
  - h. Anemostat API
  - i. Raymon Donco SAT.

B. Linear Slot Diffusers (Continuous):

1. The type of unit, margin size, material, finish, etc., shall be as shown on the Drawing Schedule. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.
2. The capacity and size of the unit shall be as shown on the drawings.
3. All units shall handle the indicated cfm as shown on the drawings while not exceeding an NC level of 25, referenced to 10-12 watts with a 10 dB room effect. Noise in classrooms may not exceed 35 dBA or 55 dBC per ANSI Standard S12.60-2002 and ASHRAE 70.
4. Install T-bars on both sides of diffusers for lay-in ceiling system, install manufacturer frame for sheetrock or plaster ceiling system. Diffuser margins system shall be compatible with ceiling types specified, color to match ceiling system. Contractor shall coordinate margin types with ceilings prior to submitting shop drawings.
5. Provide with concealed fasteners for installation in the field.
6. Linear diffusers and mounting frames shall be furnished as one piece up to 6' in length. Provide auxiliary support per manufacturer's recommendations for slot diffusers greater than 4' in length.
7. Diffusers shall be furnished with adjustable pattern deflectors capable of providing 180° pattern adjustment.
8. A manual volume damper shall be furnished and installed by the Contractor in branch ductwork to each slot diffuser. Balancing dampers shall not be installed in supply plenum or at air outlet unless otherwise indicated on the drawings.
9. Number and width of slots shall be as shown on the drawings.
10. Provide insulated plenum for each linear diffuser. Refer to linear diffuser supply plenum specification section for details.
11. Manufacturers:
  - a. Tuttle & Bailey 6000/7000
  - b. Carnes CH
  - c. Price SDS
  - d. Krueger 1900
  - e. Nailor 5000
  - f. Titus ML

- g. Anemostat SLAD
- h. Raymon Donco HPL
- i. Metalaire

#### 2.4 AIR TERMINALS - LINEAR DIFFUSER SUPPLY PLENUM

- A. Linear diffusers shall be provided with field fabricated or prefabricated supply plenums. Plenum shall be a minimum of 2-1/2" wider than total slot width, minimum length of slot, and minimum height of 10". Plenums with end fed duct connections shall not exceed 8' in length. The cross sectional area of the plenum shall be designed for a maximum velocity of 500 fpm and the aspect ratio shall be limited to a width-to-height ratio of less than 1.5. Plenums with side outlets shall be designed for a maximum velocity of 600 fpm and inlet ducts to plenum shall be spaced 5' on center maximum. Inlet ducts to plenums shall have a maximum velocity of 900 fpm. Flat-oval inlets are NOT acceptable for connection to flexible ducts. Provide sheet metal oval-to-round transition if required.

#### 2.5 LOUVERS - FIXED - ALUMINUM

- A. Louvers shall be minimum 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be minimum 0.081". Blades shall be spaced at a maximum of 5.1" apart.
- B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.
- C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.
- D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.
- E. AMCA Certified performance for 48" x 48" samples with intake airflow of 8,000 cfm shall not exhibit more than 0.19" pressure drop. Maximum water penetration shall be 0.01 ounces per square foot at the scheduled intake velocity based on 15 minute test duration when subjected to a water flow rate of 0.25 gal/min as described under the Water Penetration Test in AMCA 500-L-07.
- F. Contractor shall provide the General Contractor with the correct sizes and locations of all louvers required in masonry walls.
- G. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall.
- H. Louvers shall be suitable for duct connection.
- I. Manufacturers:
  - 1. Air Flow - "EA-403"
  - 2. Arrow - "EA-415-D"
  - 3. American Warming & Ventilating - "LE-21"
  - 4. Construction Specialties - "A4097"
  - 5. Dowco - "DBE-4"
  - 6. Louvers & Dampers, Inc. - "IL-23"
  - 7. Ruskin - "ELF375DX"

8. Vent Products - "2760"
9. Greenheck - ESD "403"
10. Pottorff - EFD

## 2.6 LOUVERED PENTHOUSES - ALUMINUM

- A. Louvers shall be 4" deep and constructed of extruded aluminum. Blade, jamb and sill thickness shall be 0.081". Blades shall be spaced approximately 3" apart.
- B. Louvers shall be of the drainable blade design with water collected on the leading edge of the blade and diverted to the jamb.
- C. Louvers shall be furnished with aluminum bird screen mounted on the inside surface.
- D. Size, cfm, finish and pressure drop for louvers shall be as scheduled on the drawings.
- E. Louvers shall be sealed around perimeter to avoid moisture penetration between the louver frame and wall of penthouse.
- F. Penthouse structure shall be constructed of an all-welded aluminum.
- G. Curb cap shall be of 14 gauge formed aluminum with mitered corners continuously heliarc-welded. Penthouse roof shall be of the same material and cross-broken for added strength. Underside of roof shall be coated with insulating mastic.
- H. Corners of penthouse shall be mitered with internal reinforcement.
- I. Penthouse and throat shall be reinforced with extruded aluminum angle and have a minimum snow load of 40 lbs. per square foot.
- J. Inlet area shall be minimum 150% of throat area for intake hoods. Outlet area shall be minimum 125% of throat area for exhaust hoods and relief vents.
- K. Louvered penthouses shall be furnished with 12" high curb (above top of roof) and be of the size and type as shown on the drawings.
- L. Manufacturers:
  1. Arrow-United
  2. American Warming & Ventilating
  3. Construction Specialties
  4. Dowco
  5. Greenheck
  6. Louvers & Dampers Inc.
  7. Ruskin
  8. Vent Products

## PART 3 - EXECUTION

### 3.1 INSTALLATION

#### A. General Installation Requirements:

1. Install items in accordance with manufacturers' instructions.
2. Check location of inlets and outlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
3. Install diffusers to ductwork with air tight connections.
4. Flexible ducts shall NOT be joined to flat-oval connections. Provide sheet metal oval-to-round transitions where required.
5. Supply grille and register blades shall be aimed in the field to provide adequate air distribution in the space. All return grilles and registers blades shall be oriented to minimize sight distance beyond installed device.

#### B. Volume Damper:

1. Provide manual volume dampers on duct take-off to diffusers when there are multiple connections to a common duct. Locate volume dampers as far as possible from the air inlet or outlet.

#### C. Maintaining Duct Cleanliness:

1. When grilles, registers, and diffusers are installed, Contractor shall prevent construction dust, dirt, and debris from entering ductwork as required by Section 23 05 00.

END OF SECTION 23 37 00

## SECTION 23 40 00 - AIR CLEANING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Filters and Filter Media.

#### 1.2 QUALITY ASSURANCE

- A. Filter media shall be tested under ANSI/UL 900 and labeled.
- B. Provide all filters and filter banks by one manufacturer.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00. Include data on media, performance, assembly and frames.

#### 1.4 EXTRA STOCK

- A. Provide a total of three (3) sets of filters for all units.
  - 1. Provide clean filters in all units at time of installation.
  - 2. Provide clean filters in all units at project final completion after all interior finishes are complete.
  - 3. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

### PART 2 - PRODUCTS

#### 2.1 MERV 4 (FIBERGLASS THROWAWAY) - TYPE B

- A. 1" thick fiberglass media with rigid frame and grille, minimum 20% efficiency per ASHRAE Standard 52.1 or MERV 4 per ASHRAE 52.2.

#### 2.2 MERV 4 (FIBERGLASS THROWAWAY) - TYPE C

- A. 2" thick fiberglass media with rigid frame and grille, minimum 20% efficiency per ASHRAE Standard 52.1 or MERV 4 per ASHRAE 52.2.

#### 2.3 MERV 8 (MEDIUM EFFICIENCY) - DISPOSABLE - TYPE D

- A. Non-woven cotton fabric, pleated media, disposable type with welded wire grid support bonded to the filter media.
- B. Heavy duty, paper board frame with diagonal support members bonded to inlet and exit sides of each pleat. Bond frame to media periphery to eliminate air bypass.

- C. 4" thick media with at least 4.6 square feet of media per square foot of face area. Maximum initial resistance of 0.30" WG at 500 fpm face velocity.
- D. 25-30% efficiency and 90-92% arrestance per ASHRAE 52.1 or MERV 8 per ASHRAE 52.2.

#### 2.4 MERV 11 (65% EFFICIENT) BAG FILTER - TYPE H

- A. Disposable type with high density, fine fiber glass media with reinforced backing and galvanized steel face frame.
- B. Self-supporting bags without sag under airflow reduced to 25% of the maximum design flow.

#### 2.5 FILTER GAUGES

- A. Inclined Manometer: One-piece molded plastic with epoxy coated aluminum scale, inclined-vertical indicating tube and built-in spirit level, 0-2" WG range, 3% of full scale accuracy.
- B. Accessories: Static pressure tips with integral compression fittings, 1/4" plastic tubing, 2- or 3-way vent valves, indicating fluid.
- C. Manufacturers:
  1. Dwyer "Mark II"
  2. Meriam Instrument.
- D. Differential Pressure Gauge: Diaphragm actuated, nominal 3" round dial, glass filled nylon housing, polycarbonate lens, zero adjustment, 0-2" W.G. range, 5% of full scale accuracy.
- E. Accessories: Static pressure tips with integral compression fittings and 1/8" NPT plastic tubing.
- F. Manufacturers:
  1. Dwyer "Minihelic II" 2-5000
  2. Marshalltown Instrument "Series 85C"

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install all products per manufacturers' instructions.
- B. Seal filter media to prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan systems without filters.
- D. Install static pressure tips upstream and downstream of filters. Mount filter gauges on outside of filter housing or filter plenum, in accessible position. Adjust and calibrate. Every filter bank, including packaged units, shall have a filter gauge.

- E. Install four (4) high efficiency filter test holes, two upstream and two downstream, at all high efficiency filter banks in air handling units and ductwork (85% efficiency and higher).  
Coordinate location of test holes with Owner.

END OF SECTION 23 40 00

## SECTION 23 57 00 - HEAT EXCHANGERS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Shell and Tube Type Heat Exchangers.
- B. Accessories and Trim.

#### 1.2 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00. Indicate dimensions, locations, and size of tappings and performance data.
- B. Submit manufacturer's installation instructions.
- C. Submit design data in sufficient detail to verify that heat exchangers meet or exceed specified requirements.
- D. Submit operation and maintenance data. Include start-up and shut down instructions, assembly drawings, and spare parts lists.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect internals from entry of foreign material by temporary caps on flanged openings.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to Section 8D of the ANSI/ASME Boilers and Pressure Vessels Code for manufacture of tubular heat exchangers and heat exchanger shells.

### PART 2 - PRODUCTS

#### 2.1 SHELL AND TUBE TYPE HEAT EXCHANGER

- A. Tubes: U-tube type with 3/4 inch OD minimum seamless copper tubes suitable for 125 psig working pressure.
- B. Shell: Steel with threaded or flanged piping connections and necessary tappings, steel saddle and attaching U-bolts, prime coated.
- C. Heads: Cast iron or fabricated steel with steel or bronze tube sheets, threaded or flanged for piping connections.
- D. Water Chamber and Tube Bundle: Removable for inspection and cleaning.
- E. Design: Heating fluid in shell and heated fluid in tubes.

- F. Manufacturers:
  - 1. Bell & Gossett
  - 2. Taco, Amtrol
  - 3. Armstrong Pumps
  - 4. Thrush
  - 5. Grundfos.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install to permit removal of tube bundle with minimum disturbance to installed equipment and piping.
- C. Pitch shell to completely drain condensate.
- D. Pipe relief valves and drain valves to nearest floor drain.

#### 3.2 STEAM-TO-WATER HEAT EXCHANGER TRIM

- A. Shell: Pressure gauge tapping with pigtail siphon, vacuum breaker.
- B. Water Inlet: Thermometer well, pressure gauge tapping, valved drain.
- C. Water Outlet: Thermometer well for temperature regulator sensor, ASME rated safety relief valve, thermometer well and pressure gauge tappings.

END OF SECTION 23 57 00

## SECTION 23 64 30 - AIR COOLED WATER CHILLERS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Chiller Package.
- B. Charge of Refrigerant and Oil.
- C. Controls and Control Connections.
- D. Connections.
- E. Starters.
- F. Sound Reduction Package

#### 1.2 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00 indicating components, assembly, dimensions, weights and loadings, required clearances, location and size of field connections, valves, strainers, thermostatic valves, rated capacities, specialties, accessories, electrical requirements and electrical power/control wiring diagrams.
- B. When submitting equipment with refrigerants and/or compressor types other than base design, prior approval shall be obtained from the Architect/Engineer before bids are received. Alternative refrigerants and associated equipment shall meet or exceed the sound performance, electrical performance, and information scheduled on the drawings and in the specifications.
- C. Submit manufacturer's installation instructions, including startup service reports and warranty.
- D. Submit operation data, start-up instructions, maintenance data, parts lists, controls, accessories, and trouble-shooting guide. Operation data shall include emergency, operation, and maintenance manuals.
- E. Submit AHRI Standard 370 sound power octave band data at 25%, 50%, 75%, and 100% load.
- F. Submit AHRI certified performance data indicating energy input versus cooling load output from minimum operating capacity to 100% of full load.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Protect units from physical damage. Leave factory shipping covers in place until installation. Protect insulation from dust, debris, and/or damage.
- C. Unit controls shall be capable of withstanding 150° F storage temperatures for an indefinite period of time.

#### 1.4 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing of the products specified in this Section with minimum five years' experience.
- B. All manufacturers shall have factory authorized and trained service personnel within 180 miles of the project site.

## 1.5 REGULATORY REQUIREMENTS

- A. Conform to ANSI/AHRI 590, ANSI/UL 1995, ANSI/ASME SEC 8 Boiler and Pressure Vessel Code, ANSI/UL 984, and ANSI/ASHRAE 15.
- B. Conform to ASHRAE 90.1.

## 1.6 WARRANTY

- A. Provide five year compressor warranty covering materials and labor cost for repair or replacement at the Owner's option.
- B. Provide one year warranty on the entire unit covering materials and labor cost for repair or replacement of defective components at the Owner's option.

## 1.7 MAINTENANCE SERVICE

- A. Chiller manufacturer or chiller certified representative shall furnish service and maintenance of complete assembly for one year from Date of Substantial Completion.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Daikin - (Design Basis).
- B. York.
- C. Carrier.

### 2.2 AIR COOLED WATER CHILLERS

- A. Provide factory assembled and tested outdoor air-cooled liquid chillers consisting of compressors, condenser, fans, evaporator (mounted remotely where scheduled as such), thermal expansion valve, refrigeration accessories, and control panel.
- B. Evaporator tubes are designed to operate under variable water flow conditions. Chiller manufacturer shall determine the minimum flow rates and maximum rate of water flow rate change. Coordinate with the Controls Contractor.
- C. Provide chiller with automatic capacity control down to 10% scheduled minimum capacity.
- D. Units shall have efficiency meeting ASHRAE 90.1.
- E. Charge unit with refrigerant will be provided and charged by the Mechanical Contractor field charging if required after installation.
- F. All refrigerant piping by heating contractor. Route refrigerant circuits to remote evaporator per manufacturers recommendations when the evaporator is mounted below the condenser on the roof.
- G. Suction accumulator piping per manufacturers recommendations is required from roof mounted condenser to remote evaporator for when the unit is off. This piping is by the heating contractor in the Third Floor Mechanical Room. Refer to IOM manuals for required length per circuit.
- H. Provide unit with a convenience outlet at condensing unit on roof.

### 2.3 COMPRESSORS

- A. Semi-hermetic direct drive rotary screw compressor(s) with oil injection, crankcase oil heater, and capacity control slide valve.

- B. Statically and dynamically balance rotating parts. Mount on internal vibration isolators.
- C. Provide oil charging valve, oil level sight glass, oil filter, and magnetic plug on strainer, arranged to ensure adequate lubrication during starting, stopping, and normal operation.
- D. Provide reciprocating compressors with suction valve unloaders with lifting mechanism operated by solenoid valve. Provide for unloaded compressor start.
- E. Provide compressor motor, suction gas cooled with solid state sensor and electronic winding overheating protection.
- F. Provide compressor heater to evaporate refrigerant returning to compressor during shut down. Energize heater when compressor is not operating.

#### 2.4 EVAPORATOR

- A. Provide shell and tube evaporator, seamless or welded steel construction with cast iron or fabricated steel heads, seamless copper or red brass tubes with integral fins, rolled or silver brazed into tube sheets. Provide multiple refrigerant circuits on multiple compressor units.
- B. Design, test, and stamp refrigerant side for the applicable refrigerant working pressure and water side for 150 psi working pressure, in accordance with ANSI/ASME SEC 8.
- C. Insulate with 0.75" thick flexible plastic or rubber elastomeric cellular foam insulation with maximum K value of 0.28.
- D. Provide water drain and vent connection and thermometer wells for temperature controller and low temperature cutout.
- E. Evaporator shall have only one entering and one leaving water mechanical groove 150 psi flange connection. If manufacturer provides two separate evaporators, contractor shall provide manifold and balancing valves conforming to the requirements of Section 23 21 00 to ensure equal flow is provided to each evaporator.
- F. Provide a suction accumulator and trap per manufacturers recommendation for remote evaporator First Floor South mechanical room.
- G. Evaporator shall be UL listed.
- H. Design, test, and stamp refrigerant side for the applicable refrigerant working pressure and water side for 150 psi working pressure in accordance with ANSI/ASME SEC 8.
- I. Evaporator shall be insulated with closed cell insulation with a minimum  $\frac{3}{4}$ ", (0.28)f 3.0.
- J. Provide thermostatically controlled heaters to protect to -20°F ambient in off-cycle.
- K. Provide drain and vent connections in the chilled water piping to allow proper drainage and venting of the heat exchangers. Provide thermometer wells for temperature controller and low temperature cutout.
- L. Install a 40 mesh strainer upstream of each heat exchanger.
- M. Evaporator shall have ANSI/AWWA C-606 grooved 150 psi flange water inlet and outlet connections.
- N. Provide a water flow differential pressure switch in horizontal piping of the supply water line to avoid evaporator freeze-up under low or no flow conditions.

#### 2.5 CONDENSERS

- A. Condenser shall provide design capacity between the minimum and maximum ambient conditions scheduled on the drawings.
- B. Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits with liquid accumulators. Air test under water to 450 psig.

- C. Provide vertical discharge propeller condenser fans with fan guard on discharge and factory mounted, louvered, galvanized steel coil guard panels to completely protect condenser coils. Wire mesh coil protection is not acceptable.
- D. Provide low sound, direct drive, high efficiency fan motors with Class F insulation, permanently lubricated ball bearings, and built-in current and overload protection.
- E. Entire fan assembly shall be statically and dynamically balanced.

## 2.6 ENCLOSURES

- A. House components in Architectural louvers by chiller manufacturer, welded steel frame with galvanized steel panels with weather resistant, baked enamel finish, color selection by Architect.

## 2.7 REFRIGERANT CIRCUIT

- A. Provide refrigerant circuits, factory supplied and piped.
- B. Provide for each refrigerant circuit:
  - 1. Liquid line solenoid and shutoff valves.
  - 2. Filter dryer (replaceable core type).
  - 3. Liquid line sight glass and moisture indicator.
  - 4. Electronic or thermal expansion valve.
  - 5. Charging valve.
  - 6. Discharge and oil line check valves.
  - 7. Compressor suction and discharge service valves.
  - 8. Condenser pressure relief valve.
  - 9. Refrigerant and oil.
- C. Refrigerant may be new or reclaimed. Reclaimed refrigerant shall meet the ARI-700-99 Specification for Fluorocarbon Refrigerants.
- D. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

## 2.8 CONTROLS

- A. On chiller, mount lockable weatherproof steel control panel, containing starters, power and control wiring, non-fused disconnect switch, factory wired with single point power connection. Provide mechanical interlock to disconnect power when door is open.
- B. For each compressor, provide across the line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for control power. Provide manual reset current overload protection.
- C. Provide the following safety controls with 40-character English display, arranged so any one will shut down machine and require manual reset:
  - 1. Low chilled water temperature switch.
  - 2. High discharge pressure switch for each compressor.
  - 3. Low suction pressure switch for each compressor.
  - 4. Oil pressure switch.
  - 5. Flow switch in chilled water line.
  - 6. Motor current overload.
  - 7. Phase reversal/unbalance/single-phasing.
  - 8. Over/under voltage.
  - 9. Failure of water temperature sensor used by chiller controller.

10. Relay for remote mounted emergency shut-down switch.
11. Low ambient/high ambient.

D. Provide the following operating controls:

1. Chilled water temperature controller that modulates capacity control device(s).
2. Timer to prevent compressor short cycling.
3. Anti-coincidental timer.
4. Timer to pump down on high evaporator refrigerant pressure.
5. Load limit thermostat to limit compressor loading on high return water temperature.
6. Low ambient control for operation down to 0°F.
7. High ambient controls for operation over 115°F.

E. Microprocessor control panel with digital readout. Display shall be multiple character LCD or lighted display with keypad.

1. User interface shall display at a minimum the following:

- a. Operating/alarm condition.
- b. Leaving chilled water temperature set point (with adjustment at the panel and via DDC).
- c. Entering and leaving chilled water temperature.
- d. Percent rated load amps output for each compressor.
- e. Condenser pressure for each circuit.
- f. Evaporator pressure for each circuit.
- g. Outside air temperature.
- h. Voltage.

2. Control panel shall communicate the following points to the DDC system via a BACnet interface:

a. Inputs:

- 1) Chiller enable.
- 2) Leaving chilled water temperature set point.
- 3) Chiller mode.
- 4) Current limit set point.

b. Outputs:

- 1) Chiller status.
- 2) Active chilled water set point.
- 3) Leaving chilled water temperature.
- 4) Entering chilled water temperature.
- 5) Alarm descriptor.
- 6) Average percent Run Load Amps (actual capacity).
- 7) Active current limit set point.

F. Chiller manufacturer shall provide a BACnet interface with the building automation system in accordance with ASHRAE/ANSI Standard 135/2001. This may be accomplished through a system integration panel, or “gateway”. Integration shall be

through an RS-232 connection. Integration panels shall be provided as part of the chiller package. Wiring between the chiller control panel(s) and the integration panel shall be the responsibility of the chiller manufacturer.

## 2.9 BEARINGS

- A. All bearings shall have a L10 life of not less than 200,000 hours per ANSI/AFBMA 9.

## 2.10 SOUND REDUCTION PACKAGE

- A. Provide sound reduction package including ultraquiet aerodynamic nine blade fan blades and compressor wrap/enclosure to limit unit generated sound power to values scheduled on the drawings. Sound power data shall conform to AHRI 370.
- B. Refer to schedule on sheet H500 for sound and chiller specific values.

# PART 3 - EXECUTION

## 3.1 INSTALLATION

### A. General Installation Requirements:

1. Install in accordance with manufacturer's instructions.
2. Align chiller package on steel or concrete foundations.
3. Install on vibration isolators as scheduled on the drawings or in Section 23 05 48.
4. Comb all condenser coils to repair bent fins.

### B. Piping Requirements:

1. Connect to chilled water piping. On inlet, provide well for temperature controller, well for temperature limit controller and well for thermometer, flow or differential pressure switch, flexible connector, and shutoff valve. On outlet, provide well for thermometer, flexible connector, shutoff valve, control valve, and balancing valve.
2. Arrange piping for easy dismantling for tube cleaning.

## 3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide factory trained representation for a period of one day to perform testing, start up, and instruction on operating and maintenance to Owner.
- B. Include startup and first year parts and labor.

END OF SECTION 23 64 30

## SECTION 23 72 00 - ENERGY RECOVERY DEVICES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Energy Recovery Wheels.
- B. Fixed Plate Energy Exchange Element.

#### 1.2 QUALITY ASSURANCE

- A. Fabrication: Conform to AMCA 99 and AHRI 430.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00.
- B. Energy transfer performance shall be clearly documented through a certification program conducted in accordance with ASHRAE 84 and AHRI 1060 standards. Submit enthalpy wheel AHRI 1060 compliance certification with reference number.
- C. Indicate ratings, performance, pressure drop, outdoor air correction factor (OACF), exhaust air transfer rate (EATR), motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight, required clearances, construction details, and field connection details.
- D. Submit manufacturer's installation instructions.
- E. Any exceptions to the specifications must be clearly noted. Contractor is responsible for any additional expenses that may occur due to any exception made.
- F. Submit operation and maintenance data. Include instructions for lubrication, belt replacement, motor and drive replacement, and spare parts lists.
- G. Submit static pressure calculations showing total pressure drops.
- H. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

## 1.5 WARRANTY

- A. Provide manufacturer's 60-month parts and labor warranty on the enthalpy wheel against defects in material and workmanship.
- B. Provide manufacturer's 60-month parts warranty on enthalpy wheel drive belt and bearings against defects in material and workmanship.

## PART 2 - PRODUCTS

### 2.1 ENERGY RECOVERY WHEEL

#### A. Enthalpy Wheel:

1. Frost Control: Provide variable speed control on rotors for frost control. Provide VFD inverter with manual override speed adjustment and turn down ratio of 20:1. Bypass dampers shall be controlled to bypass outdoor air around the wheel to avoid frosting conditions on the wheel. Outdoor air preheat coil shall be installed to maintain a minimum outdoor air temperature to avoid frosting conditions.
2. The media shall be fluted, corrugated in design to minimize the leakage of the exhaust air to the supply air through the media. The rotor media shall be coated with a polymer to avoid oxidation and latent energy transfer. All media surfaces shall be coated with desiccant prior to being formed into the fluted media structure. Surfaces sprayed, dip coated, or desiccants that must be reapplied over time are not acceptable. Impregnated desiccants in non-metallic substrates, such as synthetic will not be acceptable. Wheels with desiccant applied after wheel formation are not acceptable. Wheels shall be treated for corrosion resistance to water moisture.
3. Energy recovery effectiveness values shall be tested in accordance with ASHRAE 84 and be AHRI certified to Standard 1060 and bear the AHRI Certification symbol for AHRI Air-to-Air Energy Recovery Ventilation Equipment Certification program based on AHRI 1060.
4. Seal: Enthalpy wheel cassette shall be complete with face seal and perimeter seal to prevent cross leakage between the two airstreams. Both seals shall be non-wearable to minimize leakage up to specified differential pressure. Seals shall be adjustable.
5. Casing: Rotor casing shall limit the deflection of the rotor due to air pressure differential to less than 1/16 inch at design differential pressure. Framing shall be galvanized steel, aluminum, or other metal treated to be corrosion resistant to water moisture. Any exposed metal that is not corrosion resistant to water moisture shall be painted with primer and corrosion-resistant paint. Support rotor from bearings selected to support the rotating weight of the wheel. The bearings shall be maintained or replaced without removal of the rotor from its casing or the media from its spoke system.
6. Frame: The rotor frame shall be an industrial spoke system that provides the structural integrity required at design pressure differentials. Wheel construction shall allow for post-fabrication wheel alignment.
7. Drive: Rotor shall be driven from belt system and electric motor. Wheel shall be perimeter driven with pulley sized properly for wheel size and rotation speed. Rotor belt shall have no field adjustments required (0% stretch after initial tension). Provide motor with internal overload protection.

8. Frost Control: Provide variable speed control on rotors for frost control. Provide VFD inverter with manual override speed adjustment and turn down ratio of 20:1.

B. Media Cleaning:

1. The media shall be cleanable with hot water or light detergent) without degrading the latent recovery. Enthalpy wheel shall be self-cleaning by two counter flow airstreams.

C. Purge Section:

1. Unit to be provided with a factory set, field adjustable purge section designed to limit cross contamination to less than 10% of the exhaust flow rate. Purge swing arm shall be fully sealed with seals as described above. Rotation of wheel shall be in the direction from the return air through the purge to the supply air side.

D. Dampers:

1. Provide dampers as needed to allow for 100% airflow bypass around the wheel to allow for economizer.
2. Refer to drawings for size and location.
3. Provided by unit manufacturer. Refer to Section 23 09 00 for requirements.

E. Controls:

1. Provide unit with microprocessor controls with remote control panel located as noted on the drawings. Coordinate with Temperature Control Contractor for all wiring of system.
2. Unit shall be equipped with an outdoor air temperature sensor and controller such that the energy recovery wheel can be stopped during moderate temperature periods. The controller shall perform a stop/jog function for the wheel long enough to promote the self-cleaning features of the wheel but not long enough to induce energy recovery.
3. Unit shall be equipped with a rotation sensor and controller such that should the energy recovery wheel not rotate during a signaled run period, the controller shall send a 24-volt AC signal suitable for operating a relay to be used as an alarm contact. The controller shall not initiate an alarm during a stop/jog function.
4. Unit shall be equipped with defrost controls to prevent frost from forming on the enthalpy wheel and to maintain exhaust and outside air ventilation at all times.

F. Manufacturers:

1. Innergy Tech
2. Novel Aire
3. DRI
4. Seibu Giken (SG America)
5. Enventus or Xetex/AIRotor

## 2.2 FIXED PLATE ENERGY EXCHANGE ELEMENT

- A. Element shall be of cross-flow type and constructed of embossed aluminum with performance as scheduled on the drawings. Cross leakage shall be less than 1%.
- B. Exchange element to be epoxy air-dried phenolic coated for use in corrosive atmosphere.

- C. Provide insulated, stainless steel drain pan under exchange element section. Pitch drain pan to connection on side of unit closest to floor drain. Drain pan shall conform to the latest edition of ASHRAE Standard 62, including addenda.
- D. Unit shall be UL 1812 listed for ducted air-to-air heat exchangers.
- E. Unit shall be capable of transferring sensible and latent energy between airstreams. Latent energy transfer shall be accomplished by direct water vapor transfer from one airstream to the other, without exposing transfer media in succeeding cycles directly to the exhaust airstream and then to the fresh airstream.
- F. Exhaust and fresh air streams shall, at all times, travel in separate passages, and air streams shall not mix.
- G. Heat exchanger shall be equipped with face and bypass dampers to modulate effectiveness of the plate exchanger. Bypass area shall be sized for a static pressure more than the pressure drop through the face area. Face and bypass dampers shall be factory installed.
- H. Airflow through the energy exchange element shall avoid deposition of particulates on the interior of the energy plate material.
- I. Case shall be constructed of galvanized, 20-gauge steel, with lapped corners, and gasketed zinc plated screw fasteners.
- J. Manufacturers:
  - 1. Innergytech
  - 2. RenewAire
  - 3. Heatex
- K. Dampers:
  - 1. Provide dampers as needed to allow for 100% airflow bypass around the wheel to allow for economizer.

## 2.3 CONTROLS

- A. Unit shall be equipped with an outdoor air temperature sensor and controller such that the bypass dampers can be modulated during moderate temperature periods.
- B. Unit shall be equipped with defrost controls to prevent frost from forming on the fixed plate.
- C. Refer to Specification Section 23 09 00 for additional control information.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install per manufacturer's instructions.

- B. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan(s) have been test run under observation.
- C. P-traps must be installed for all drain pans.

END OF SECTION 23 72 00

## SECTION 23 73 23 - CUSTOM AIR HANDLING UNITS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Custom Air Handling Units - (Applies to Flinn indoor DOAS-4 only)

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer specializing in design and manufacturing of custom air handling equipment for industrial and commercial applications. Manufacturer shall have been producing custom air handling equipment for a minimum of ten years.
- B. Fabrication of units shall conform to AHRI 430, ASHRAE/ANSI Standard 111 and SMACNA - HVAC Duct Construction Standards.
- C. Unit shall be factory assembled and verified. Shipping splits shall be joined at the factory to confirm proper alignment of all components between each section.
- D. Unit components shall have a flame spread index of not over 25 and a smoke developed index of not over 50 per ASTM-E84; NFPA-255 and UL-723.
- E. Adhesives, sealants, tapes, insulations, vapor retarders, films, and other supplementary materials added to ducts and AHUs shall have flame spread/smoke developed ratings not over 25/50 per ASTM E84, NFPA 255, or UL 723.
- F. A unit manufacturer's representative, along with the Mechanical Contractor, Testing, Adjusting, and Balancing Contractor, and Temperature Control Contractor shall all be present for the unit start up.
- G. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.
- H. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00.
- B. Provide dimensioned computer-generated drawings showing unit plan, elevation views, all internal components, wall and floor penetrations, structural frame design, and unit weights at lifting lugs. Drawings shall be a minimum of 1/4"=1'-0" scale.
- C. Provide panel joint and corner details showing thermal breaks.

- D. Show all internal floor, wall, and roof support, beams, and columns.
  - E. Detail connection of the base of the unit as it sits on the curb or support steel.
  - F. Detail connection of shipping splits.
  - G. Indicate metal gauges, material finishes, assembly, construction details, and field connection details including the following:
    - 1. Unit electric characteristics with connected load.
    - 2. Construction details and material finishes.
    - 3. All required service and operation clearances.
    - 4. Field connection and fabrication details.
    - 5. Filter, coil, and damper performance data.
    - 6. Piping connection diagrams and field fabrication details.
    - 7. Power and control circuit wiring diagrams edited for each unit's application.
    - 8. Interconnection wiring diagrams with numbered terminal connections.
    - 9. Catalog data, brochures, and illustrations edited for each unit's application.
  - H. Include data on all fans and accessories. Indicate fan class. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.
  - I. Provide 8 octave band sound power produced at the inlet and outlet of each fan.
  - J. Provide calculated 8 octave maximum sound power levels at unit discharge and return connection, and maximum casing radiated sound power levels. Provide tested sound power levels at unit discharge and radiated sound power levels.
  - K. Provide static pressure calculations including individual internal component pressure losses (including clean filters) and available external static pressure. Total internal pressure drop shall not exceed values scheduled. External static pressure shall not be less than values scheduled.
  - L. Any exceptions to the specifications must be clearly noted to the Engineer prior to acceptance. Contractor is responsible for all expenses due to exceptions.
  - M. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.
  - N. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
  - O. The manufacturer shall submit documentation stating their construction standards meet or exceed specified leakage rates. Submit factory
- 1.4 EXTRA STOCK
- A. Provide one additional set of replacement filters for all units beyond standard sets listed under internal components.

- B. Provide one additional set of belts for all fans.

#### 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.
- B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

#### 1.6 REGULATORY REQUIREMENTS

- A. Conform to NFPA 70, 90A, and 90B.
- B. Unit shall bear ETL Label.
- C. Unit shall contain only UL listed components.
- D. Manufacturer shall be ISO-9000 certified.
- E. Conform to ASHRAE 90.1.

#### 1.7 SUBSTITUTIONS

- A. All base bid pricing shall be based on the drawings, schedules and this specification.
- B. A manufacturer's standard construction methods or previously arranged buying agreements shall not be acceptable reasons for deviating from these drawings and specifications.
- C. If a manufacturer requests to deviate from the requirements described herein, the Manufacturer and/or Contractor may list voluntary add or deduct prices for alternate materials, equipment manufacturers or construction methods on the bid form. These voluntary prices will not be used in determining the low bidder.
- D. All voluntary adds or deducts shall be discussed and agreed to by the Owner and Engineer prior to the award of the air handling unit bid and before the submittal process begins.

#### 1.8 WARRANTY

- A. Provide a manufacturer's parts and labor warranty against factory defects in material and workmanship for the entire unit for a period of 1 year after startup or 18 months from shipment.
- B. Provide an extended manufacturer's warranty for a period of one year(s) beyond the warranty period listed above against factory defects in material and workmanship (including paint) for the entire unit.

#### 1.9 MAINTENANCE AND SERVICE CONTRACT

- A. Furnish complete service and maintenance of air handling units for one year from Date of Substantial Completion.

- B. Provide maintenance service, with a maximum time interval between calls of two months. Provide 24-hour emergency service on breakdowns and unit malfunctions.
- C. Include maintenance items outlined in Manufacturer's operating and maintenance data including:
  - 1. Minimum of two filter replacements beyond the two called out elsewhere in the specifications.
  - 2. Minimum of one fan belt replacement.
  - 3. Ensure proper belt tension. Adjust as required.
- D. Submit copy of service call work order or report, and include description of all work performed.

#### 1.10 GENERAL DESCRIPTION

- A. Unit Location:
  - 1. The air handling unit (DOAS-4) is a variable air volume, unit located in a non-conditioned (heating only) room in the basement,.
  - 2. The unit will be set on a concrete housekeeping pad by the Contractor.
- B. Unit Description:
  - 1. The unit shall contain all the components as described in these specifications and as shown on the drawings and schedules.
  - 2. Refer to air handling unit drawings and schedules for additional information.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Innovent
- B. Trane Alliance.
- C. Air Enterprises.
- D. Air Flow Equipment.
- E. Buffalo.
- F. Climatecraft.
- G. Energy Labs.
- H. Engineered Air.
- I. Governair.

- J. Haakon.
- K. Heatcraft.
- L. Temtrol.

## 2.2 GENERAL UNIT ENVELOPE

### A. Thermal Resistance:

#### 1. Walls and Roof:

- a. Walls and Roof shall be a minimum of 4" thick with a minimum thermal resistance of  $R = 16.5$  at the center of a panel. Insulation material shall be Fiberglass Polyurethane Foam. Insulation density shall be no less than 3.0 lb/ft<sup>3</sup>.
- b. Exterior panels of conditioned sections shall not condense given the following conditions: supply air conditions: 52°F; exterior unit conditions: 91.1°F db/74.6°F wb . Manufacturer shall submit documentation demonstrating ability to prohibit condensation.
- c. Panel joints and seams shall be thermally broken. Manufacturers shall submit details showing the thermal break at panel joints and corners. Thermal break shall consist of a rigid EPDM or neoprene separation between the interior and exterior wall panels. Only screws will be permitted as a thermal bridge through the panels. Caulk will not be accepted as a barrier for the through-metal path.

#### 2. Floors:

- a. Floors shall be a minimum of 4" thick with a minimum thermal resistance of  $R = 16.5$  at the center of a panel. Insulation material shall be fiberglass polyurethane foam. Insulation density shall be no less than 3.0 lb/ft<sup>3</sup>.

### B. Deflection:

- 1. Structural reinforcement shall be designed so no member exceeds a deflection of 1/200 of span based on equipment loading and differential static of 8" W.C..

### C. Leakage Rate/Pressure Rating:

#### 1. Leakage Rate:

- a. The entire exterior unit casing shall be a constructed with an absolute leakage of 1% of design cfm when tested at 8" W.C.
- b. Manufacturer shall submit documentation stating their construction standards are within these leakage requirements. Housing construction shall utilize EPDM or neoprene foam gaskets at joints, seams, and split points as the pressure seal. Caulk shall not be used as the primary pressure sealant.

## 2.3 UNIT STRUCTURE

### A. Floor Structure:

1. Perimeter floor frame members shall be ASTM A500-03a welded cold formed carbon steel using standard shapes and sizes.
2. Intermediate flooring cross members shall be commercial quality, ASTM B209 sheet steel.
3. Finish base frame after fabrication with minimum of 1.5 mils of corrosion resistant epoxy primer with pencil hardness B, 60-degree gloss of less than or equal to 40 for proper finish adhesion, and adhesion shall comply with ASTM D-3359-B with no lifting.

### B. Internal Support Structure Members:

1. Construct internal horizontal and vertical cross members of commercial quality, ASTM B209 sheet steel.

### C. Internal supports shall not interfere with mechanical equipment operation or maintenance.

### D. Perimeter base frame shall have integral welded lifting lugs fabricated from same material as the perimeter floor frame. Lifting lugs shall be removable.

## 2.4 FLOOR CONSTRUCTION

### A. Floor Plates/Sheets:

1. Floor sheets shall be ASTM B209 aluminum.
2. Floor plates/sheets shall be a minimum of 10 gauge with checker plate with a rust resistive epoxy finish.

### B. Floor to Adjacent Wall Connection:

1. The floor shall have continuously welded upturned. All joints/corners shall also be continuously welded.

### C. Floor Plate/Sheet to Floor Plate/Sheet Connection:

1. All floor to floor connections shall be continuously welded to adjacent floor sheets.

### D. Floor Plate/Sheet to Unit Base Connection:

1. Floor shall be tack welded to unit base. Floors screwed or bolted to base will not be permitted.

### E. Floors shall be constructed to prevent "oil canning".

## 2.5 EXTERIOR WALL CONSTRUCTION

### A. Interior Liner:

1. Interior liner shall be bright ASTM A90 and A653 G60 galvanized steel and shall remain unpainted.
2. Interior liner shall be a minimum of 22 gauge solid sheets.

### B. Exterior Shell:

1. Exterior shell shall be ASTM A90 and A653 G90 galvanized steel.
2. Exterior shell shall be a minimum of 16gauge
3. Exterior shell shall be a bright galvanized finish.

## 2.6 ROOF CONSTRUCTION

### A. Interior Liner:

1. Interior liner shall be bright ASTM A90 and A653 G60 galvanized steel and shall remain unpainted.
2. Interior liner shall be a minimum of 22 gauge solid sheets. Refer to drawings for perforated liner locations.

### B. Exterior Shell:

1. Exterior shell shall be ASTM A90 and A653 G90 galvanized steel.
2. Exterior shell shall be a minimum of 16 gauge.

## 2.7 MULTI-SECTION UNITS

- A. Structure shall be designed and fabricated to prevent sagging when lifting individual sections.
- B. Design and manufacture units to facilitate field assembly.
- C. Provide gaskets at all split joints. Caulking is not permitted at shipping splits.
- D. Provide internal lifting eyes such that mating sections can be set together without sliding.
- E. Flanged perimeter shall be drilled with assembly holes with continuous gasketing.
- F. Gaskets shall be high quality weather resistant closed cell neoprene sponge rubber.
- G. The shipping split sections shall not have any standing seams or ridges at the floor.

## 2.8 DOORS

- A. Unit doors shall be double wall and insulated with the same materials used in the surrounding unit walls.
- B. Doors shall be the same material and thickness as the surrounding walls.

- C. Exterior layer shall be a minimum of 16 gauge. Interior layer shall be a minimum of 22 gauge.
- D. Door frames shall be continuously welded and formed of the same materials as the surrounding wall.
- E. Doors shall contain a continuous neoprene bulb type gasket.
- F. Each door shall have continuous piano hinges.
- G. Each door shall have a minimum of two (2) high compression type latches, operable from both sides. All exterior doors shall have a secured padlock fitting.
- H. Each door shall contain a double pane tempered, reinforced or safety glass window.
- I. Doors shall be a minimum of 24" wide and 60" high, unless noted otherwise.

## 2.9 INTERIOR WALL PANEL CONSTRUCTION - DOUBLE WALL

- A. Where there is a temperature difference across an interior partition, where large differential pressures exist (such as across fan sections) and where shown on the drawings, panels shall be double wall.
- B. Liners shall be bright ASTM A90 and A653 G60 galvanized steel and shall remain unpainted.
- C. Liners shall be a minimum of 22 gauge solid sheets.
- D. Interior wall panels shall be the same thickness and insulated with the same insulation as specified for exterior wall panels.
- E. Internal walls shall be completely sealed with EPDM foam gasket to the exterior wall or air tunnel pressure barrier surface.
- F. Usage: Fan section, damper sections, cooling coils, etc.

## 2.10 INTERNAL COMPONENTS

- A. Motors:
  - 1. Provided and installed by unit manufacturer. Refer to Section 23 05 13 for requirements.
- B. Internal Vibration Isolation:
  - 1. Provided and installed by unit manufacturer. Refer to Section 23 05 48 for requirements.
- C. Air Coils:
  - 1. Provided and installed by unit manufacturer. Refer to Section 23 82 16 for requirements.

2. Provide drain pan and drain connection for all cooling coils. Fabricate drain pan from 20 gauge stainless steel. Install a drain pan under each cooling coil per ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot. Pipe drain pans individually to floor drain.
3. Unit manufacturer shall design and provide 304 stainless steel structure to support cooling coils and galvanized steel structure to support other coils. Structure shall be arranged such that any individual coil may be removed through the face of the structure without affecting the other coils or cutting/removal of housing panels.
4. Manufacturer shall insulate the underside of all drain pans, except those integral with the floor, with a minimum of 3/4" cellular flexible elastomeric foam sheet (Type E).

D. Fans:

1. Provided and installed by unit manufacturer. Refer to Section 23 34 16 for requirements.

E. Filters:

1. Provided and installed by unit manufacturer. Refer to Section 23 40 00 for requirements.
2. Pre-Filter Section:
  - a. Provide front-loading particulate pre-filter section located downstream of return fan module as scheduled on drawings. Filter module shall be equipped with framing for 4" deep MERV-13 pleated media filters. Provide pre-filter module with full height hinged access door.
  - b. Maximum particulate pre-filter face velocity shall not exceed 230 feet/minute.
  - c. Reference Section 23 40 00 for filter requirements.

F. Control Dampers and Actuators:

1. Supply and exhaust dampers shall be provided and installed by unit manufacturer. Refer to Section 23 09 00 for requirements.
2. Dampers shall be installed to allow the mounting and future maintenance of damper actuators. One direct coupled actuator shall be used per damper section. Jack shafting is not acceptable.

G. Variable Frequency Drives:

1. Provided and installed by unit manufacturer. Refer to Section 26 29 23 for requirements.

H. Electrical Power:

1. Internal wiring and devices provided and installed by unit manufacturer where designated on drawings. Refer to drawings for division of work between contractor and manufacturer. Refer to Division 26 for requirements.

2. All electrical wiring and devices, lighting, and electric unit heaters shown as being provided by the manufacturer shall be furnished and pre-wired back to an electrical distribution panel located in the service vestibule of each unit. The electrical distribution panel shall be a maximum of 60 amp, 3 phase, 4 wire 208/120 volt panelboard. The Electrical Contractor, after installation and assembly of the unit, will connect main power to the unit.
3. Provide shop drawings of the unit, including wiring schematics, to both the Electrical and Temperature Control Contractors to coordinate their work.
4. All wiring shall conform to NFPA 70. All starters and disconnects shall be NEMA (not IEC) rated.

I. Controls:

1. Provided and installed by the Temperature Control Contractor in the Field.

2.11 ACCESSORIES

A. Motor Removal I-Beam:

1. Motor removal I-beam shall be provided to facilitate removal of motors 5 HP and larger. Structural steel frame shall be provided to support motor removal I-beam.

PART 3 - EXECUTION

3.1 FACTORY INSTALLATION TRAINING

- A. The manufacturer shall provide travel, room and board for minimum of two days of factory training for a minimum of two Contractor's Representatives for the purpose of training the contractors on unit rigging, hoisting and installation.

3.2 FACTORY REPRESENTATION DURING INSTALLATION

- A. The manufacturer shall provide a qualified representative at the project site during rigging, hoisting and installation of unit. Representative shall ensure proper installation and section connection methods are employed.

3.3 MANUFACTURER RESPONSIBILITIES

- A. Manufacturer shall inspect unit installation and assist in start-up and balancing of unit. Manufacturer's start-up engineer shall assist in commissioning of all unit functions and submit report containing all data recorded and a certification that the unit is operating properly.
- B. Seal all openings and protect internal components from damage during shipment.
- C. Manufacturer shall clean dust and debris from unit prior to shipment.

### 3.4 CONTRACTOR RESPONSIBILITIES

#### A. General Installation Requirements on Site: (Flinn)

1. Verify unit with shipping splits can be hoisted down the new area well and into the basement mechanical room opening created as part of this project.
2. Field verify column location where DOAS-4 encloses the existing column. Provide unit section that allows manufacturer to enclose column as shown on DOAS-4 plan view drawing.
3. Verify that proper power supply is available.
4. During construction provide temporary closures of metal or taped polyethylene over openings into housing ducts to prevent dust from entering ductwork.
5. Control panels, conduit, piping, or equipment may not be mounted on the exterior of the housing walls or roof without prior approval of Architect/Engineer and unit manufacturer.
6. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the housing.
7. Perform Owner training as required.

#### B. General Installation Requirements for Equipment:

1. Install clean filters in unit at final completion.
2. Install all items in accordance with manufacturer's instructions.
3. Provide openings in panels for thermometers and controllers. Provide pitot tube openings for testing systems.
4. Locate ducts with sufficient space around equipment for normal operation and maintenance.
5. Install all additional reinforcing, columns and beams as detailed by the manufacturer.
6. Clean dust and debris from each section of housing after it is installed. Clean inside of fan housings, fan scrolls, and coils of all units.
7. Do not damage lining or devices in process of cleaning. Replace any damaged material.
8. When installing field installed components (piping, electrical, etc.), Contractor shall protect manufacturer installed finishes (i.e., epoxy coating, etc.). If any damage occurs, the Contractor shall repair finishes as required to match existing finishes per manufacturer's recommendations.

### 3.5 PRESSURE TESTING OF UNIT

#### A. Factory Testing:

1. Housing Leak Testing:
  - a. Test housing at pressures specified under Leakage Rate/Pressure Rating in Part 2 of this specification.
  - b. Sections operating in a negative pressure shall be tested as negative. Sections operating in a positive pressure shall be tested as positive.
  - c. Leakage rate shall not exceed percentages specified under Leakage Rate/Pressure Rating in Part 2 of this specification.
  - d. Determine leakage by measuring the airflow forced into (or out of) the air handling unit at the test pressure.
  - e. Perform air flow measurements in compliance with ASHRAE/ANSI standard 111.

- f. Make any repairs necessary if unit does not pass test and retest.
  2. Provide detailed report, including all data and test methods, as part of Owner's Operation and Maintenance Manuals.
  3. Factory testing shall be conducted on DOAS-4
- B. Manufacturer Conducted Field Testing:
  1. Housing Leak Testing:
    - a. Once unit is installed and the fans are operational, test housing for leakage.
    - b. Test housing at pressures specified under Leakage Rate/Pressure Rating in Part 2 of this specification.
    - c. Sections operating in a negative pressure shall be tested as negative. Sections operating in a positive pressure shall be tested as positive.
    - d. Leakage shall not exceed the rates specified under Leakage Rate/Pressure Rating in Part 2 of this specification.
    - e. Determine leakage by measuring the airflow forced into (or out of) the air handling unit at the test pressure.
    - f. Perform air flow measurements in compliance with ASHRAE/ANSI standard 111.
    - g. Make any repairs necessary if unit does not pass test and retest.
  2. Notify Owner and Engineer prior to testing. Owner and Engineer may be present to witness testing
  3. Provide detailed report, including all data and test methods, as part of Owner's Operation and Maintenance Manuals.
  4. Field testing shall be conducted after field penetrations have been made and sealed.
  5. Field testing shall be conducted on DOAS-4.

END OF SECTION 23 73 23

## SECTION 23 74 13 - ROOFTOP MODULAR AIR HANDLING UNITS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Modular Outdoor Air Handling Units.
  - 1. Flinn: RTU-2, RTU-3
- B. QUALITY ASSURANCE
- C. AHU Unit: Manufacturer specializing in design and manufacturing of the products specified in this section with a minimum of five years' experience.
- D. Fabrication: Conform to AMCA 99 and AHRI 430.
- E. Fan Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- F. Sound Ratings: Tested to AMCA 300.
- G. Fan Energy Index (FEI): Fans shall meet or exceed the minimum FEI scheduled at the specified airflow, pressure, and air density (duty point). In no case shall the FEI at the specified duty point fall below 1.0.
- H. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.
- I. Electrical control wiring shall be in accordance with NEC codes and ETL requirements.
- J. Unit shall contain only UL listed components.
- K. Conform to ASHRAE 90.1.
- L. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

#### 1.2 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00. Indicate ratings, fan performance, motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
  - 1. Product Data
    - a. Include data on all fans and accessories. Submit motor ratings and electrical characteristics, plus motor and electrical accessories. Submit multi-speed fan curves including minimum and maximum fan speed with specified operating points clearly plotted. Submit the Fan Energy Index (FEI) at the selected duty point.

- b. Select fans using external static pressure noted in the schedule. Manufacturer responsible for calculation of internal static pressure. Manufacturer shall include an allowance for clean filters in the internal static pressure. An allowance for the difference between dirty filters and clean filters is included in the external static. Submit static pressure calculations showing total pressure drops, including tabulated internal pressure drops and specified external static pressure drops
  - c. Submit sound power level data for both fan outlet and casing radiation at rated capacity.
  - d. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions
  - e. Submit manufacturer's data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.
  - f. Provide a copy of data of filter media, filter performance data, filter assembly, and filter frames with unit submittal for reference only.
- B. Submit manufacturer's installation instructions.
  - C. All base bid pricing shall be based on the drawings, schedules and this specification
    - 1. If a manufacturer requests to deviate from the requirements described herein, the Manufacturer and/or Contractor may list voluntary add or deduct prices on the bid form. These voluntary prices will not be used in determining the low bidder.
    - 2. All voluntary adds or deducts shall be discussed and agreed to by the Owner and Architect/Engineer prior to the award of the air handling unit bid and before the submittal process begins.
  - D. Any exceptions to the specifications must be clearly noted to the Architect/Engineer prior to acceptance. Contractor is responsible for all expenses due to exceptions.
  - E. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
  - F. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.
- 1.3 EXTRA STOCK
- A. Provide clean filters in all units at time of installation.
  - B. Provide clean filters in all units at project final completion after all interior finishes are complete.
  - C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.
  - B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

## 1.5 WARRANTY

- A. Provide a manufacturer's 1-year parts and labor warranty against defects in material and workmanship.

## 1.6 GENERAL DESCRIPTION

### A. Unit Location:

1. The air handling unit (RTU-2 and RTU-3 - Flinn) is a variable air volume modular unit, located on the roof.
2. The unit will be set on a roof curb by the Contractor.

### B. Unit Description:

1. The unit shall contain all the components described in these specifications and shown on the drawings and schedules.
2. Refer to air handling unit drawings and schedules for additional information

## PART 2 - PRODUCTS

### 2.1 MODULAR OUTDOOR AIR HANDLING UNITS

#### A. Manufacturers:

1. Trane - "T" Series
2. Daikin - Skyline
3. Carrier - 39 Series
4. JCI/York - Solutions
5. Air Flow Equipment - Wolverine
6. Ventrol - ITF Outdoor Unit
7. Temtrol - Series ITF

#### B. Housing:

1. Minimum 18 gauge G90 galvanized steel exterior panels reinforced and braced with galvanized steel framework.
2. Removable access panels for coil and fan removal.
3. Unit shall be double wall constructed and insulated in all sections. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 20 gauge solid galvanized steel. Cover all portions of the interior of the unit exposed to the airstream with steel to allow cleaning and prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. If casing sections are not provided by the unit manufacturer with double wall construction, the Contractor is responsible for covering exposed insulation with galvanized sheet metal. The minimum R-value of the panel assemblies shall be 8.

4. Install a stainless steel drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
5. Units shall be draw-thru or blow-thru as noted on the drawings and shall not exceed the overall dimensions.
6. Provide unit base to allow unit to set on top of rooftop curb. Seal entire length and width under base to create a weather tight seal between the curb and the unit.
7. The external surface of the unit shall be factory painted to withstand a salt spray test in accordance with ASTM B117 for a minimum of 500 consecutive hours. Unit casing shall be prepared and coated with a minimum of 1.5 mil enamel finish. Color shall be white. Confirm with Owner.
8. The unit's roof shall be double wall constructed. The inner roof shall be installed in such a manner to prevent air bypass between internal components. The outer roof shall be sloped a minimum of 0.25" per foot either from one side of the unit to the other, or from the center to the sides of the unit. All seams shall be gasketed and capped to prevent water infiltration. The roof assembly shall have a drip seal that overhangs all the walls of the unit.
9. Provide unit with a full length, continuous, base rail channel. Base rail channels shall be formed of a minimum 12 gauge galvanized steel. Support all major components from base rail.

C. Doors:

1. Unit doors shall be double wall and insulated with the same materials used in the surrounding unit walls.
2. Door shall have a protective flange to shield gasket from exposure. Door frame shall be mounted on raised door frame and shall channel water away from gasket.
3. Doors shall contain a continuous neoprene bulb type gasket.
4. Each door shall contain a double pane tempered, reinforced or safety glass window.
5. Each door shall have a minimum of two (2) high compression type latches, operable from both sides.
6. Provide minimum 12" x 18" hinged access doors on both sides of the fan housing.

D. Access Sections:

1. Provide access sections as shown on the drawings between unit sections. Provide access doors on both sides of section.

E. Fan:

1. Direct Drive Single Width, Single Inlet Plenum Multi-fan Array with Airfoil Blades:
  - a. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type.
  - b. Statically and dynamically balanced.
  - c. Grease lubricated ball bearings, selected for 200,000 hours L-50 life at the design operating conditions.
  - d. Provide extended lubrication lines for all bearings to an easily accessible location.
  - e. Factory balanced fans will be used with variable speed controls to operate at all speeds up to the design speed.

- f. Fan(s) shall have internal spring isolators.
- g. Piezometer Air Flow Measuring: Provide fan with factory installed piezometer ports for monitoring the pressure difference between the fan inlet and the smallest diameter of the inlet cone. Ports shall be installed by the factory to ensure proper location of the taps to match how the fans were tested. Orifices shall be factory drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor shall extend to a termination plate mounted on the fan housing. High pressure flow probes shall be factory mounted in the low velocity fan inlet. Flow probes from the high-pressure sensor shall extend to a termination plate mounted on the fan housing. Provide piezometer on each fan in an array. Transducer for measuring differential pressure shall be provided by the Temperature Control Contractor (TCC). Include with fan submittal the empirically derived formulas developed by the fan manufacturer for each supply and return fan provided with the air handling unit, along with the recommended differential pressure transducer range.

2. Double Width, Double Inlet Centrifugal Fan(s), with Airfoil Blades:

- a. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type. Substitution of BI or BIA fans for FC is acceptable if efficiency is not lower.
- b. Statically and dynamically balanced.
- c. Grease lubricated ball bearings, selected for 200,000 hours L-50 life at the design operating conditions.
- d. Provide extended lubrication lines for all bearings to an easily accessible location.
- e. Provide approved belt guards with openings for tachometer readings for external drives only.
- f. Factory balanced fans will be used with variable speed controls to operate at all speeds up to the design speed.
- g. Fan(s) shall have internal spring isolators.
- h. Multiple fan arrangements shall be provided with gravity backdraft dampers on each fan.
- i. Piezometer Air Flow Measuring: Provide fan with factory installed piezometer ports for monitoring the pressure difference between the fan inlet and the smallest diameter of the inlet cone. Ports shall be installed by the factory to ensure proper location of the taps to match how the fans were tested. Orifices shall be factory drilled in the smallest diameter of the inlet cone venturi. Flow tubes from each venturi sensor shall extend to a termination plate mounted on the fan housing. High pressure flow probes shall be factory mounted in the low velocity fan inlet. Flow probes from the high-pressure sensor shall extend to a termination plate mounted on the fan housing. Provide piezometer on each fan. Transducer for measuring differential pressure shall be provided by the Temperature Control Contractor (TCC). Include with fan submittal the empirically derived formulas developed by the fan manufacturer for each supply and return fan provided with the air handling unit, along with the recommended differential pressure transducer range.

F. Motors and Drives:

- 1. AC Induction Motors: Contractor Note: If ECM availability does not align with project schedule.
  - a. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.

- b. Motor mounting bracket shall be adjustable to allow tightening of belts.
- c. Motors shall be open drip-proof or TEFC type with grease lubricated bearings.
- d. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 05 13.
- e. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP (15 kW) and below. On units over 20 HP (15 kW), use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
- f. No equipment shall be selected or operate above 90% of its motor nameplate rating. Variable Frequency Drives:

- 1. Provided and installed by unit manufacturer. Refer to Section 26 29 23 for requirements.

H. Multi-Zone Units:

- 1. Equip with zone dampers as shown on drawings.
- 2. Maximum 1700 fpm through either hot or cold opening when one damper is closed.
- 3. Units shall be blow-through design with heating and cooling coils.
- 4. Unit casing shall have access panels for servicing of all hot and cold zone dampers.
- 5. The unit manufacturer shall provide zone dampers. Refer to Section 23 09 00 for damper requirements. If the unit manufacturer is unable to meet the requirements listed in Section 23 09 00, the unit manufacturer shall provide dampers from an outside source that meet these specifications.
- 6. Extend damper rods outside of the casing to allow attachment of damper motors on the top or bottom of the casing.

I. Coils

1. Hot Water Coils:

- a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
- b. Suitable for continuous operation at 200 psi. Maximum air velocity of 1000 fpm.
- c. Galvanized steel casing. Coil headers and U-bends shall not be exposed.
- d. AHRI rated with 0.0005 fouling factor.
- e. Size coils sized based on EWT, EAT, gpm and cfm as scheduled. LAT shall be at least as high as scheduled. APD and WPD shall not exceed scheduled values.
- f. Maximum 144 fins per foot.
- g. Turbulators are not permitted unless tube velocities are below 2 FPS at design flow or noted otherwise. Turbulators shall be allowed if removable headers are specified.
- h. Coils shall have drain and vent connections at supply and return headers with valves. Extend valving outside of the unit casing.
- i. Install coils level to allow drainage.
- j. Minimum 0.035" tube wall thickness.
- k. Manufacturers:
  - 1) Trane
  - 2) York
  - 3) Daikin
  - 4) Carrier

- 5) Marlo Heatcraft
- 6) or American Air Filter.

2. Chilled Water Coils:

- a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
- b. Stainless steel casing. Coil headers and U-bends shall not be exposed.
- c. Maximum air velocity of 500 fpm.
- d. AHRI rated with 0.0005 fouling factor.
- e. Coils shall be sized based on EWT, EAT, gpm and cfm as scheduled. The leaving DB, leaving WB, APD and WPD shall not exceed the scheduled values.
- f. Maximum 144 fins per foot. No water carryover shall occur at design airflow and no anti-carryover coating shall be used.
- g. Suitable for 200 psig operation.
- h. Coils shall have drain and vent connections at supply and return headers. Install coils level for proper drainage. Coils shall be completely drainable at the header. Minimum 5/8" OD tubes. Minimum 0.035" tube wall thickness. Same as the unit manufacturer or Trane, Daikin, Carrier or York.

Pre-Filter Section:

1. Provide side-loading particulate pre-filter section located downstream of return fan module as scheduled on drawings. Filter module shall be equipped with framing for 2" deep MERV-8 pleated media filters. Provide pre-filter module with full height hinged access door.
2. Maximum particulate pre-filter face velocity shall not exceed 230 feet/minute.
3. Reference Section 23 40 00 for filter requirements.

K. Final Filter Section:

1. Provide front-loading final filter section located downstream of supply fan module as scheduled on drawings. Filter module shall be equipped with framing for 12" deep cartridge filters with seals on all four sides where each filter is inserted in the frame to prevent air bypass. Provide final filter module with full height hinged access door.
2. Maximum final filter face velocity shall not exceed 400 feet/minute.
3. Reference Section 23 40 00 for filter requirements.

L. Intake/Hood: Provide intake/exhaust hood of same construction as main unit casing. The hood shall be sized for scheduled air flow.

M. External Pipe Cabinet:

1. Provide external pipe cabinet spanning all coil and humidifier sections.
2. Minimum cabinet depth shall be 12".
3. Pipe cabinet shall be supplied by the manufacturer.
4. Pipe cabinet shall be factory assembled and shall be of the same construction as the main unit casing.
5. Provide two (2) access door(s). Each door shall be of the same construction as the unit doors and a minimum width of 20 inches.

N. Electrical Power:

1. Provide factory-mounted, weather-resistant (enclosed and gasketed), vapor-tight light fixtures in each accessible section of the unit. The fixture shall be complete with junction box, globe, aluminum globe guard, switch, receptacle, and bulb. Provide with factory-mounted outdoor service receptacles. Lighting and utility receptacles shall be wired to a single 120-volt point, terminating at a designated junction box mounted on the air-handling unit. The Mechanical Contractor is responsible to complete all wiring connection between shipping splits after assembly.

PART 3 - EXECUTION

3.1 INSTALLATION

A. General Installation Requirements

1. Install per manufacturer's instructions.
2. During construction provide temporary closures of metal or taped polyethylene over openings into housing ducts to prevent dust from entering ductwork.
3. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the housing.
4. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

B. Coil Requirements:

1. Comb all coils to repair bent fins.
2. Extend coil drain and vent connections to outside unit housing. Provide normally closed valve on drain and vent connection outside of unit housing.

3.2 MANUFACTURER'S FIELD SERVICES

- A. Provide factory authorized field representative for starting unit and training operator.
- B. Prepare and start systems with installing contractor observation.

END OF SECTION 23 74 13

SECTION 23 74 16.12 - PACKAGED ROOFTOP AIR CONDITIONING UNITS AND DEDICATED  
OUTDOOR AIR UNITS - 35 TON AND BELOW

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged Rooftop Unit.
  - 1. Washington: RTU-2W
  - 2. Lincoln: RTU-4L
  - 3. East High School: DOAS-3EH, RTU-4EH, 5EH, 6EH, 7EH, 8EH, 9EH, 10EH
- B. Unit Controls.
- C. Roof Mounting Frame and Base.

1.2 QUALITY ASSURANCE

- A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).
- B. All units must be UL or ETL listed and must contain UL labeled components.
- C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.
- D. Conform to ASHRAE 90.1.
- E. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 23 05 00.
- B. Indicate electrical service and duct connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.
- D. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.
- E. Provide 8 octave maximum sound power levels at unit discharge and return connection.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

#### 1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

#### 1.6 WARRANTY

- A. Provide five (5) year manufacturer's warranty for compressors.
- B. Provide five (5) year manufacturer's warranty for heat exchanger.
- C. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

#### 1.7 MAINTENANCE SERVICE

- A. Contractor shall furnish complete service and maintenance of packaged roof top units for one year from Date of Substantial Completion.
- B. Provide maintenance service with a two-month interval as maximum time period between calls. Provide 24-hour emergency service on breakdowns and malfunctions.
- C. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of four (quarterly) filter replacements, minimum of one fan belt replacement, and controls checkout, seasonal adjustments, and recalibrations.
- D. Submit copy of service call work order or report and include description of work performed to Owner and Architect/Engineer.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 23 05 00 for additional information.
- B. Daikin
- C. Trane
- D. York

- E. Carrier
- F. Valent
- G. Aaon

## 2.2 MANUFACTURED UNITS

- A. Provide roof-mounted units having gas burner and electric refrigeration.
- B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, exhaust fan, heat exchanger and burner, controls, air filters, refrigerant cooling coil and compressor, condenser coil, condenser fan, and a full refrigerant charge.
- C. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

## 2.3 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors or removable access panels with quick fasteners locking door handle type with piano hinges. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.
- B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.
- C. Insulation: Minimum of 1/2" thick, 1.5 lb./cu.ft. density coated glass fiber insulation on surfaces where conditioned air is handled. Protect edges from erosion.
- D. Heat Exchangers: Aluminized steel, of welded construction.
- E. Air Filters: Four inch thick MERV 13 glass fiber disposable media in metal frames.

## 2.4 ROOF MOUNTING FRAME AND BASE

- A. Roof Mounting Curb (For units that do not sit on a metal support system by structural): Minimum 24 inches high, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

## 2.5 FANS/MOTORS

- A. Fans:
  - 1. Supply Fans: SWSI plenum fan.
  - 2. Exhaust Fans: Propeller or SWSI plenum fan.

3. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
4. Fan and motor assemblies shall be resiliently mounted.
5. Direct drive motor.
6. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
7. All fans must be statically and dynamically balanced.

B. Motors:

1. Motors shall be open drip-proof with grease lubricated bearings.
2. No equipment shall be selected or operate above 90% of its motor nameplate rating.
3. Motor shall have 1.15 service factor.
4. ECM motors may be provided.

2.6 BURNER

- A. Gas Burner: Atmospheric type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shutoff, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shutoff pilot. fully modulating gas valve with minimum 12:1 turndown.
- B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.
- C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.
- D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, or adjustable time delay relays with switch for continuous fan operation.

2.7 EVAPORATOR COIL

- A. Provide copper tube with aluminum fin coil assembly.
- B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

- D. Provide insulation on liquid refrigerant and suction piping between compressor and evaporator coil where not protected by drain pans. Insulation shall be elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

## 2.8 HOT GAS REHEAT COIL

- A. Provide copper tube with aluminum fin coil assembly.
- B. Valves to reroute hot refrigerant gas from the discharge line of the compressor through the reheat coil.

## 2.9 COMPRESSOR

- A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0°F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B. Five minute timed off circuit shall delay compressor start.
- C. Provide capacity control by providing inverter duty compressors.
- D. The use of hydrochlorofluorocarbon (HCFC) or chlorofluorocarbon (CFC) based refrigerants is prohibited.

## 2.10 CONDENSER

- A. Provide copper tube aluminum fin coil assembly with sub-cooling rows.
- B. Provide direct drive low noise blade design propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Fan blade shall be aluminum or composite material.
- C. Provide refrigerant pressure switches to cycle condenser fans.
- D. Provide hail guards on all condenser coils.
- E. Liquid and discharge isolation valves with staged and digital scrolls.
- F. Fan motors shall be an ECM type motor for proportional control. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

## 2.11 MIXING SECTION

- A. Dampers: Provide remote controlled outside and return air dampers with damper operator and remote rheostat for adjusting outside air quantity.

- B. Gaskets: Provide tight fitting dampers with edge gaskets. Gaskets must be mechanically fastened (use of adhesive alone shall not be acceptable). Damper blades shall be gasketed with side seals to provide an air leakage rate of Class 1A at 1" w.c. pressure differential for a 24"x 24" damper. A barometric exhaust damper shall be provided to exhaust air out the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator.
- C. Damper Actuator: 24 volt with gear train sealed in oil, with spring return on units 7.5 tons cooling capacity and larger.

## 2.12 POWER EXHAUST

- A. Factory installed by economizer supplier or compatible equivalent.
- B. Controlled by economizer controls.
- C. Power exhaust shall be factory wired to electrical section complete with conduit, feeders, disconnect, and overcurrent protection. Power exhaust shall be energized based on building pressure or when dampers open past the adjustable setpoint of the economizer control.
- D. Must comply with Energy Code Fan Power Limitation formula.
- E. Fans:
  1. Exhaust Fans: Propeller
  2. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
  3. Fan and motor assemblies shall be resiliently mounted
  4. Direct drive motor.
  5. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
  6. All fans must be statically and dynamically balanced.
- F. Motors:
  1. Motors shall be open drip-proof with grease lubricated bearings.
  2. No equipment shall be selected or operate above 90% of its motor nameplate rating.
  3. Motor shall have 1.15 service factor.

## 2.13 ENERGY RECOVERY

- A. Required where noted in the schedules. Refer to specification section 23 72 00.

## 2.14 ELECTRICAL

- A. Provide with single point power connection to service all controls, dampers, outlet, and fans, complete with non-fused disconnect switch, short circuit protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection, transformer, and convenience outlet.

- B. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect.
- C. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.
- D. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.
- E. All units shall include a transformer for controls and convenience outlet.
- F. Only one power cable connection to the unit shall be necessary.
- G. Motor shall include phase failure protection and prevent the motor from operation in the event of phase loss.

## 2.15 OPERATING CONTROLS - SINGLE ZONE UNITS

- A. When variable speed drives are applied:
  - 1. Single Zone VAV: An electronic variable frequency drive shall be provided for the supply air fan. Each drive shall be factory installed out of the airstream in a conditioned cabinet. Drives shall meet UL Standard 95-5V. The completed unit assembly shall be listed by a recognized safety agency, such as ETL. Drives are to be accessible through a hinged door assembly. Mounting arrangements that expose drives to high temperature unfiltered ambient air are not acceptable.
- B. Room thermostat shall incorporate:
  - 1. Automatic switching from heating to cooling.
  - 2. Preferential rate control to minimize overshoot and deviation from set point.
  - 3. Set-up for four separate temperatures per day.
  - 4. Instant override of setpoint for continuous or timed period from one hour to 31 days.
  - 5. Short cycle protection.
  - 6. Programming based on weekdays, Saturday and Sunday.
  - 7. Switch selection features including imperial or metric display, 12 or 24 hour clock, keyboard disable, remote sensor, fan on-auto.
- C. Room thermostat display shall include:
  - 1. Time of day.
  - 2. Actual room temperature.
  - 3. Programmed temperature.
  - 4. Programmed time.
  - 5. Duration of timed override.
  - 6. Day of week.
  - 7. System model indication: heating, cooling, auto, off, fan auto, fan on.
  - 8. Stage (heating or cooling) operation.

- D. Provide low limit sequence to close outside air dampers and stop supply fan.
- E. Mixed Air Controls: Maintain selected supply air temperature and revert dampers to minimum outside air position on a call for heating and above 75°F ambient, when ambient air enthalpy exceeds return air enthalpy.
- F. Dehumidification Controls: Maintain the relative humidity setpoint with the hot refrigerant gas reheat coil.

#### 2.16 DDC TEMPERATURE CONTROLS

- A. Install standalone control module providing communication between unit controls and packaged DDC temperature control system.
- B. Control module shall be compatible with temperature control system specified in Section 23 09 00. Provide BACnet gateway for communication.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.
- B. Verify that proper power supply is available.

#### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting curb and provide watertight enclosure to protect ductwork and utility services. Install unit level.
- C. All field wiring shall be in accordance with the National Electrical Code.
- D. P-traps must be provided for all drain pans.
- E. Comb all coils to repair bent fins.
- F. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

#### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide initial start-up and shutdown during first year of operation.

END OF SECTION 23 74 16.12

SECTION 23 74 16.14 - PACKAGED ROOFTOP AIR CONDITIONING UNITS AND DEDICATED OUTDOOR AIR UNITS WITH ENERGY RECOVERY - GAS/DX

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged Rooftop Unit.
  - 1. Flinn: DOAS-1, 2, 3, 5, 6, 7, and 8
  - 2. Lincoln: DOAS-1L, 2L, 3L, 4L; RTU-1L, 2L, 3L
  - 3. Washington: DOAS-1W, 2W, 3W; RTU-1W, 3W
  - 4. East High School: DOAS-1EH, 2EH; RTU-1EH, 2EH, 11EH, 12EH, 13EH, 14EH
- B. Unit Controls.
- C. Roof Mounting Frame and Base.
- D. Economizers.
- E. Heat Recovery.
- F. Power Exhaust.

1.2 QUALITY ASSURANCE

- A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).
- B. All units must be UL or ETL listed and must contain UL labeled components.
- C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.
- D. Conform to ASHRAE 90.1.
- E. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the airstream when tested at design airflow and with no airflow, using the rain test apparatus described in Section 58 of UL 1995.

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.4 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.

- B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

#### 1.5 WARRANTY

- A. Provide five (5) year manufacturer's warranty for compressors.
- B. Provide five (5) year manufacturer's warranty for heat exchanger.
- C. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 23 05 00 for additional information.
- B. Daikin
- C. Trane
- D. York
- E. Carrier
- F. Valent
- G. Aaon

#### 2.2 MANUFACTURED UNITS

- A. Provide roof-mounted units having gas burner, electric heating elements, and electric refrigeration.
- B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, return fan, exhaust fan, heat exchanger and burner, electric heating elements, controls, air filters, refrigerant cooling coil and compressor, condenser coil, condenser fan, and a full refrigerant charge.
- C. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

## 2.3 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors with locking door handle with piano hinges. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 18 gauge, with access doors or removable panels of minimum 20 gauge.
- B. Outside Air Intakes: The outside air intakes shall be located a minimum of 15 inches above the roof mounting curb to minimize the effect of heat pickup from the roof during the natural cooling cycle and the effects of snow on the roof during winter operation. Each air intake shall be furnished with rain eliminators.
- C. Insulation: All sections shall be double wall, foam injected casings.
- D. Heat Exchangers: Stainlesssteel, of welded construction.
- E. Air Filters: Four inch thick MERV 13 glass fiber disposable media in metal frames.
- F. Heat Recovery: Heat wheel.

## 2.4 ROOF MOUNTING FRAME

- A. Unit Roof Mounting Frame: Provided by structural contractor, refer to structural drawings. Mechanical contractor to provide smaller curbs only around ductwork roof penetrations. Minimum 24 inches (600 mm) high, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

## 2.5 FANS/MOTORS

- A. Fans:
  - 1. Supply Fans: Airfoil centrifugal; SWSI plenum or vane axial fan.
  - 2. Return Fans: Airfoil centrifugal; SWSI plenum or vane axial fan.
  - 3. Exhaust Fans: Airfoil centrifugal; SWSI plenum or vane axial fan.
  - 4. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
  - 5. Fan and motor assemblies shall be resiliently mounted.
  - 6. Direct drive motor.
  - 7. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
  - 8. All fans must be statically and dynamically balanced.
- B. Motors:
  - 1. Motors shall be open drip-proof with grease lubricated bearings.
  - 2. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 05 13.
  - 3. No equipment shall be selected or operate above 90% of its motor nameplate rating.
  - 4. Motor shall have 1.15 service factor.
  - 5. ECM motors may be provided.

## 2.6 BURNER

- A. Gas Burner: Forced draft type burner with adjustable combustion air supply, pressure regulator, gas valves, manual shutoff, intermittent spark or glow coil ignition, flame sensing device, and automatic 100 percent shutoff pilot. Fully modulating gas valve with minimum 10:1 turndown. The burner shall operate efficiently at all firing rates. The burner shall have proven open damper low-high-low pre-purge cycle and proven low fire start. The combustion air control damper shall be in the closed position during the off cycle to reduce losses.
- B. Gas Burner Safety Controls: Energize ignition, limit time for establishment of flame, prevent opening of gas valve until pilot flame is proven, stop gas flow on ignition failure, energize blower motor, and after airflow proven and slight delay, allow gas valve to open.
- C. High Limit Control: Temperature sensor with fixed stop at maximum permissible setting, de-energize burner on excessive bonnet temperature and energize burner when temperature drops to lower safe value.
- D. Supply Fan Control: Temperature sensor sensing bonnet temperatures and independent of burner controls, or adjustable time delay relays with switch for continuous fan operation.

## 2.7 ELECTRIC HEATING COIL

- A. Helical nickel-chrome resistance wire coil heating elements with refractory ceramic support bushings easily accessible with automatic reset thermal cut-out, built-in magnetic contactors, galvanized steel frame, control circuit transformer and fuse, manual reset thermal cut-out, airflow proving device, toggle switch (pilot duty), fused disconnect.
- B. Controls shall start supply fan before electric elements are energized and continue operating until air temperature reaches minimum setting, with switch for continuous fan operation.
- C. Heating shall have four stages of modulating SCR control.

## 2.8 EVAPORATOR COIL

- A. Provide copper tube with aluminum fin coil assembly.
- B. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- C. Provide capillary tubes or thermostatic expansion valves for units of 6 tons capacity and less, and thermostatic expansion valves and alternate row circuiting for units 7.5 tons cooling capacity and larger.

- D. Provide insulation on liquid refrigerant and suction piping between compressor and evaporator coil where not protected by drain pans. Insulation shall be elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.27 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Maximum 1" thick per layer where multiple layers are specified.

## 2.9 HOT GAS REHEAT COIL

- A. Provide copper tube with aluminum fin coil assembly.
- B. Valves to reroute hot refrigerant gas from the discharge line of the compressor through the reheat coil.

## 2.10 COMPRESSOR

- A. Provide hermetic or semi-hermetic compressors (quantity as scheduled on drawings), 3600 rev/min maximum, resiliently mounted with positive lubrication, crankcase heater for operation down to 0°F, high and low pressure safety controls, motor overload protection, suction and discharge service valves and gauge ports, and filter drier.
- B. Five minute timed off circuit shall delay compressor start.
- C. Provide capacity control by providing inverter duty compressors.
- D. The use of hydrochlorofluorocarbon (HCFC) or chlorofluorocarbon (CFC) based refrigerants is prohibited.

## 2.11 CONDENSER

- A. Provide copper tube aluminum fin coil assembly with sub-cooling rows.
- B. Provide direct drive low noise blade design propeller fans, resiliently mounted with fan guard, motor overload protection, wired to operate with compressor. Fan blade design shall be a dynamic profile for low tip speed. Fan blade shall be aluminum or composite material.
- C. Provide refrigerant pressure switches to cycle condenser fans.
- D. Provide hail guards on all condenser coils.
- E. Liquid and discharge isolation valves with staged and digital scrolls.
- F. Fan motors shall be an ECM type motor for proportional control. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase.

## 2.12 MIXING SECTION

- A. Dampers: (May be omitted from DOAS units) Provide outside, return, and relief dampers with damper operator and control package to automatically vary outside air quantity. Outside air damper shall fail to closed position. Relief dampers may be gravity balanced.

- B. Gaskets: Provide tight fitting dampers with edge gaskets. Gaskets must be mechanically fastened (use of adhesive alone shall not be acceptable). Damper blades shall be gasketed with side seals to provide an air leakage rate of Class 1A at 1" w.c. pressure differential for a 24"x 24" damper. A barometric exhaust damper shall be provided to exhaust air out the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator.
- C. Damper Actuator: 24 volt with gear train sealed in oil, with spring return on units 7.5 tons cooling capacity and larger.

## 2.13 ECONOMIZERS

- A. Factory installed by approved rooftop unit manufacturer with fully modulating motorized outside air and return air dampers.
- B. To be controlled by differential enthalpy with fixed dry-bulb controller with minimum position setting.
- C. Shall be capable of introducing up to 100% outside air.
- D. Shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.
- E. Dampers shall be capable of completely closing when unit is in unoccupied mode.
- F. Outside air damper normally closed and return air damper normally open.
- G. Provide factory installed and tested, outdoor air monitor that controls outdoor air  $\pm 15\%$  accuracy down to 40 cfm per ton.
- H. Economizer Fault Detection and Diagnostics (FDD):
  - 1. Air-cooled unitary direct-expansion units that are equipped with an economizer shall include a fault detection and diagnostics system complying with the following:
    - a. The following temperature sensors shall be permanently installed to monitor system operation:
      - 1) Outside air.
      - 2) Supply air.
      - 3) Return air.
    - b. Temperature sensors shall have an accuracy of  $\pm 2^\circ\text{F}$  over the range of  $40^\circ\text{F}$  to  $80^\circ\text{F}$ .
    - c. Refrigerant pressure sensors, where used, shall have an accuracy of  $\pm 3$  percent of full scale.
    - d. The unit controller shall be configured to provide system status by indicating the following:
      - 1) Free cooling available.

- 2) Economizer enabled.
  - 3) Compressor enabled.
  - 4) Heating enabled.
  - 5) Mixed air low limit cycle active.
  - 6) The current value of each sensor.
- e. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans, and the heating system can be independently tested and verified.
- f. The fault detection and diagnostics system shall be configured to detect the following faults:
- 1) Air temperature sensor failure/fault.
  - 2) Not economizing when the unit should be economizing.
  - 3) Economizing when the unit should not be economizing.
  - 4) Damper not modulating.
  - 5) Excess outdoor air.
- g. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.

## 2.14 HEAT RECOVERY

### A. Heat Wheel:

1. Heat Recovery Device: Heat Wheel - Aluminum Substrate with 4 Angstrom Molecular Sieve Desiccant:
  - a. Energy recovery shall be an integral part of unit from the manufacturer. No field assembly, ducting, or wiring shall be required with the energy recovery option.
  - b. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.
  - c. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer per the scheduled performance.
  - d. Energy recovery wheel media shall be constructed of fluted aluminum with permanently-bonded zeolite desiccant.
  - e. Energy recovery wheel cassette shall be mounted perpendicular (90°) to the base of the unit.
  - f. A VFD shall be required to modulate the speed of the wheel and to provide soft start to extend the life of the belt.
  - g. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.
  - h. Rotor media shall be reinforced using aluminum structural spokes with extruded central hub and shaft and shall be connected to shaft using pillow bearings.
  - i. Energy wheel cassette shall include seals, drive motor, and linked drive belt.
  - j. Latent energy shall be transferred entirely in the vapor phase with no condensation.
  - k. The energy recovery cassette and wheel drive motor shall be an Underwriters Laboratories recognized component for electrical and fire safety.
  - l. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.

2. Heat Recovery Device: Heat Wheel - Polymer Substrate with Silica Gel Desiccant:
  - a. Energy recovery shall be an integral part of unit from the manufacturer. No field assembly, ducting, or wiring shall be required with the energy recovery option.
  - b. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.
  - c. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer per the scheduled performance.
  - d. Energy recovery wheel shall be constructed of lightweight polymer substrate with permanently-bonded silica gel desiccant.
  - e. Energy recovery wheel cassette shall be mounted perpendicular (90°) to the base of the unit.
  - f. A VFD shall be required to modulate the speed of the wheel and to provide soft start to extend the life of the belt.
  - g. Individual pie-shaped wheel sections shall be removable from wheel cassette for maintenance.
  - h. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.
  - i. Rim shall be continuous rolled stainless steel, and the wheel shall be connected to the shaft by means of taper locks.
  - j. Energy wheel cassette shall include seals, drive motor, and urethane drive belt.
  - k. Latent energy shall be transferred entirely in the vapor phase with no condensation.
  - l. The energy recovery cassette and wheel drive motor shall be an Underwriters Laboratories recognized component for electrical and fire safety.
  - m. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.

#### 2.15 POWER EXHAUST

- A. Factory installed by economizer supplier or compatible equivalent.
- B. Controlled by economizer controls.
- C. Power exhaust shall be factory wired to electrical section complete with conduit, feeders, disconnect, and overcurrent protection. Power exhaust shall be energized based on building pressure or when dampers open past the adjustable setpoint of the economizer control.
- D. Must comply with Energy Code Fan Power Limitation formula.
- E. Fans:
  1. Exhaust Fans: Propeller or SWSI plenum fan.
  2. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
  3. Fan and motor assemblies shall be resiliently mounted.
  4. Direct drive motor or with V-belt drive and rubber isolated hinge mounted motor.
  5. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
  6. All fans must be statically and dynamically balanced.

F. Motors:

1. Motors shall be open drip-proof with grease lubricated bearings.
2. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 05 13.
3. No equipment shall be selected or operate above 90% of its motor nameplate rating.
4. Motor shall have 1.15 service factor.
5. ECM motors may be provided.

2.16 ELECTRICAL

- A. Provide with single point power connection to service all controls, dampers, outlet, and fans, complete with non-fused disconnect switch, short circuit protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection, transformer, and convenience outlet.
- B. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect.
- C. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.
- D. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.
- E. All units shall include a transformer for controls and convenience outlet.
- F. Only one power cable connection to the unit shall be necessary.
- G. Motor shall include phase failure protection and prevent the motor from operation in the event of phase loss.

2.17 OPERATING CONTROLS - SINGLE ZONE UNITS

- A. Provide low limit sequence to close outside air dampers and stop supply fan.
- B. Dehumidification Controls: Maintain the relative humidity setpoint with the hot refrigerant gas reheat coil.

2.18 DDC TEMPERATURE CONTROLS

- A. Install standalone control module providing communication between unit controls and packaged DDC temperature control system.
- B. Control module shall be compatible with temperature control system specified in Section 23 09 00. Provide BACnet gateway for communication.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.
- B. Verify that proper power supply is available.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting curb and provide watertight enclosure to protect ductwork and utility services. Install unit level.
- C. All field wiring shall be in accordance with the National Electrical Code.
- D. P-traps must be provided for all drain pans.
- E. Comb all coils to repair bent fins.
- F. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide initial start-up and shutdown during first year of operation.

END OF SECTION 23 74 16.14

SECTION 23 74 16.15 - PACKAGED INDOOR DEDICATED OUTDOOR AIR UNITS WITH ENERGY RECOVERY - HYDRONIC

PART 1 - GENERAL

1.1 SECTION INCLUDES

A. Packaged Indoor Air Handling Unit.

1. Lincoln: DOAS-5L, 7L, 8L
2. Washington: DOAS-4W

B. Unit Controls.

C. Frame and Base.

D. Economizers.

E. Heat Recovery.

F. Power Exhaust.

1.2 QUALITY ASSURANCE

A. All insulation inside the unit and in the air stream must comply with the requirement of NFPA 90A (maximum flame spread of 25 and maximum smoke developed of 50).

B. All units must be UL or ETL listed and must contain UL labeled components.

C. Fans shall be tested and rated in cabinet in accordance with AMCA Standard 210. All fan assemblies shall be dynamically balanced in cabinet at final assembly.

D. Conform to ASHRAE 90.1.

1.3 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting frames are in place, ready for immediate installation of units.

1.4 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data.

B. Include manufacturer's descriptive literature, installation instructions, maintenance and repair data, and parts listing.

1.5 WARRANTY

A. Provide five (5) year manufacturer's warranty for compressors.

- B. Provide five (5) year manufacturer's warranty for heat exchanger.
- C. Provide three (3) year manufacturer's warranty for controls and electrical components (thermostats, VFD, etc.).

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Basis of Design: The scheduled manufacturer is the Basis of Design. The Contractor is responsible for all costs, schedule impacts, and construction coordination, including design costs and regulatory agency approvals, related to using a specified alternate product other than the Basis of Design. Refer to Section 23 05 00 for additional information.
- B. Daikin
- C. Trane
- D. York
- E. Carrier
- F. Valent
- G. Aeon

### 2.2 MANUFACTURED UNITS

- A. Provide indoor units having hot water heating coil, chilled water cooling coil, and hot water reheat coil with energy recovery wheel, supply fan and exhaust fan.
- B. Unit shall be self-contained, packaged, factory assembled, pre-wired and tested, consisting of cabinet and frame, supply fan, return fan, exhaust fan, coils, controls, air filters.
- C. Unit shall be furnished with non-fused disconnect switch, short fuse protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection.

### 2.3 FABRICATION

- A. Cabinet: Galvanized steel with baked enamel finish, access doors with locking door handle with piano hinges. Access doors shall be provided at each section (e.g., filter section, supply fan section, etc.). All exterior access panels must be permanently labeled on the outside indicating what is behind the panel. Structural members shall be minimum 24 gauge, with access doors or removable panels of minimum 24 gauge.
- B. Insulation: All sections shall be double wall, foam injected casings.
- C. Air Filters: Four inch thick MERV 13 glass fiber disposable media in metal frames.
- D. Air Coils:

1. Provide drain pan and drain connection for all cooling coils. Fabricate drain pan from 20 gauge (1.01 mm) stainless steel. Install a drain pan under each cooling coil per ASHRAE 62.1. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" (10 mm) per foot (meter). Pipe drain pans individually to floor drain.
2. Unit manufacturer shall design and provide 304 stainless steel structure to support cooling coils and galvanized steel structure to support other coils. Structure shall be arranged such that any individual coil may be removed through the face of the structure without affecting the other coils or cutting/removal of housing panels.

E. Manufacturer shall insulate the underside of all drain pans, except those integral with the floor, with a minimum of 3/4" (20 mm) cellular flexible elastomeric foam sheet (Type E).

F. Heat Recovery: Heat wheel.

## 2.4 MULTI-SECTION UNITS

A. Structure shall be designed and fabricated to prevent sagging when lifting individual sections.

B. Design and manufacture units to facilitate field assembly.

C. Provide gaskets at all split joints. Caulking is not permitted at shipping splits.

D. Provide internal lifting eyes such that mating sections can be set together without sliding.

E. Flanged perimeter shall be drilled with assembly holes with continuous gasketing.

F. Gaskets shall be high quality weather resistant closed cell neoprene sponge rubber.

## 2.5 FANS/MOTORS

A. Fans:

1. Supply Fans: Airfoil centrifugal; SWSI plenum or vane axial fan.
2. Return Fans: Airfoil centrifugal; SWSI plenum or vane axial fan.
3. Exhaust Fans: Airfoil centrifugal; SWSI plenum or vane axial fan.
4. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
5. Fan and motor assemblies shall be resiliently mounted.
6. Direct drive motor.
7. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
8. All fans must be statically and dynamically balanced.

B. Motors:

1. Motors shall be open drip-proof with grease lubricated bearings.
2. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 05 13.
3. No equipment shall be selected or operate above 90% of its motor nameplate rating.

4. Motor shall have 1.15 service factor.
5. ECM motors may be provided.

## 2.6 MIXING SECTION

- A. Gaskets: Provide tight fitting dampers with edge gaskets. Gaskets must be mechanically fastened (use of adhesive alone shall not be acceptable). Damper blades shall be gasketed with side seals to provide an air leakage rate of Class 1A at 1" w.c. pressure differential for a 24"x 24" damper. A barometric exhaust damper shall be provided to exhaust air out the back of the unit. A bird screen shall be provided to prevent infiltration of rain and foreign materials. Exhaust damper blades shall be lined with vinyl gasketing on contact edges. Control of the dampers shall be by a factory installed direct coupled actuator.
- B. Damper Actuator: 24 volt with gear train sealed in oil, with spring return on units 7.5 tons cooling capacity and larger.

## 2.7 COILS

### A. Hot Water Coils:

1. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
2. Suitable for continuous operation at 200 psi (1380 kPa). Maximum air velocity of 1000 fpm (5 m/s).
3. Galvanized steel casing. Coil headers and U-bends shall not be exposed.
4. AHRI rated with 0.0005 fouling factor.
5. Size coils sized based on EWT, EAT, gpm (water flow L/s) and cfm (airflow L/s) as scheduled. LAT shall be at least as high as scheduled. APD and WPD shall not exceed scheduled values.
6. Maximum 144 (472) fins per foot (meter).
7. Turbulators are not permitted unless tube velocities are below 2 FPS at design flow or noted otherwise. Turbulators shall be allowed if removable headers are specified.
8. Coils shall have drain and vent connections at supply and return headers with valves. Extend valving outside of the unit casing.
9. Install coils level to allow drainage.
10. Minimum 0.035" tube wall thickness.

### B. Chilled Water Coils:

1. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
2. Stainless steel casing. Coil headers and U-bends shall not be exposed.
3. Maximum air velocity of 500 fpm (2.5 m/s).
4. AHRI rated with 0.0005 fouling factor.
5. Coils shall be sized based on EWT, EAT, gpm (water flow L/s) and cfm (airflow L/s) as scheduled. The leaving DB, leaving WB, APD and WPD shall not exceed the scheduled values.
6. Maximum 144 (472) fins per foot (meter). No water carryover shall occur at design airflow and no anti-carryover coating shall be used.
7. Suitable for 200 psig (1380 kPa gauge) operation.

8. Coils shall have drain and vent connections at supply and return headers. Install coils level for proper drainage. Coils shall be completely drainable. Minimum 1/2" (12 mm) OD tubes. Minimum 0.024" (0.6 mm) tube wall thickness.

## 2.8 ECONOMIZERS

- A. Factory installed by approved rooftop unit manufacturer with fully modulating motorized outside air and return air dampers.
- B. To be controlled by differential enthalpy with fixed dry-bulb controller with minimum position setting.
- C. Shall be capable of introducing up to 100% outside air.
- D. Shall maintain minimum airflow into the building during occupied period and provide design ventilation rate for full occupancy.
- E. Dampers shall be capable of completely closing when unit is in unoccupied mode.
- F. Outside air damper normally closed and return air damper normally open.
- G. Provide factory installed and tested, outdoor air monitor that controls outdoor air  $\pm 15\%$  accuracy down to 40 cfm per ton.
- H. Economizer Fault Detection and Diagnostics (FDD):
  1. Air-cooled unitary direct-expansion units that are equipped with an economizer shall include a fault detection and diagnostics system complying with the following:
    - a. The following temperature sensors shall be permanently installed to monitor system operation:
      - 1) Outside air.
      - 2) Supply air.
      - 3) Return air.
    - b. Temperature sensors shall have an accuracy of  $\pm 2^\circ\text{F}$  over the range of  $40^\circ\text{F}$  to  $80^\circ\text{F}$ .
    - c. Refrigerant pressure sensors, where used, shall have an accuracy of  $\pm 3$  percent of full scale.
    - d. The unit controller shall be configured to provide system status by indicating the following:
      - 1) Free cooling available.
      - 2) Economizer enabled.
      - 3) Compressor enabled.
      - 4) Heating enabled.
      - 5) Mixed air low limit cycle active.
      - 6) The current value of each sensor.

- e. The unit controller shall be capable of manually initiating each operating mode so that the operation of compressors, economizers, fans, and the heating system can be independently tested and verified.
- f. The fault detection and diagnostics system shall be configured to detect the following faults:
  - 1) Air temperature sensor failure/fault.
  - 2) Not economizing when the unit should be economizing.
  - 3) Economizing when the unit should not be economizing.
  - 4) Damper not modulating.
  - 5) Excess outdoor air.
- g. The unit shall be configured to report faults to a fault management application available for access by day-to-day operating or service personnel or annunciated locally on zone thermostats.

## 2.9 HEAT RECOVERY

### A. Heat Wheel:

1. Heat Recovery Device: Heat Wheel - Aluminum Substrate with 4 Angstrom Molecular Sieve Desiccant:
  - a. Energy recovery shall be an integral part of unit from the manufacturer. No field assembly, ducting, or wiring shall be required with the energy recovery option.
  - b. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.
  - c. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer per the scheduled performance.
  - d. Energy recovery wheel media shall be constructed of fluted aluminum with permanently-bonded zeolite desiccant.
  - e. Energy recovery wheel cassette shall be mounted perpendicular (90°) to the base of the unit.
  - f. A VFD shall be required to modulate the speed of the wheel and to provide soft start to extend the life of the belt.
  - g. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.
  - h. Rotor media shall be reinforced using aluminum structural spokes with extruded central hub and shaft and shall be connected to shaft using pillow bearings.
  - i. Energy wheel cassette shall include seals, drive motor, and linked drive belt.
  - j. Latent energy shall be transferred entirely in the vapor phase with no condensation.
  - k. The energy recovery cassette and wheel drive motor shall be an Underwriters Laboratories recognized component for electrical and fire safety.
  - l. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.
2. Heat Recovery Device: Heat Wheel - Polymer Substrate with Silica Gel Desiccant:
  - a. Energy recovery shall be an integral part of unit from the manufacturer. No field assembly, ducting, or wiring shall be required with the energy recovery option.

- b. Energy recovery media shall be accessible through a 2" thick, foam-injected, double-wall, hinged access door with quarter-turn latches.
- c. Energy recovery shall be provided through a total enthalpy wheel providing sensible and latent energy transfer per the scheduled performance.
- d. Energy recovery wheel shall be constructed of lightweight polymer substrate with permanently-bonded silica gel desiccant.
- e. Energy recovery wheel cassette shall be mounted perpendicular (90°) to the base of the unit.
- f. A VFD shall be required to modulate the speed of the wheel and to provide soft start to extend the life of the belt.
- g. Individual pie-shaped wheel sections shall be removable from wheel cassette for maintenance.
- h. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours.
- i. Rim shall be continuous rolled stainless steel, and the wheel shall be connected to the shaft by means of taper locks.
- j. Energy wheel cassette shall include seals, drive motor, and urethane drive belt.
- k. Latent energy shall be transferred entirely in the vapor phase with no condensation.
- l. The energy recovery cassette and wheel drive motor shall be an Underwriters Laboratories recognized component for electrical and fire safety.
- m. Thermal performance shall be certified by the wheel manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment.

## 2.10 POWER EXHAUST

- A. Factory installed by economizer supplier or compatible equivalent.
- B. Controlled by economizer controls.
- C. Power exhaust shall be factory wired to electrical section complete with conduit, feeders, disconnect, and overcurrent protection. Power exhaust shall be energized based on building pressure or when dampers open past the adjustable setpoint of the economizer control.
- D. Must comply with Energy Code Fan Power Limitation formula.
- E. Fans:
  - 1. Exhaust Fans: Propeller or SWSI plenum fan.
  - 2. All fans shall be aluminum or composite construction with fan shaft: turned, ground and polished steel; keyed to wheel hub.
  - 3. Fan and motor assemblies shall be resiliently mounted.
  - 4. Direct drive motor or with V-belt drive and rubber isolated hinge mounted motor.
  - 5. All fan bearings must be capable of being lubricated by easily accessible grease fittings.
  - 6. All fans must be statically and dynamically balanced.
- F. Motors:
  - 1. Motors shall be open drip-proof with grease lubricated bearings.
  - 2. Motors shall be "variable frequency drive rated" when controlled by VFDs. Refer to Section 23 05 13.
  - 3. No equipment shall be selected or operate above 90% of its motor nameplate rating.

4. Motor shall have 1.15 service factor.
5. ECM motors may be provided.

## 2.11 ELECTRICAL

- A. Provide with single point power connection to service all controls, dampers, outlet, and fans, complete with non-fused disconnect switch, short circuit protection of all internal electrical components, and all necessary motor starters, contactors, and over-current protection, transformer, and convenience outlet.
- B. All units must be so constructed that when the electrical section access panel is opened, all electrical power to the unit (with the exception of the 120 volt duplex convenience outlet) is disconnected by means of a single disconnect.
- C. All wiring must be labeled, numbered, and terminate in "spade clips". All terminal strips must be keyed to the wiring numbers. Each control device must be permanently labeled to indicate its function.
- D. Wiring diagrams for all circuits must be permanently affixed to the inside of the electrical section access panel. The markings of terminal strips and wiring must agree with the numbering on the wiring diagrams.
- E. All units shall include a transformer for controls and convenience outlet.
- F. Only one power cable connection to the unit shall be necessary.
- G. Motor shall include phase failure protection and prevent the motor from operation in the event of phase loss.

## 2.12 OPERATING CONTROLS - SINGLE ZONE UNITS

- A. Provide low limit sequence to close outside air dampers and stop supply fan.
- B. Dehumidification Controls: Maintain the relative humidity setpoint with the hot refrigerant gas reheat coil.

## 2.13 DDC TEMPERATURE CONTROLS

- A. Install standalone control module providing communication between unit controls and packaged DDC temperature control system.
- B. Control module shall be compatible with temperature control system specified in Section 23 09 00. Provide BACnet gateway for communication.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that roof is ready to receive work and opening dimensions are as indicated on shop drawings and illustrated by the manufacturer.

- B. Verify that proper power supply is available.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Mount units on factory built roof mounting curb and provide watertight enclosure to protect ductwork and utility services. Install unit level.
- C. All field wiring shall be in accordance with the National Electrical Code.
- D. P-traps must be provided for all drain pans.
- E. Comb all coils to repair bent fins.
- F. Contractor shall coordinate unit access stair and walkway placement to ensure compliance with OSHA requirements.

### 3.3 MANUFACTURER'S FIELD SERVICES

- A. Provide initial start-up and shutdown during first year of operation.

END OF SECTION 23 74 16.14

## SECTION 23 81 26 - SPLIT SYSTEM AIR CONDITIONING UNITS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Split system air conditioning units.

#### 1.2 SUBMITTALS

- A. Submit shop drawings under provisions of Section 23 05 00.
- B. Indicate drain, electrical, and refrigeration rough-in connections on shop drawings or product data.
- C. Submit manufacturer's installation instructions.

#### 1.3 DELIVERY, STORAGE, AND HANDLING

- A. Accept units and components on site in factory protective containers, with factory shipping skids and lifting lugs. Inspect for damage.
- B. Comply with manufacturer's installation instruction for rigging, unloading, and transporting units.
- C. Protect units from weather and construction traffic by storing in dry, roofed location until units are ready for immediate installation.

#### 1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A for the installation of computer room air conditioning units.
- B. Conform to ASHRAE 90.1 (latest published edition) - Energy Standard for Buildings Except Low-Rise Residential Buildings.

#### 1.5 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, installation instructions, and maintenance and repair data.

#### 1.6 WARRANTY

- A. Provide five (5) year manufacturer's warranty on all compressors.

## PART 2 - PRODUCTS

### 2.1 SPLIT SYSTEM WALL MOUNTED UNITS

#### A. Manufacturers:

1. Carrier/Toshiba
2. LG
3. Panasonic/Sanyo
4. Samsung
5. Daikin Applied
6. Trane/Mitsubishi
7. York/Hitachi
8. Lennox

#### B. Manufactured Units:

1. Provide packaged, air-cooled, factory assembled, pre-wired and pre-piped unit consisting of cabinet, fans, filters, remote condensing unit, and controls. Wall-mounted units shall be furnished with integral wall mounting bracket and mounting hardware.
2. Assemble unit for wall-mounted or ceiling installation with service access required.
3. Performance shall be as scheduled on the drawings.
4. Unit shall be rated per AHRI Standards 210/240 and listed in the AHRI directory as a matched system.
5. Provide unit with factory-supplied cleanable air filters.
6. The units shall be listed by Electrical Laboratories (ETL) in accordance with UL-1995 certification and bear the ETL label.
7. All wiring shall be in accordance with the National Electric Code (NEC).

#### C. Evaporator Cabinet and Frame:

1. Cabinet:
  - a. Refer to schedule on drawings for mounting type (wall-mounted).
  - b. Exposed units shall have a finished appearance with concealed refrigerant piping, condensate drain piping, and wiring connections.

#### D. Evaporator Fans and Motors:

1. Fans:
  - a. The evaporator fan shall be direct drive with a single motor having permanently lubricated bearings.
  - b. The fan shall be statically and dynamically balanced.
  - c. The indoor fan shall have at least three speeds.
2. Motor:
  - a. Direct driven, digitally controlled with multiple speeds. Permanently lubricated with internal overload protection.

E. Evaporator Coils (Direct Expansion):

1. Direct expansion cooling coil of seamless copper tubes expanded into aluminum fins.
2. Single refrigeration circuit with externally equalized expansion valve.
3. Coils shall be pressure tested at the factory.
4. A sloped, corrosion-resistant condensate pan with drain shall be provided under the coil.

F. Electrical Panel:

1. Service Connections, Wiring, and Disconnect Requirements: Conform to the National Electrical Code and local electrical codes.

G. Control:

1. The unit shall have a hard-wired 7-day programmable remote controller to operate the system. Provide wall mounting bracket for controller.
2. Remote controller shall have "automatic", "dry" (dehumidification), and "fan only" operating modes.
3. The remote controller shall have the following features:
  - a. On/Off power switch.
  - b. Mode Selector to operate the system in auto, cool, heat, fan, or dehumidification (dry) operation.
  - c. Fan Setting to provide multiple fan speeds.
  - d. Swing Louver for adjusting supply louver discharge.
  - e. On/Off Timer for automatically switching the unit off or on.
  - f. Temperature Adjustment allows for the increase or decrease of the desired temperature.
  - g. Powerful Operation to allow quick cool down or heating up in the desired space to achieve maximum desired temperature in the shortest allowable time.
4. The remote controller shall perform fault diagnostic functions that may be system related, indoor or outdoor unit related depending on the fault code.
5. Temperature range on the remote controller shall be 64°F to 90°F in cooling mode and 50°F to 86°F in heating mode.
6. The indoor unit microprocessor shall have the capability to receive and process commands via return air temperature and indoor coil temperature sensors enabled by commands from the remote controller.
7. Integration: Manufacturer shall provide a BACnet interface with the building automation system in accordance with ASHRAE/ANSI Standard 135. This may be accomplished through a system integration panel or "gateway". Integration panels shall be provided as part of the split system.

H. Outdoor Unit:

1. General:
  - a. The outdoor unit shall be specifically matched to the corresponding indoor unit size. The outdoor unit shall be completely factory assembled and pre-wired with all necessary electronic and refrigerant controls.

2. Cabinet:
  - a. The outdoor unit shall be fabricated of galvanized steel, bonderized and coated with a baked enamel finish for corrosion protection.
3. Fan:
  - a. The fan shall be direct drive, propeller type fan with fan guard.
  - b. Fan blades shall be statically and dynamically balanced.
  - c. The fan shall have permanently lubricated type bearings.
  - d. Motor shall be protected by internal thermal overload protection.
  - e. Airflow shall be horizontal discharge.
4. Coil:
  - a. The outdoor coil shall be nonferrous construction with corrugated fin tube.
  - b. The coil shall be protected with an internal guard.
  - c. Refrigerant flow from the condenser shall be controlled via a metering device.
5. Compressor:
  - a. Hermetic or scroll refrigerant compressors with resilient suspension system, inverter driven, oil strainer, sight glass/moisture indicator, internal motor protection, high pressure switch, and crankcase heater.
  - b. The outdoor unit shall have an accumulator and four-way reversing valve.
6. Refrigerant:
  - a. Unit shall use R-410a.
  - b. The use of chlorofluorocarbon (CFC)-based refrigerants is prohibited.

I. Integral Condensate Pump:

1. Packaged unit matched to evaporator unit including float switch, pump, motor assembly, check valve, and reservoir.
2. Provide alarm to indicate high level reservoir.
3. Unit shall be powered from evaporator unit with appropriate field connections available.

J. Condensate Pump:

2.2 PIPING

A. Design Pressure: 450 psig; Maximum Design Temperature: 250°F

B. Type ACR Seamless Copper Tube Linesets; Brazed Joints:

1. 3/4" and under.
2. Tubing: Type ACR seamless copper tube linesets, ASTM B1003. Sizes indicated are nominal designation.
3. Joints: Brazed with silver solder.
4. Fittings: Wrought copper solder joint, ANSI B16.22.

5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged, and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.
6. Limitations:
  - a. Only between refrigerant splitter box and indoor terminal unit.

C. Type ACR Hard Drawn Seamless Copper Tube; Brazed Joint:

1. 4" and under.
2. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
3. Joints: Brazed with silver solder.
4. Fittings: Wrought copper solder joint, ANSI B16.22.
5. Special Requirements: All tubing shall be cleaned, dehydrated, pressurized with dry nitrogen, plugged and tagged by manufacturer "for refrigeration service". During brazing operations, continuously purge the interior of the pipe with nitrogen to prevent oxide formation.

D. Piping - 1-3/8" and Under; Dual Concentric Crimp Mechanical Press Connection (Contractor's Option):

1. Tubing: Type ACR hard drawn seamless copper tube, ASTM B280. Sizes indicated are nominal designation.
2. Joints: Dual concentric crimp band mechanical press connection.
3. Manufacturers:
  - a. Parker-Zoomlock
  - b. MaxiPro ACR
  - c. Nibco ACR Press

E. Refrigerant linesets are not permitted.

1. Provide manufacturer-packaged refrigerant linesets and accessories of sizes needed for installation. Verify lengths of piping required for installation.

## 2.3 INSULATION

- A. EPDM (NBR/PVC Blend is not permitted) elastomeric cellular foam; ANSI/ASTM C534; flexible plastic; 0.25 maximum 'K' value at 75°F, 25/50 flame spread/smoke developed rating when tested in accordance with ASTM E84 (UL 723). Minimum 1/2" thick for pipe sizes less than 1-1/4" and 3/4" thick for pipe sizes 1-1/4" and above. ROOF MOUNTING CURB
- A. Curb height as shown on drawings, minimum 14 gauge galvanized steel, one-piece construction, insulated, all welded, wood nailer.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that proper power supply is available.

### 3.2 INSTALLATION

#### A. General Installation Requirements:

1. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
2. Install units in accordance with manufacturer's instructions. Install all units level and plumb. Indoor units shall be installed using manufacturer's standard mounting hardware securely fastened to building structure.
3. Refer to Section 23 05 29 for roof support rails for outdoor unit.
4. Coordinate the exact mounting location of all indoor and outdoor units with architectural and electrical work. Coordinate installation of ceiling-mounted units with ceiling grid layout. Provide additional ceiling grid reinforcement or modification as required and coordinate the work with the GC. Locate the indoor unit where it is readily accessible for maintenance and filter changes. Where outdoor units are located on the roof, locate at least 10' from the roof edge.
5. Verify locations of wall-mounted remote controllers with drawings and room details before installation. Coordinate mounting heights to be consistent with other wall-mounted devices. Height above finished floor shall not exceed 48".

#### B. Condensate Removal:

1. Install condensate piping with trap and route from drain pan to nearest drain. Discharge to nearest code-approved receptor or to a properly vented indirect waste fitting. Flush all piping before making final connections to units.

#### C. Comb all coils to repair bent fins.

#### D. Install new filters in the unit at Substantial Completion.

#### E. A factory-authorized service agent shall assist in commissioning the unit and inspecting the installation prior to startup. Submit startup report with O&M manuals.

### 3.3 REFRIGERANT PIPING

- A. Install refrigerant piping from the indoor unit(s) to the condensing unit. Refrigerant pipe sizes, lengths, specialties and configurations shall be as recommended by the manufacturer. Evacuate refrigerant piping and fully charge system with refrigerant per manufacturer's requirements.
- B. Provide weather-tight insulated roof curb to accommodate refrigerant piping and conduit roof penetrations.
- C. Insulate all refrigerant piping. Both liquid and suction lines shall be insulated between the indoor and outdoor units.

D. Joining of Piping:

1. Brazed Joints:

- a. Make up joints with brazing filler metal conforming to ANSI/AWS A5.8. Cut copper tubing ends perfectly square and remove all burrs inside and outside. Thoroughly clean sockets of fittings and ends of tubing to remove all oxide, dirt, and grease just prior to brazing. Apply flux evenly, but sparingly, to all surfaces to be joined. Brazing filler metal with a flux coating may also be used. Heat joints uniformly to proper brazing temperature so braze filler metal flows to all mated surfaces. Wipe excess braze filler metal, leaving a uniform fillet around cup of fitting.
- b. Flux shall conform to ANSI/AWS A5.31.
- c. Remove composition discs and all seals during brazing if not suitable for a minimum of 840°F or greater than the melting temperature of the brazing filler metal, whichever is greater.

2. Mechanical Press Connection:

- a. Copper press fitting shall be made in accordance with the manufacturer's installation instructions.
- b. Examination: Upon delivery to the jobsite, examine copper tubing and fittings for debris, defects, incise marks (manufacturer's engraving on tube), holes, or cracks.
- c. Fully insert tubing into the fitting and mark tubing.
- d. Prior to making connection, the fitting alignment shall be checked against the mark made on the tube to ensure the tubing is fully engaged in the fitting.
- e. Joint shall be pressed with a tool approved by the manufacturer.
- f. Installers shall be trained by manufacturer personnel or representative. Provide documentation upon request.

E. Insulation:

1. Insulate all refrigerant pipes between the heat pump and indoor units. This includes the liquid pipe, the suction pipe, the hot gas pipe, and the high/low pressure gas pipe. All fittings, valves, and specialty refrigerant components in the piping between the indoor and heat pump units shall also be insulated. The insulation shall have a continuous vapor barrier and shall pass through hangers and supports unbroken. All exterior insulated piping shall be painted with minimum of one (1) coat of UV resistant paint. Over size hangers and supports to allow the insulation to pass through unbroken. Following are the minimum insulation thicknesses unless noted otherwise in the manufacturer's literature or required by local AHJ:
  2. ASHRAE 2016:
  3. IECC 2018:
    - a. Refrigerant Suction (40°F & Below):
      - 1) Up to 1": 1/2"
      - 2) 1" and up: 1"

- b. Refrigerant Suction (41°F to 60°F):
  - 1) Up to 1-1/2": 1/2"
  - 2) 1-1/2" and up: 1"
- c. Refrigerant Low Pressure Gas (141°F-200°F):
  - 1) Up to 1-1/2": 1-1/2"
  - 2) 1-1/2" and up: 2"
- d. Refrigerant High Pressure Gas (201°F-250°F):
  - 1) Up to 4": 2-1/2"
- e. Refrigerant Liquid:
  - 1) Up to 1-1/2": 1"
  - 2) 1-1/2" and up: 1-1/2"

END OF SECTION 23 81 26

## SECTION 23 82 00 - TERMINAL HEAT TRANSFER UNITS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Finned Tube Radiation.
- B. Unit Heaters.
- C. Cabinet Heaters.
- D. Fan Coil Units.
- E. Unit Ventilators - Horizontal Type

#### 1.2 QUALITY ASSURANCE

- A. All filters shall be UL listed Class 1 or Class 2.
- B. All electrical equipment shall have a UL label.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00.
- B. Submit catalog data including arrangements, cross sections of cabinets, grilles, bracing, typical elevations.
- C. Submit schedules of equipment and enclosures indicating length, number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, and comparison of specified to actual heat output.
- D. Indicate mechanical and electrical service locations and requirements. Show deviations from scheduled products.
- E. Submit manufacturers' installation instructions.
- F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

#### 1.4 DELIVERY, STORAGE AND HANDLING

- A. Protect units from physical damage by storing in protected areas and leaving factory covers in place.

#### 1.5 REGULATORY REQUIREMENTS

- A. Conform to ASHRAE 90.1.

## 1.6 OPERATION AND MAINTENANCE DATA

- A. Submit manufacturer's operation and maintenance data. Include operating, installation, maintenance and repair data, and parts listings.

## PART 2 - PRODUCTS

### 2.1 FINNED TUBE RADIATION - WALL HUNG

- A. Cabinets shall be 14 gauge steel with baked enamel finish.
- B. Final color selection shall be by the Architect.
- C. Element hangers shall be quiet operating, cradle type.
- D. Cabinet top shall be continuously supported on wall mounting strips. Lower front face of cabinet shall be secured to the enclosure brackets.
- E. All cabinet and accessories shall be securely connected with no exposed fasteners.
- F. Provide end caps, corner pieces, adjustable extensions, etc. as required for proper appearance and service.
- G. Provide custom cabinet at corners where, in the Architect/Engineer's opinion, standard fittings will not fit correctly or have acceptable appearance. Custom cabinet shall be 14 gauge sheet metal with finish and shape to match manufacturer's cabinet. Submit drawings of each custom cabinet for approval.
- H. Provide removable cabinet sections at all control valves. It shall not be necessary to remove several sections to maintain control valves.
- I. Support 1/2" tubes on 36" centers and larger tubes on 48" centers.
- J. Elements shall be copper tube with aluminum fins.
- K. Cabinet size, element length, and element size shall meet the scheduled capacities, but not be less than the sizes scheduled.
- L. Products:
  - 1. Vulcan 'Linovector.'
  - 2. Sterling 'Versa-Line.'
  - 3. Zehnder-Rittling 'Regency.'
  - 4. Shaw-Perkins 'Crown-Line.'

### 2.2 UNIT HEATERS

- A. Casings shall be heavy gauge steel with a baked finish.
- B. Coils shall have copper heads and tubes, and aluminum fins.

- C. Units shall have threaded pipe connections for hanger rods.
- D. Fans shall be direct drive propeller type, factory balanced, with fan guards and totally enclosed motors with integral thermal overload protection.
- E. Horizontal units shall have adjustable outlet air louvers.
- F. Provide unit mounted and wired disconnects. Contractor shall be responsible for providing and wiring disconnect when using a manufacturer who does not provide factory mounted option.
- G. Products:
  - 1. Trane - S or P.
  - 2. Daikin - UHH or UDH.
  - 3. Modine - HS or V.
  - 4. Vulcan - HV or VV.
  - 5. Sterling HS or VS.
  - 6. Zehnder-Rittling - H or V.
  - 7. Sigma H or V.
  - 8. Airtherm HA or VA.

### 2.3 HOT WATER CABINET HEATERS

- A. Units shall include cabinet, fan, motor, coil, filter, inlet grille and discharge grille.
- B. Cabinets: 16 gauge exposed surfaces and 18 gauge concealed surfaces. Plastic exposed parts are not acceptable.
- C. Baked enamel finish. Color selected by Architect.
- D. All motors shall be three-speed permanent split capacitor with integral thermal overload protection.
- E. Coils shall have finned copper tubes.
- F. Provide 1" thick disposable filters or 1/2" thick washable 65% aluminum filters ahead of all coils.
- G. Provide a concealed unit mounted fan switch with "Off-High-Medium-Low" positions that doubles as disconnect.
- H. Manufacturers:
  - 1. Trane - 'Force-Flo.'
  - 2. Sterling, Modine.
  - 3. Zehnder-Rittling.
  - 4. Sigma.
  - 5. Vulcan.
  - 6. Airtherm.
  - 7. Beacon Morris.
  - 8. Daikin.

## 2.4 FAN COIL UNITS

- A. Units shall include cabinet, fan, motor, coils, filter and discharge grille.
- B. Exposed cabinets shall be minimum 18 gauge steel with baked enamel finish, color selected by the Architect and no plastic exposed parts.
- C. Fans: Centrifugal forward-curved, double-width with galvanized steel scrolls.
- D. All motors shall be three-speed permanent split capacitor with integral thermal overload protection.
- E. Coils shall have copper headers and tubes and aluminum fins.
- F. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
- G. Provide manufacturer provided condensate pumps for all horizontal fan coil units both ducted and non ducted applications. Wall mounted fan coil units shall include a condensate pump provided by manufacturer where noted on the drawings.
- H. Provide auxiliary drain pan to collect condensation in the valve compartment.
- I. Provide condensate level switch to prevent unit from operating if the drain becomes blocked.
- J. Provide condensate piping and tie into drainage system.
- K. Filters: 1" woven glass fiber disposable type.
- L. Provide a factory-installed manual switch disconnect with load side fuse to protect any fan coil units with a maximum overcurrent protection rating of 20 amps or less.
- M. Provide oversized left and right end piping compartments.
- N. Provide with tamperproof cabinet front.
- O. Provide with a motor cord quick disconnect.
- P. Units shall have separate heating and cooling coils.
- Q. Manufacturers:
  - 1. Daikin.
  - 2. Air-Therm.
  - 3. Trane
  - 4. IEC.
  - 5. Enviro-Tech/JCI.

6. Nailor.
7. Williams.
8. First Co.
9. Zehnder-Rittling.

## 2.5 UNIT VENTILATORS (TRADITIONAL HORIZONTAL TYPE)

- A. Unit shall be in a blow through configuration and shall utilize chilled water and/or heating water coils per the control specifications.
- B. Unit shall include cabinet, fan, motor, coil, filter, dampers, inlet grille, discharge grille, and outside air louver.
- C. Cabinets shall have 16 gauge front, top, bottom and sides, with exposed edges rounded.
- D. Baked enamel finish. Color selected by Architect.
- E. Removable front panels secured with camlock fasteners.
- F. Discharge Grilles: Heavy steel bars welded in place.
- G. Inlet grilles shall be removable for access to filters.
- H. Provide 6" false plenum back for all replacement unit ventilators.
- I. Outside air louver shall be extruded aluminum with bird screen on the back side.
- J. Provide wall sleeve for louver installation.
- K. Cabinets shall have space at both ends for coil piping.
- L. Unit shall have outside air and return air dampers. All dampers shall be gasketed for tight shutoff.
- M. Fans: Forward curved, double width, factory balanced, direct drive.
- N. Motors shall be two-speed permanent split capacitor type.
- O. Coils: Plate fin type with copper tubes and aluminum fins.
- P. Provide separate hot water and chilled water coils as scheduled on the drawings.
- Q. The heating coil is to be in the reheat position.
- R. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.

- S. Provide manufacturer provided condensate pumps for all unit ventilators.
- T. Provide 1" thick disposable filter upstream of the coil.
- U. Unit shall have valve to control discharge temperature. Refer to control section for further detail.
- V. Provide unit mounted disconnect/speed switch.
- W. Manufacturers:
  - 1. Daikin
  - 2. Trane.
  - 3. Engineered Air.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. General Installation Requirements:
  - 1. Install all products per manufacturers' instructions.
  - 2. Coordinate recess sizes for recessed equipment.
  - 3. Protect units with protective covers during construction.
  - 4. Comb all coils to repair bent fins.
- B. Fin Tube:
  - 1. Locate finned tube radiation as shown and run cover wall-to-wall, unless otherwise shown. Center elements under windows.
- C. Unit Heater:
  - 1. Hang unit heaters from building structure, not from piping. Mount as high as possible within manufacturer's recommended mounting height requirements. If unit heaters cannot be installed within manufacturer's recommended range, notify Architect/Engineer prior to mounting.
- D. Unit Ventilator:
  - 1. Coordinate exact locations of unit ventilators. Level units and support from structure.

### 3.2 CLEANING

- A. After construction is complete, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, with materials furnished by manufacturer.

C. Install new filters.

END OF SECTION 23 82 00

## SECTION 23 82 01 - BLOWER COIL UNITS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Blower Coil Unit.

#### 1.2 QUALITY ASSURANCE

- A. Unit: Manufacturer specializing in design and manufacturing of the products specified in this section with a minimum of five years' experience.
- B. Fabrication: Conform to AMCA 99 and ARI 430.
- C. Fan Performance Ratings: Conform to AMCA 210 and bear AMCA Certified Rating Seal.
- D. Sound Ratings: Tested to AMCA 300.
- E. Air Coils: Certify capacities, pressure drops, and selection procedures per ARI 410.
- F. Electrical control wiring shall be in accordance with NEC codes and ETL requirements.
- G. Unit shall contain only UL listed components.
- H. All products to be manufactured in America.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00. Indicate ratings, fan performance, motor electrical characteristics, gauges, material finishes, assembly, unit dimensions, weight loading, required clearances, construction details, and field connection details.
  - 1. Product Data
    - a. Provide fan curves with specified operating point clearly plotted. Select fans using external static pressure noted in the schedule. Manufacturer responsible for calculation of internal static pressure. Manufacturer shall include an allowance for clean filters in the internal static pressure. An allowance for the difference between dirty filters and clean filters is included in the external static. Submit static pressure calculations showing total pressure drops, including tabulated internal pressure drops and specified external static pressure drops
    - b. Submit shop drawings indicating coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions
    - c. Submit manufacturer's data showing that coil capacities, pressure drops, and selection procedures meet or exceed specified requirements.
    - d. Provide a copy of data of filter media, filter performance data, filter assembly, and filter frames with unit submittal for reference only.
  - B. Submit manufacturer's installation instructions.

- C. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site with protective coverings in-place. Loose shipped items must be in factory-provided protective coverings, with factory-installed shipping skids and lifting lugs.
- B. Store unit in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

#### 1.5 WARRANTY

- A. Provide a manufacturer's 1-year parts and labor warranty against defects in material and workmanship.

#### 1.6 EXTRA STOCK

- A. Provide clean filters in all units at time of installation.
- B. Provide clean filters in all units at project final completion after all interior finishes are complete.
- C. Provide one additional set of replacement filters for all units. Deliver to Owner at job site.

### PART 2 - PRODUCTS

#### 2.1 BLOWER COILS

- A. Acceptable Manufacturers
  - 1. Trane
  - 2. Nailor
  - 3. IEC – International Environmental
  - 4. JCI/Superior Rex
  - 5. ETI
  - 6. Daikin
- B. Housing:
  - 1. Minimum 18 gauge G60 galvanized steel exterior panels reinforced and braced with galvanized steel framework.
  - 2. Removable access panels for coil and fan removal.
  - 3. Install a stainless steel drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62. Extend drain pans the entire width of each coil, including piping and header if in the air stream, and from the upstream face of each coil to a distance 1/2 of the vertical coil height downstream from the downstream face. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
  - 4. Units shall be draw-thru and shall not exceed the overall dimensions.

C. Fan:

1. Double width, double inlet, forward curved centrifugal.
2. Fan RPM shall not exceed 110% of scheduled value with the scheduled wheel type. Substitution of BI or BIA fans for FC is acceptable if efficiency is not lower.
3. Statically and dynamically balanced.
4. Grease lubricated ball bearings, selected for 200,000 hours L-50 life at the design operating conditions.
5. Provide approved belt guards with openings for tachometer readings for external drives only.
6. Fan(s) shall have internal spring isolators.

D. Motors and Drives:

1. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.
2. Motor mounting bracket shall be adjustable to allow tightening of belts.
3. Motors shall be open drip-proof or TEFC type with grease lubricated bearings.
4. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. On units over 20 HP, use fixed sheaves. This Contractor shall provide replacement sheaves and belts as required to allow final air balancing.
5. No equipment shall be selected or operate above 90% of its motor nameplate rating.

E. Coils

1. Hot Water Coils:
  - a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
  - b. Suitable for continuous operation at 200 psi. Maximum air velocity of 1000 fpm.
  - c. Copper insulated casing. Coil headers and U-bends shall not be exposed.
  - d. Size coils sized based on EWT, EAT, gpm and cfm as scheduled. LAT shall be at least as high as scheduled. APD and WPD shall not exceed scheduled values.
  - e. Install coils level to allow drainage.

2. Chilled Water Coils:
  - a. Extended surface type with seamless copper tubes and continuous plate type aluminum fins.
  - b. copper insulated casing. Coil headers and U-bends shall not be exposed.
  - c. Maximum air velocity of 500 fpm.
  - d. Coils shall be sized based on EWT, EAT, gpm and cfm as scheduled. The leaving DB, leaving WB, APD and WPD shall not exceed the scheduled values.
  - e. Suitable for 200 psig operation.

F. Filter Section

1. Provide an angle filter section for 1" thick filters. Provide hinged access doors.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install per manufacturer's instructions.
- B. Comb all coils to repair bent fins.
- C. During construction provide temporary closures of metal or taped polyethylene over openings into housing ducts to prevent dust from entering ductwork.
- D. Seal all contractor installed penetrations airtight. Seal all openings prior to cleaning. Seal holes with proper SMACNA closures conforming to pressure class of the housing.
- E. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 23 82 01

## SECTION 23 84 19.01 - POOL DEHUMIDIFICATION UNIT (FLINN AND EAST HIGH SCHOOL)

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pool Dehumidification Unit. (Flinn and East High School)

#### 1.2 QUALITY ASSURANCE

- A. Fan Performance: Bear AMCA Certified Rating Seal - Air Performance.
- B. Fabrication: Conform to AMCA 99 and AHRI 430.
- C. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.
- D. Pool Dehumidification Unit: Product of manufacturer regularly engaged in production of components who issues complete catalog data on total product.
- E. Unit Components: All internal components of the pool dehumidification unit such as fans, motors, coils, casing, frame, etc. shall be suitable for a pool environment without corrosion.
- F. Conform to ASHRAE 90.1.
- G. All air handling and distribution equipment mounted outdoors shall be designed to prevent rain intrusion into the air stream when tested at design air flow and with no air flow, using the rain test apparatus described in Section 58 of UL 1995.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00.
- B. Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.
- C. Provide fan curves with specified operating point clearly plotted.
- D. Submit manufacturer's installation instructions.
- E. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.
- F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

### PART 2 - PRODUCTS

#### 2.1 POOL DEHUMIDIFICATION UNIT

- A. Housing:
  - 1. Designed for outdoor installation. Thermally broken construction designed to prevent condensate from forming on the exterior surface of the air handling unit

casing at an exterior temperature of 95°FDB and 78°FWB and an interior air temperature of 55°FDB.

2. SMACNA leakage class rating of 5.0.
3. Unit shall ship in one piece. 10 gauge coated welded steel structural base with lifting lugs. 22 gauge painted steel pitched roof. Frame and panel construction with aluminum structural tube framing members. Panels shall be able to be removed without affecting the integrity of the casing structure.
4. Maximum panel deflection shall not exceed L/250 at design total static pressure.
5. 2" thick double wall thermal-break panels, 22 gauge painted steel outer wall, 0.04" aluminum inner wall, foam injected insulation, minimum R-13 insulation value for walls and ceilings.
6. 2" thick paneled floor construction with 0.063" flat aluminum walk-on surface and 22 gauge galvanized steel underside of paneled floor not exposed to airstream, foam injected insulation.
7. Safety grating at supply/return air openings in unit floor.
8. Install sealing collars to the interior and exterior of each penetration to prevent air leakage where coil piping, air vents, drain piping, and electrical conduits penetrate the air handling unit casing. Silicone sealants and duct sealants are not acceptable to seal casing penetrations.
9. Double wall insulated and lockable access doors with corrosion resistant compression latches. Doors shall have pressure relief safety latches.
10. Outside air inlet and exhaust air outlet with weather hood and aluminum bird screen.
11. Corrosion resistant materials and coatings on all components for pool unit construction.

B. Fans:

1. Airfoil plenum fans, welded aluminum wheel, statically and dynamically balanced, direct drive assembly, corrosion resistant coatings.
2. Spring isolated fan/motor base, flex connectors at fan inlet
3. AMCA certified ratings for sound and performance.

C. Motors and Drives:

1. Motors shall be per Section 23 05 13.
2. TEFC premium efficiency motors, VFD rated with class F insulation, shaft grounding provided on each motor.

D. Direct Expansion Coils:

1. Evaporator Coil
  - a. Rated in accordance with AHRI 410-2001.
  - b. Suitable for 250 psig operation. Maximum air velocity of 550 fpm.
  - c. Coil with galvanized steel casing, 0.016" thick copper tubes and aluminum fins.
  - d. Coils shall have saturated suction temperature, EAT and cfm as scheduled. Leaving DB, WB, and APD shall not exceed scheduled values.
  - e. Maximum 144 fins per foot. No water carryover shall occur at design airflow and no anti-carryover coating shall be used.

- f. Protect entire coil from chlorine with corrosion resistant coating. Fin-only coating is not acceptable.
  - g. Install an aluminum drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot.
2. Hot Gas Reheat Coil:
- a. Coil with galvanized steel casing, 0.016" thick copper tubes and aluminum fins.
  - b. Coated coil construction, same as the evaporator coil.
  - c. Maximum 144 fins per foot.
  - d. Modulating control valve.
- E. Exterior Condensing Section:
- 1. Construct condenser coils of aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits with liquid accumulators. Air test under water to 425 psig.
  - 2. Hermetic scroll compressors, condenser coils, and vertical discharge propeller condenser fans with fan guard on discharge and factory mounted, louvered, galvanized steel coil guard panels.
  - 3. Provide fan motors with permanently lubricated ball bearings and built-in current and overload protection.
- F. Indirect Fired Furnace:
- 1. Indirect fired inshot gas furnace, 409SS heat exchanger tubes, 10:1 turndown.
  - 2. ETL listed per ANSI Z83.8 standards.
- G. Heat Recovery:
- 1. Aluminum sensible cross flow plate heat exchanger. Aluminum frame, aluminum plates, aluminum drain pan.
  - 2. Magnehelic pressure gauges.
- H. Filters:
- 1. Outside air filter: Angle filter section for 2" thick pleated MERV 8 filters with aluminum side access filter rack.
  - 2. Return air filter: Angle filter section for 2" thick aluminum filter.
  - 3. Provide magnehelic pressure gauges and dirty filter indicator switches for all filter banks.

I. Dampers:

1. Outside air inlet: galvanized steel formed blade, galvanized steel frame, modulating actuator.
2. Exhaust air outlet: aluminum airfoil blade, aluminum frame, two position actuator.
3. Plate heat exchanger face and bypass: galvanized steel formed blade, galvanized steel frame, modulating actuator.
4. Recirculation: aluminum airfoil blade, aluminum frame, modulating actuator.
5. AMCA certified performance, synthetic bearings, leakage rating of 3cfm/ft<sup>2</sup> at 1" w.g.

J. Controls:

1. Provide fully programmed packaged controller to maintain space temperature and humidity.
2. Sensors/transducers/switches provided and installed along with interface card for communication with the building facility management control system (FMCS).
3. In normal operation, the pool dehumidification unit shall maintain pool area at a negative pressure with respect to the rest of the building. Modulating outside air, return and exhaust air dampers shall be used to minimize total energy consumption.
4. Provide 100% outside air purge cycle controls capable of supply and exhaust fan operation. The unit shall be capable of purge cycle with full heating down to -20 °F outside air temperature. The pool dehumidification unit shall maintain the pool area at a negative pressure during purge cycle.
5. Safety controls shall include high and low refrigerant pressure switches.

K. Electrical:

1. Unit ETL listed as a complete package and factory wired to unit mounted NEMA 3R control panel.
2. Major electrical components UL listed (non-fused disconnect switch, control circuit fusing, control circuit transformer, fan motor starters, overloads, etc).
3. Power wiring enclosed in conduit.
4. Single point power connection.
5. Unit shall have a short circuit current rating (SCCR) of 5 kA.
6. LED light strips in all sections wired to a single light switch, 120V transformer included to power lighting circuit.
7. GFCI duplex service outlet, 120V transformer included to power the circuit.
8. Unit has phase/voltage protection.

L. Variable Frequency Drives:

1. Provided and installed by unit manufacturer. Refer to Section 26 29 23 for requirements.

M. Acceptable Manufacturers: Innovent, Munters, Annexair.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install per manufacturer's instructions.
- B. Install unit on 36" tall curb to allow for routing ductwork inside the curb.
- C. Comb all coils to repair bent fins.
- D. Unit startup shall be by qualified manufacturer's representative and shall demonstrate all modes of unit operation to owner's representative.

### 3.2 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 23 84 19

## SECTION 23 84 19.02 - POOL DEHUMIDIFICATION UNIT (LINCOLN)

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Pool Dehumidification Unit. (Lincoln)

#### 1.2 QUALITY ASSURANCE

- A. Fan Performance: Bear AMCA Certified Rating Seal - Air Performance.
- B. Fabrication: Conform to AMCA 99 and AHRI 430.
- C. Air Coils: Certify capacities, pressure drops, and selection procedures per AHRI 410.
- D. Pool Dehumidification Unit: Product of manufacturer regularly engaged in production of components who issues complete catalog data on total product.
- E. Unit Components: All internal components of the pool dehumidification unit such as fans, motors, coils, casing, frame, etc. shall be suitable for a pool environment without corrosion.
- F. Conform to ASHRAE 90.1.

#### 1.3 SUBMITTALS

- A. Submit shop drawings per Section 23 05 00.
- B. Indicate assembly, unit dimensions, weight loading, required clearances, construction details, field connection details, capacities, ratings, fan performance, motor electrical characteristics, and gauges and finishes of materials.
- C. Provide fan curves with specified operating point clearly plotted.
- D. Submit manufacturer's installation instructions.
- E. Submit operation and maintenance data. Include instructions for lubrication, filter replacement, motor and drive replacement, and spare parts lists.
- F. Submit electrical power/controls wiring diagrams and product data indicating general assembly, components, safety controls, and service connections.

#### 1.4 EXTRA STOCK

- A. Install clean 4" MERV 13 efficiency filters in units at time of final completion.
- B. Provide one additional set of replacement filters for all units.

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs.
- B. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

## PART 2 - PRODUCTS

### 2.1 POOL DEHUMIDIFICATION UNIT

#### A. Housing:

- 1. Heavy gauge steel reinforced and braced with steel angle framework.
- 2. 18 gauge paintable galvanized sheet steel, cleaned and painted with enamel paint.
- 3. Removable access panels for coil and fan removal.
- 4. Insulate coil and fan section interiors with 1" thick, 3/4 lb. density fiberglass.
- 5. Provide insulated, corrosion resistant drain pan under coil and fan sections.
- 6. Provide minimum 12" x 18" hinged access doors on both sides of the fan housing.

#### B. Fans:

- 1. Double width, double inlet, airfoil centrifugal, statically and dynamically balanced.
- 2. Grease lubricated ball bearings, selected for 200,000 hours L-50 life at the design operating conditions. Provide extended lubrication lines for all bearings to an easily accessible location.
- 3. Provide OSHA belt guards with openings for tachometer readings.

#### C. Motors and Drives:

- 1. Motors shall be per Section 23 05 13.
- 2. Motors shall have slide rails, adjusting screws, anchor bolts and bedplates.
- 3. Motor mounting bracket shall be adjustable to allow tightening of belts.
- 4. Drives shall be V-belt type with adjustable pitch sheaves for units 20 HP and below. Use fixed sheaves on larger units. Contractor shall provide replacement sheaves and belts as required for air balancing.

#### D. Provide an acoustically lined discharge plenum enclosing the motor and drive assembly.

#### E. Water Coils:

- 1. Extended surface type with seamless copper tubes and continuous plate type aluminum fins. Maximum 120 fins per foot. Minimum 0.035" tube wall thickness.
- 2. Suitable for continuous operation at 200 psi. Maximum air velocity of 800 fpm.
- 3. Galvanized steel casing.
- 4. AHRI rated with 0.0005 fouling factor.
- 5. Coils shall have EWT, EAT, gpm and cfm as scheduled. LAT shall be at least as high as scheduled. APD and WPD shall not exceed scheduled values.

6. Coils shall have drain and vent connections at supply and return headers with valves. Locate valves outside of the unit casing.
7. Install coils level to allow drainage.
8. Headers and pipe connectors shall be copper or brass for use in copper piping systems or cast iron with ferrous pipe connectors for use in steel piping systems. If header material does not match piping material, use dielectric fittings.
9. Protect entire coil from chlorine with Heresite or Vinyl Chloride Acetate Copolymer coating. Fin-only coating is not acceptable.
10. Maximum 144 fins per foot (472 fins per meter). No water carryover shall occur at design airflow and no anti-carryover coating shall be used.
11. Install a drain pan under each cooling coil meeting requirements as outlined in ASHRAE 62.1. The drain pans shall extend the entire width of each coil, including piping and header if in the air stream. The length shall be as necessary to limit water droplet carryover beyond the drain pan to 0.0044oz per ft<sup>2</sup> (1.3 g/m<sup>2</sup>) of face area per hour under peak sensible and peak dew point design conditions, considering both latent load and coil face velocity. Pitch drain pans in two directions towards the outlet, with a slope of at least 1/8" per foot (10 mm per meter).

F. Heat Recovery:

1. Plate heat exchanger.

G. Filters:

1. Provide an angle filter section for 2 thick MERV 13 filters. Maximum filter velocity shall not exceed specified value. Provide full size hinged access doors.
2. Provide separate filters for outdoor air and return air.

H. Controls:

1. Provide thermostat and humidistat. Thermostat shall cycle system to maintain space temperature. Humidistat shall cycle system to maintain space humidity.
2. Provide guards for thermostat and humidistat.
3. In normal operation, the pool dehumidification unit shall maintain pool area at a negative pressure with respect to the rest of the building. Modulating outside air, return and exhaust air dampers shall be used to minimize total energy consumption.
4. Provide 100% outside air purge cycle manual controls capable of supply and exhaust fan operation. The unit shall be capable of purge cycle with full heating down to -15°F outside air temperature. The pool dehumidification unit shall maintain the pool area at a negative pressure during purge cycle.
5. Safety controls shall include high and low refrigerant pressure switches and internal overheating protection on electric coils.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install per manufacturer's instructions.
- B. Assemble units by bolting sections together.

- C. Install on vibration isolators as scheduled on the drawings or in Section 23 05 48.
- D. Comb all coils to repair bent fins.
- E. Unit startup shall be by qualified manufacturer's representative and shall demonstrate all modes of unit operation to owner's representative.

### 3.2 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

END OF SECTION 23 84 19

## SECTION 26 05 00 - BASIC ELECTRICAL REQUIREMENTS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Requirements applicable to all Division 26 Sections. Also refer to Division 1 - General Requirements. This section is also applicable to Fire Alarm and Detection Systems Section 28 31 00.
- B. All materials and installation methods shall conform to the applicable standards, guidelines and codes referenced herein and within each specification section.

#### 1.2 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)

#### 1.3 SCOPE OF WORK

- A. This Specification and the associated drawings govern furnishing, installing, testing and placing into satisfactory operation the Electrical Systems.
- B. The Contractor shall furnish and install all new materials as indicated on the drawings, and/or in these specifications, and all items required to make the portion of the Electrical Work a finished and working system.
- C. Description of Systems shall be as follows:
  - 1. Electrical power system to and including luminaires, equipment, motors, devices, etc.
  - 2. Electrical power service system from the Utility Company to and including service entrance equipment, distribution and metering.
  - 3. Grounding system.
  - 4. Fire alarm system.
  - 5. Wiring system for temperature control system as shown on the drawings.
  - 6. Wiring of equipment furnished by others.
  - 7. Removal work and/or relocation and reuse of existing systems and equipment.
  - 8. Telecommunications rough-in, as shown on drawings, for installation of telecommunications equipment by others under separate contract.
- D. Work Not Included:
  - 1. Telecommunications cabling will be by others, in raceways and conduits furnished and installed as part of the Electrical work.
  - 2. Temperature control wiring for plumbing and HVAC equipment (unless otherwise indicated) will be by other Contractors.

#### 1.4 OWNER FURNISHED PRODUCTS

- A. The Owner will supply the following items for installation and/or connection by this Contractor:
  - 1. Not applicable.
- B. The following items shall be relocated, installed and/or connected by this Contractor:
  - 1. Not applicable.
- C. The Owner will supply manufacturer's installation data for Owner-purchased equipment for this project.
- D. This Contractor shall make all electrical system connections shown on the drawings **or** required for fully functional units.
- E. This Contractor is responsible for all damage to Owner furnished equipment caused during installation.

#### 1.5 WORK SEQUENCE

- A. All work that will produce excessive noise or interference with normal building operations, as determined by the Owner, shall be scheduled with the Owner. It may be necessary to schedule such work during unoccupied hours. The Owner reserves the right to determine when restricted construction hours are required.
- B. Schedule overtime hours for the following work:
  - 1. East High School: Existing 2000A, 208/120V, 3ph-4W distribution system to backfeed from new SB-MAIN-N via TR-570 when active.
- C. Itemize all work and list associated hours and pay scale for each item.

#### 1.6 ALTERNATES

- A. Alternate #1: East High School - All work associated with installing air conditioning within the existing air handling units that serve the Fieldhouse as shown on the drawings.>.
- B. Alternate #2: East High School - All work associated with replacing the existing HVAC system within the 1980 Addition as shown on the drawings. Base Bid will leave this area as existing to remain.

#### 1.7 DIVISION OF WORK BETWEEN MECHANICAL, ELECTRICAL, and CONTROL CONTRACTORS

- A. Division of work is the responsibility of the Prime Contractor. Any scope of work described at any location on the contract document shall be sufficient for including said requirement in the project. The Prime Contractor shall be solely responsible for determining the appropriate subcontractor for the described scope. In no case shall the project be assessed an additional cost

for scope that is described on the contract documents on bid day. The following division of responsibility is a guideline based on typical industry practice.

B. Definitions:

1. "Mechanical Contractors" refers to the Contractors listed in Division 21/22/23 of this Specification.
2. Motor Power Wiring: The single phase or 3 phase wiring extending from the power source (transformer, panelboard, feeder circuits, etc.) through disconnect switches and motor controllers to, and including the connections to the terminals of the motor.
3. Motor Control Wiring: The wiring associated with the remote operation of the magnetic coils of magnetic motor starters or relays, or the wiring that permits direct cycling of motors by means of devices in series with the motor power wiring. In the latter case, the devices are usually single phase, have "Manual-Off-Auto" provisions, and are usually connected into the motor power wiring through a manual motor starter.
4. Control devices such as start-stop push buttons, thermostats, pressure switches, flow switches, relays, etc., generally represent the types of equipment associated with motor control wiring.
5. Motor control wiring is single phase and usually 120 volts. In some instances, the voltage will be the same as the motor power wiring. When the motor power wiring exceeds 120 volts, a control transformer is usually used to give a control voltage of 120 volts.
6. Temperature Control Wiring: The wiring associated with the operation of a motorized damper, solenoid valve or motorized valve, etc., either modulating or two-position, as opposed to wiring that directly powers or controls a motor used to drive equipment such as fans, pumps, etc. This wiring will be from a 120-volt source and may continue as 120 volt, or be reduced in voltage (24 volt), in which case a control transformer shall be furnished as part of the temperature control wiring.
7. Control Motor: An electric device used to operate dampers, valves, etc. It may be two-position or modulating. Conventional characteristics of such a motor are 24 volts, 60 cycles, 1 phase, although other voltages may be encountered.
8. Low Voltage Technology Wiring: The wiring associated with the technology systems, used for analog or digital signals between equipment.
9. Telecommunications/Technology Rough-in: Relates specifically to the backboxes, necessary plaster rings and other miscellaneous hardware required for the installation or mounting of telecommunications/technology information outlets.

C. General:

1. The purpose of these Specifications is to outline the Electrical and Mechanical Contractors' responsibilities related to electrical work required for items such as temperature controls, mechanical equipment, fans, chillers, compressors, etc. The exact wiring requirements for much of the equipment cannot be determined until the systems have been selected and submittals approved. Therefore, the electrical drawings show only known wiring related to such items. All wiring not shown on the electrical drawings, but required for mechanical systems, is the responsibility of the Mechanical Contractor.
2. Where the drawings require the Electrical Contractor to wire between equipment furnished by the Mechanical Contractor, such wiring shall terminate at terminals provided in the equipment. The Mechanical Contractor shall furnish complete wiring diagrams and supervision to the Electrical Contractor and designate the terminal numbers for correct wiring.

3. The Electrical Contractor shall establish electrical utility elevations prior to fabrication and installation. The Electrical Contractor shall coordinate utility elevations with other trades. When a conflict arises, priority shall be as follows:
  - a. Luminaires.
  - b. Gravity flow piping, including steam and condensate.
  - c. Electrical bus duct.
  - d. Sheet metal.
  - e. Cable trays, including access space.
  - f. Other piping.
  - g. Conduits and wireway.

D. Mechanical Contractor's Responsibility:

1. Assumes responsibility for internal wiring of all equipment furnished by the Mechanical Contractor.
2. Assumes all responsibility for miscellaneous items furnished by the Mechanical Contractor that require wiring but are not shown on the electrical drawings or specified in the Electrical Specification. If items such as relays, flow switches, or interlocks are required to make the mechanical system function correctly or are required by the manufacturer, they are the responsibility of the Mechanical Contractor.
3. Assumes all responsibility for Temperature Control wiring, if the Temperature Control Contractor is a Subcontractor to the Mechanical Contractor.
4. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

E. Temperature Control Contractor's or Subcontractor's Responsibility:

1. Wiring of all devices needed to make the Temperature Control System functional.
2. Verifying any control wiring on the electrical drawings as being by the Electrical Contractor. All wiring required for the Control System, but not shown on the electrical drawings, is the responsibility of the Temperature Control Contractor or Subcontractor.
3. Coordinating equipment locations (such as PE's, EP's, relays, transformers, etc.) with the Electrical Contractor, where wiring of the equipment is by the Electrical Contractor.

F. Electrical Contractor's Responsibility:

1. Furnishes and installs all combination starters, manual starters and disconnect devices shown on the Electrical Drawings or indicated to be by the Electrical Contractor in the Mechanical Drawings or Specifications.
2. Installs and wires all remote-control devices furnished by the Mechanical Contractor or Temperature Control Contractor when so noted on the Electrical Drawings.
3. Furnishes and installs motor control and temperature control wiring, when noted on the drawings.
4. Furnishes, installs, and connects all relays, etc., for automatic shutdown of certain mechanical equipment (supply fans, exhaust fans, etc.) upon actuation of the Fire Alarm System.
5. This Contractor is responsible for coordination of utilities with all other Contractors. If any field coordination conflicts are found, the Contractor shall coordinate with other Contractors to determine a viable layout.

## 1.8 COORDINATION DRAWINGS

### A. Definitions:

1. Coordination Drawings: A compilation of the pertinent layout and system drawings that show the sizes and locations, including elevations, of system components and required access areas to ensure that no two objects will occupy the same space.
  - a. Mechanical trades shall include, but are not limited to, mechanical equipment, ductwork, fire protection systems, plumbing piping, medical gas systems, hydronic piping, steam and steam condensate piping, and any item that may impact coordination with other disciplines.
  - b. Electrical trades shall include, but are not limited to, electrical equipment, conduit 1.5" and larger, conduit racks, cable trays, pull boxes, transformers, raceway, busway, lighting, ceiling-mounted devices, and any item that may impact coordination with other disciplines.
  - c. Maintenance clearances and code-required dedicated space shall be included.
  - d. The coordination drawings shall include all underground, underfloor, in-floor, in chase, and vertical trade items.
2. Spaces with open/cloud ceiling architecture shall indicate the overhead utilities and locate equipment as required to maintain clearance above lights. The intent for the installation is to maintain a maximum allowable vertical clearance and an organized/clean manner in the horizontal. Notify Architect/Engineer of the maximum clearance which can be maintained. Failure to comply will result in modifications with no cost to Owner.
  - a. In cloud ceiling architecture, when open cabling/wire and/or cable tray crosses gaps between ceiling clouds and/or walls, cabling is to transition to conduits to span the gaps in order to conceal cabling from below.
3. The contractors shall use the coordination process to identify the proper sequence of installation of all utilities above ceilings and in other congested areas, to ensure an orderly and coordinated end result, and to provide adequate access for service and maintenance.

### B. Participation:

1. The contractors and subcontractors responsible for work defined above shall participate in the coordination drawing process.
2. One contractor shall be designated as the Coordinating Contractor for purposes of preparing a complete set of composite electronic CAD coordination drawings that include all applicable trades, and for coordinating the activities related to this process. The Coordinating Contractor for this project shall be the Mechanical Contractor.
  - a. The Coordinating Contractor shall utilize personnel familiar with requirements of this project and skilled as draftspersons/CAD operators, competent to prepare the required coordination drawings.

3. Electronic CAD drawings shall be submitted to the Coordinating Contractor for addition of work by other trades. IMEG will provide electronic file copies of ventilation drawings for contractor's use if the contractor signs and returns an "Electronic File Transfer" waiver provided by IMEG. IMEG will not consider blatant reproductions of original file copies an acceptable alternative for coordination drawings.

C. Drawing Requirements:

1. The file format and file naming convention shall be coordinated with and agreed to by all contractors participating in the coordination process and the Owner.
  - a. Scale of drawings:
    - 1) General plans: 1/4 Inch = 1'-0" (minimum).
    - 2) Mechanical, electrical, communication rooms, and including the surrounding areas within 10 feet: 1/2 Inch = 1'-0" (minimum).
    - 3) Shafts and risers: 1/2 Inch = 1'-0" (minimum).
    - 4) Sections of shafts and mechanical and electrical equipment rooms: 1/4 Inch = 1'-0" (minimum).
    - 5) Sections of congested areas: 1/2 Inch = 1'-0" (minimum).
2. Ductwork layout drawings shall be the baseline system for other components. Ductwork layout drawings shall be modified to accommodate other components as the coordination process progresses.
3. There may be more drawings required for risers, top and bottom levels of mechanical rooms, and shafts.
4. The minimum quantity of drawings will be established at the first coordination meeting and sent to the A/E for review. Additional drawings may be required if other areas of congestion are discovered during the coordination process.

D. General:

1. Coordination drawing files shall be made available to the A/E and Owner's Representative. The A/E will only review identified conflicts and give an opinion, but will not perform as a coordinator.
2. A plotted set of coordination drawings shall be available at the project site.
3. Coordination drawings are not shop drawings and shall not be submitted as such.
4. The contract drawings are schematic in nature and do not show every fitting and appurtenance for each utility. Each contractor is expected to have included in the bid sufficient fittings, material, and labor to allow for adjustments in routing of utilities made necessary by the coordination process and to provide a complete and functional system.
5. The contractors will not be allowed additional costs or time extensions due to participation in the coordination process.
6. The contractors will not be allowed additional costs or time extensions for additional fittings, reroutings or changes of duct size, that are essentially equivalent sizes to those shown on the drawings and determined necessary through the coordination process.
7. The A/E reserves the right to determine space priority of equipment in the event of spatial conflicts or interference between equipment, piping, conduit, ducts, and equipment provided by the trades.
8. Changes to the contract documents that are necessary for systems installation and coordination shall be brought to the attention of the A/E.

9. Access panels shall preferably occur only in gypsum board walls or plaster ceilings where indicated on the drawings.
  - a. Access to mechanical, electrical, technology, and other items located above the ceiling shall be through accessible lay-in ceiling tile areas.
  - b. Potential layout changes shall be made to avoid additional access panels.
  - c. Additional access panels shall not be allowed without written approval from the A/E at the coordination drawing stage.
  - d. Providing additional access panels shall be considered after other alternatives are reviewed and discarded by the A/E and the Owner's Representative.
  - e. When additional access panels are required, they shall be provided without additional cost to the Owner.
10. Complete the coordination drawing process and obtain sign-off of the drawings by all contractors prior to installing any of the components.
11. Conflicts that result after the coordination drawings are signed off shall be the responsibility of the contractor or subcontractor who did not properly identify their work requirements, or installed their work without proper coordination.
12. Updated coordination drawings that reflect as-built conditions may be used as record documents.

#### 1.9 QUALITY ASSURANCE

##### A. Contractor's Responsibility Prior to Submitting Pricing/Bid Data:

1. The Contractor is responsible for constructing complete and operating systems. The Contractor acknowledges and understands that the Contract Documents are a two-dimensional representation of a three-dimensional object, subject to human interpretation. This representation may include imperfect data, interpreted codes, utility guides, three-dimensional conflicts, and required field coordination items. Such deficiencies can be corrected when identified prior to ordering material and starting installation. The Contractor agrees to carefully study and compare the individual Contract Documents and report at once in writing to the Architect/Engineer any deficiencies the Contractor may discover. The Contractor further agrees to require each subcontractor to likewise study the documents and report at once any deficiencies discovered.
2. The Contractor shall resolve all reported deficiencies with the Architect/Engineer prior to awarding any subcontracts, ordering material, or starting any work with the Contractor's own employees. Any work performed prior to receipt of instructions from the Architect/Engineer will be done at the Contractor's risk.

##### B. Qualifications:

1. Only products of reputable manufacturers as determined by the Architect/Engineer are acceptable.
2. All Contractors and subcontractors shall employ only workmen who are skilled in their trades. At all times, the number of apprentices at the job site shall be less than or equal to the number of journeymen at the job site.

C. Compliance with Codes, Laws, Ordinances:

1. Conform to all requirements of the City of Rockford, Illinois Codes, Laws, Ordinances and other regulations having jurisdiction.
2. Conform to all published standards of Rockford Public Schools .
3. If there is a discrepancy between the codes and regulations and these specifications, the Architect/Engineer shall determine the method or equipment used.
4. If the Contractor notes, at the time of bidding, that any parts of the drawings or specifications do not comply with the codes or regulations, Contractor shall inform the Architect/Engineer in writing, requesting a clarification. If there is insufficient time for this procedure, Contractor shall submit with the proposal a separate price to make the system comply with the codes and regulations.
5. All changes to the system made after the letting of the contract to comply with codes or the requirements of the Inspector, shall be made by the Contractor without cost to the Owner.
6. If there is a discrepancy between manufacturer's recommendations and these specifications, the manufacturer's recommendations shall govern.
7. If there are no local codes having jurisdiction, the current issue of the National Electrical Code shall be followed.

D. Permits, Fees, Taxes, Inspections:

1. Procure all applicable permits and licenses.
2. Abide by all laws, regulations, ordinances, and other rules of the State or Political Subdivision where the work is done, or as required by any duly constituted public authority.
3. Pay all charges for permits or licenses.
4. Pay all fees and taxes imposed by State, Municipal, and other regulatory bodies.
5. Pay all charges arising out of required inspections by an authorized body.
6. Pay all charges arising out of required contract document reviews associated with the project and as initiated by the Owner or authorized agency/consultant.
7. Where applicable, all fixtures, equipment and materials shall be listed by Underwriter's Laboratories, Inc. or a nationally recognized testing organization.

E. Utility Company Requirements:

1. Secure from the private or public utility company all applicable requirements.
2. Comply with all utility company requirements.
3. The Owner shall make application for and pay for new electrical service equipment and installation. The Contractor shall coordinate schedule and requirements with the Owner and Utility Company.
4. The contractor is responsible for completing utility requested forms and sharing utility requested load data from the construction documents.
5. Furnish the metering Verify approved manufacturers and equipment with the Utility Company.
6. The Owner shall apply and pay for any changes for removal of existing electrical service by the utility company. The Contractor shall verify approved manufacturers and equipment with the Utility Company.

F. Examination of Drawings:

1. The drawings for the electrical work are completely diagrammatic, intended to convey the scope of the work and to indicate the general arrangements and locations of equipment, outlets, etc., and the approximate sizes of equipment.
2. Contractor shall determine the exact locations of equipment and rough-ins, and the exact routing of raceways to best fit the layout of the job. Conduit entry points for electrical equipment including, but not limited to, panelboards, switchboards, switchgear and unit substations, shall be determined by the Contractor unless noted in the contract documents.
3. Scaling of the drawings will not be sufficient or accurate for determining these locations.
4. Where job conditions require reasonable changes in arrangements and locations, such changes shall be made by the Contractor at no additional cost to the Owner.
5. Because of the scale of the drawings, certain basic items, such as junction boxes, pull boxes, conduit fittings, etc., may not be shown, but where required by other sections of the specifications or required for proper installation of the work, such items shall be furnished and installed.
6. If an item is either shown on the drawings or called for in the specifications, it shall be included in this contract.
7. The Contractor shall determine quantities and quality of material and equipment required from the documents. Where discrepancies arise between drawings, schedules and/or specifications, the greater and better-quality number shall govern.
8. Where used in electrical documents the word "furnish" shall mean supply for use, the word "install" shall mean connect up complete and ready for operation, and the word "provide" shall mean to supply for use and connect up complete and ready for operation.
9. Any item listed as furnished shall also be installed unless otherwise noted.
10. Any item listed as installed shall also be furnished unless otherwise noted.

G. Electronic Media/Files:

1. Construction drawings for this project have been prepared utilizing Revit.
2. Contractors and Subcontractors may request electronic media files of the contract drawings and/or copies of the specifications. Specifications will be provided in PDF format.
3. Upon request for electronic media, the Contractor shall complete and return a signed "Electronic File Transmittal" form provided by IMEG.
4. If the information requested includes floor plans prepared by others, the Contractor will be responsible for obtaining approval from the appropriate Design Professional for use of that part of the document.
5. The electronic contract documents can be used for preparation of shop drawings and as-built drawings only. The information may not be used in whole or in part for any other project.
6. The drawings prepared by IMEG for bidding purposes may not be used directly for ductwork layout drawings or coordination drawings.
7. The use of these CAD documents by the Contractor does not relieve them from their responsibility for coordination of work with other trades and verification of space available for the installation.
8. The information is provided to expedite the project and assist the Contractor with no guarantee by IMEG as to the accuracy or correctness of the information provided. IMEG accepts no responsibility or liability for the Contractor's use of these documents.

H. Field Measurements:

1. Verify all pertinent dimensions at the job site before ordering any conduit, conductors, wireways, bus duct, fittings, etc.

1.10 SUBMITTALS

A. Submittals shall be required for the following items, and for additional items where required elsewhere in the specifications or on the drawings.

1. Submittals list:

Referenced Specification Section	Submittal Item
26 05 35	Surface Raceways
26 09 33	Lighting Control System
26 12 19	Pad-Mounted, Liquid-Filled Transformers
26 22 00	Dry Type Transformers
26 24 13	Switchboards
26 24 16	Panelboards
26 24 19	Motor Control
26 27 26	Wiring Devices
26 28 13	Fuses
26 28 16	Disconnect Switches
26 29 23	Variable Frequency Drives
26 43 00	Surge Protection Devices
26 51 19	LED Lighting
28 31 00	Fire Alarm and Detection Systems
Drawings	Photocells

B. General Submittal Procedures: In addition to the provisions of Division 1, the following are required:

1. Transmittal: Each transmittal shall include the following:

- a. Date
- b. Project title and number
- c. Contractor's name and address
- d. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
- e. Description of items submitted and relevant specification number
- f. Notations of deviations from the contract documents
- g. Other pertinent data

2. Submittal Cover Sheet: Each submittal shall include a cover sheet containing:

- a. Date
- b. Project title and number
- c. Architect/Engineer

- d. Contractor and subcontractors' names and addresses
  - e. Supplier and manufacturer's names and addresses
  - f. Division of work (e.g., electrical, plumbing, heating, ventilating, etc.)
  - g. Description of item submitted (using project nomenclature) and relevant specification number
  - h. Notations of deviations from the contract documents
  - i. Other pertinent data
  - j. Provide space for Contractor's review stamps
3. Composition:
- a. Submittals shall be submitted using specification sections and the project nomenclature for each item.
  - b. Individual submittal packages shall be prepared for items in each specification section. All items within a single specification section shall be packaged together where possible. An individual submittal may contain items from multiple specifications sections if the items are intimately linked (e.g., pumps and motors).
  - c. All sets shall contain an index of the items enclosed with a general topic description on the cover.
4. Content: Submittals shall include all fabrication, erection, layout, and setting drawings; manufacturers' standard drawings; schedules; descriptive literature, catalogs and brochures; performance and test data; wiring and control diagrams; dimensions; shipping and operating weights; shipping splits; service clearances; and all other drawings and descriptive data of materials of construction as may be required to show that the materials, equipment or systems and the location thereof conform to the requirements of the contract documents.
5. Contractor's Approval Stamp:
- a. The Contractor shall thoroughly review and approve all shop drawings before submitting them to the Architect/Engineer. The Contractor shall stamp, date and sign each submittal certifying it has been reviewed.
  - b. Unstamped submittals will be rejected.
  - c. The Contractor's review shall include, but not be limited to, verification of the following:
    - 1) Only approved manufacturers are used.
    - 2) Addenda items have been incorporated.
    - 3) Catalog numbers and options match those specified.
    - 4) Performance data matches that specified.
    - 5) Electrical characteristics and loads match those specified.
    - 6) Equipment connection locations, sizes, capacities, etc. have been coordinated with other affected trades.
    - 7) Dimensions and service clearances are suitable for the intended location.
    - 8) Equipment dimensions are coordinated with support steel, housekeeping pads, openings, etc.
    - 9) Constructability issues are resolved (e.g., weights and dimensions are suitable for getting the item into the building and into place, sinks fit into countertops, etc.).

- d. The Contractor shall review, stamp and approve all subcontractors' submittals as described above.
  - e. The Contractor's approval stamp is required on all submittals. Approval will indicate the Contractor's review of all material and a complete understanding of exactly what is to be furnished. Contractor shall clearly mark all deviations from the contract documents on all submittals. If deviations are not marked by the Contractor, then the item shall be required to meet all drawing and specification requirements.
6. Submittal Identification and Markings:
- a. The Contractor shall clearly mark each item with the same nomenclature applied on the drawings or in the specifications.
  - b. The Contractor shall clearly indicate the size, finish, material, etc.
  - c. Where more than one model is shown on a manufacturer's sheet, the Contractor shall clearly indicate exactly which item and which data is intended.
  - d. All marks and identifications on the submittals shall be unambiguous.
- 7. Schedule submittals to expedite the project. Coordinate submission of related items.
  - 8. Identify variations from the contract documents and product or system limitations that may be detrimental to the successful performance of the completed work.
  - 9. Reproduction of contract documents alone is not acceptable for submittals.
  - 10. Incomplete submittals will be rejected without review. Partial submittals will only be reviewed with prior approval from the Architect/Engineer.
  - 11. Submittals not required by the contract documents may be returned without review.
  - 12. The Architect/Engineer's responsibility shall be to review one set of shop drawing submittals for each product. If the first submittal is incomplete or does not comply with the drawings and/or specifications, the Contractor shall be responsible to bear the cost for the Architect/Engineer to recheck and handle the additional shop drawing submittals.
  - 13. Submittals shall be reviewed and approved by the Architect/Engineer before releasing any equipment for manufacture or shipment.
  - 14. Contractor's responsibility for errors, omissions or deviation from the contract documents in submittals is not relieved by the Architect/Engineer's approval.

C. Electronic Submittal Procedures:

- 1. Distribution: Email submittals as attachments to all parties designated by the Architect/Engineer, unless a web-based submittal program is used.
- 2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
- 3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
- 4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. Submittal file name: 26 XX XX.description.YYYYMMDD
  - b. Transmittal file name: 26 XX XX.description.YYYYMMDD

5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.

#### 1.11 SCHEDULE OF VALUES

- A. The requirements herein are in addition to the provisions of Division 1.
- B. Format:
  1. Use AIA Document Continuation Sheets G703 or another similar form approved by the Owner and Architect/Engineer.
  2. Submit in Excel format.
  3. Support values given with substantiating data.
- C. Preparation:
  1. Itemize work required by each specification section and list all providers. All work provided by subcontractors and major suppliers shall be listed on the Schedule of Values. List each subcontractor and supplier by company name.
  2. Break down all costs into:
    - a. Material: Delivered cost of product with taxes paid.
    - b. Labor: Labor cost, excluding overhead and profit.
  3. Itemize the cost for each of the following:
    - a. Overhead and profit.
    - b. Bonds.
    - c. Insurance.
    - d. General Requirements: Itemize all requirements.
  4. For each line item having an installed cost of more than \$5,000, break down costs to list major products or operations under each item. At a minimum, provide material and labor cost line items for the following:
    - a. Each piece of equipment requiring shop drawings. Use the equipment nomenclature (SB-1, PANEL P-1, etc.) on the Schedule of Values.
    - b. Each type of small unitary equipment (e.g., FDS, FCS, CS, etc.). Multiple units of the same type can be listed together provided quantities are also listed so unit costs can be determined.
    - c. Each conduit system (medium voltage, normal, emergency, low voltage systems, etc.). In addition, for larger projects breakdown the material and labor for each conduit system based on geography (building, floor, and/or wing).
    - d. Fire alarm broken down into material and labor for the following:
      - 1) Engineering
      - 2) Controllers, devices, sensors, etc.
      - 3) Conduit
      - 4) Wiring
      - 5) Programming
      - 6) Commissioning

- e. Site utilities (5' beyond building)
- f. Seismic design
- g. Testing
- h. Commissioning
- i. Record drawings
- j. Punchlist and closeout

D. Update Schedule of Values when:

- 1. Indicated by Architect/Engineer.
- 2. Change of subcontractor or supplier occurs.
- 3. Change of product or equipment occurs.

1.12 CHANGE ORDERS

- A. A detailed material and labor takeoff shall be prepared for each change order, along with labor rates and markup percentages. Change orders with inadequate breakdown will be rejected.
- B. Change order work shall not proceed until authorized.

1.13 PRODUCT DELIVERY, STORAGE, HANDLING and MAINTENANCE

- A. Exercise care in transporting and handling to avoid damage to materials. Store materials on the site to prevent damage.
- B. Keep all materials clean, dry and free from damaging environments.
- C. Coordinate the installation of heavy and large equipment with the General Contractor and/or Owner. If the Electrical Contractor does not have prior documented experience in rigging and lifting similar equipment, he/she shall contract with a qualified lifting and rigging service that has similar documented experience. Follow all equipment lifting and support guidelines for handling and moving.
- D. Contractor is responsible for moving equipment into the building and/or site. Contractor shall review site prior to bid for path locations and any required building modifications to allow movement of equipment. Contractor shall coordinate the work with other trades.

1.14 NETWORK / INTERNET CONNECTED EQUIPMENT

- A. These specifications may require certain equipment or systems to have network, Internet and/or remote access capability ("Network Capability"). Any requirement for Network Capability shall be interpreted only as a functional capability and is not to be construed as authority to connect or enable any Network Capability. Network Capability may only be connected or enabled with the express written consent of the Owner.

1.15 WARRANTY

- A. Provide one-year warranty for all fixtures, equipment, materials, and workmanship.

- B. The warranty period for all work in this specification Division shall commence on the date of Substantial Completion or successful system performance whichever occurs later. The warranty may also commence if a whole or partial system or any separate piece of equipment or component is put into use for the benefit of any party other than the installing contractor with prior written authorization of the Owner. In this instance, the warranty period shall commence on the date when such whole system, partial system or separate piece of equipment or component is placed in operation and accepted in writing by the Owner.
- C. Warranty requirements extend to correction, without cost to the Owner, of all work found to be defective or nonconforming to the contract documents. The Contractor shall bear the cost of correcting all damage due to defects or nonconformance with contract documents excluding repairs required as a result of improper maintenance or operation, or of normal wear as determined by the Architect/Engineer.

#### 1.16 INSURANCE

- A. This Contractor shall maintain insurance coverage as set forth in Division 1 of these specifications.

#### 1.17 MATERIAL SUBSTITUTION

- A. Where several manufacturers' names are given, the manufacturer for which a catalog number is given is the basis for job design and establishes the quality.
- B. Equivalent equipment manufactured by the other listed manufacturers may be used. Contractor shall ensure that all items submitted by these other manufacturers meet all requirements of the drawings and specifications and fits in the allocated space. When using other listed manufacturers, the Contractor shall assume responsibility for any and all modifications necessary (including, but not limited to structural supports, electrical connections and rough-in, and regulatory agency approval, etc.) and coordinate such with other contractors. The Architect/Engineer shall make the final determination of whether a product is equivalent.
- C. Any material, article or equipment of other unnamed manufacturers which will adequately perform the services and duties imposed by the design and is of a quality equal to or better than the material, article or equipment identified by the drawings and specifications may be used if approval is secured in writing from the Architect/Engineer via addendum. The Contractor assumes all costs incurred as a result of using the offered material, article or equipment, on the Contractors part or on the part of other Contractors whose work is affected.
- D. Voluntary add or deduct prices for alternate materials may be listed on the bid form. These items will not be used in determining the low bidder. This Contractor assumes all costs incurred as a result of using the offered material or equipment on the Contractors part or on the part of other Contractors whose work is affected.
- E. All material substitutions requested after the final addendum must be listed as voluntary changes on the bid form.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. All items of material having a similar function (e.g., safety switches, panelboards, switchboards, contactors, motor starters, dry type transformers) shall be of the same manufacturer unless specifically stated otherwise on drawings or elsewhere in specifications.

## PART 3 - EXECUTION

### 3.1 JOBSITE SAFETY

- A. Neither the professional activities of the Architect/Engineer, nor the presence of the Architect/Engineer or the employees and subconsultants at a construction site, shall relieve the Contractor and any other entity of their obligations, duties and responsibilities including, but not limited to, construction means, methods, sequence, techniques or procedures necessary for performing, superintending or coordinating all portions of the work of construction in accordance with the contract documents and any health or safety precautions required by any regulatory agencies. The Architect/Engineer and personnel have no authority to exercise any control over any construction contractor or other entity or their employees in connection with their work or any health or safety precautions. The Contractor is solely responsible for jobsite safety. The Architect/Engineer and the Architect/Engineer's consultants shall be indemnified and shall be made additional insureds under the Contractor's general liability insurance policy.

### 3.2 EXCAVATION, FILL, BACKFILL, COMPACTION

- A. General:

1. Prior to the commencement of any excavation or digging, the Contractor shall verify all underground utilities with the regional utility locator. Provide prior notice to the locator before excavations. Contact information for most regional utility locaters can be found by calling 811.
2. The Contractor shall do all excavating, filling, backfilling, compacting, and restoration in connection with the work.

- B. Excavation:

1. Make all excavations to accurate, solid, undisturbed earth, and to proper dimensions.
2. If excavations are carried in error below indicated levels, concrete of same strength as specified for the foundations or thoroughly compacted sand-gravel fill, as determined by the Architect/Engineer shall be placed in such excess excavations under the foundation. Place thoroughly compacted, clean, stable fill in excess excavations under slabs on grade, at the Contractor's expense.
3. Trim bottom and sides of excavations to grades required for foundations.
4. Protect excavations against frost and freezing.
5. Take care in excavating not to damage surrounding structures, equipment or buried pipe. Do not undermine footing or foundation.
6. Perform all trenching in a manner to prevent cave-ins and risk to workmen.
7. Where original surface is pavement or concrete, the surface shall be saw cut to provide clean edges and assist in the surface restoration.

8. If satisfactory bearing soil is not found at the indicated levels, immediately notify the Architect/Engineer or their representative, and do no further work until the Architect/Engineer or their representative gives further instructions.
9. Excavation shall be performed in all ground conditions, including rock, if encountered. Bidders shall visit the premises and determine the soil conditions by actual observations, borings, or other means. The cost of all such inspections, borings, etc., shall be borne by the bidder.
10. If a trench is excavated in rock, a compacted bed with a depth of 3" (minimum) of sand and gravel shall be used to support the conduit unless masonry cradles or encasements are used.
11. Mechanical excavation of the trench to line and grade of the conduit or to the bottom level of masonry cradles or encasements is permitted, unless otherwise indicated on the electrical drawings.
12. Mechanical excavation of the trench to line and grade where direct burial cables are to be installed is permitted provided the excavation is made to a depth to permit installation of the cable on a fine sand bed at least 3 inches deep.

C. Dewatering:

1. Furnish, install, operate and remove all dewatering pumps and pipes needed to keep trenches and pits free of water.

D. Underground Obstructions:

1. Known underground piping, conduit, feeders, foundations, and other obstructions in the vicinity of construction are shown on the drawings. Review all Bid Documents for all trades on the project to determine obstructions indicated. Take great care in making installations near underground obstructions.
2. If objects not shown on the drawings are encountered, remove, relocate, or perform extra work as directed by the Architect/Engineer.

E. Fill and Backfilling:

1. No rubbish or waste material is permitted for fill or backfill.
2. Provide all necessary sand and/or CA6 for backfilling.
3. Native soil materials may be used as backfill if approved by the Geotechnical Engineer.
4. Dispose of the excess excavated earth as directed.
5. Backfill materials (native soil material, sand, and/or CA6) shall be suitable for required compaction, clean and free of perishable materials, frozen earth, debris, earth with a high void content, and stones greater than 4 inches in diameter. Water is not permitted to rise in unbackfilled trenches.
6. Backfill all trenches and excavations immediately after installing of conduit, or removing forms, unless other protection is directed.
7. Around piers and isolated foundations and structures, backfill and fill shall be placed and consolidated simultaneously on all sides to prevent wedge action and displacement. Spread fill and backfill materials in 6" uniform horizontal layers with each layer compacted separately to required density.
8. For conduits that are not concrete encased, lay all conduits on a compacted bed of sand at least 3" deep. Backfill around conduits with sand, in 6" layers and compact each layer.

9. Conduits that are concrete encased or in a ductbank, conduit spacers, and cradles shall be installed on a bed of compacted CA-6 gravel. Refer to conduit section for backfilling and ductbank requirements.
10. Backfill with native soil material (if approved) or sand up to grade for all conduits under slabs or paved areas. All other conduits shall have sand backfill to 6" above the top of the conduit.
11. Place all backfill above the sand in uniform layers not exceeding 6" deep. Place then carefully and uniformly tamp each layer to eliminate lateral or vertical displacement.
12. Where the fill and backfill will ultimately be under a building, floor or paving, each layer of fill shall be compacted to 95% of the maximum density as determined by AASHTO Designation T-99 or ASTM Designation D-698. Moisture content of soil at time of compaction shall not exceed plus or minus 2% of optimum moisture content as determined by AASHTO T-99 or ASTM D-698 test.
13. After backfilling of trenches, no superficial loads shall be placed on the exposed surface of the backfill until a period of 48 hours has elapsed.

F. Surface Restoration:

1. Where trenches are cut through graded, planted or landscaped areas, the areas shall be restored to the original condition. Replace all planting and landscaping features removed or damaged to its original condition. At least 6" of topsoil shall be applied where disturbed areas are to be seeded or sodded. All lawn areas shall be sodded unless seeding is called out in the drawings or specifications.
2. Concrete or asphalt type pavement, seal coat, rock, gravel or earth surfaces removed or damaged shall be replaced with comparable materials and restored to original condition. Broken edges shall be saw cut and repaired as directed by Architect/Engineer.

3.3 ARCHITECT/ENGINEER OBSERVATION OF WORK

A. The contractor shall provide seven (7) calendar days' notice to the Architect/Engineer prior to:

1. Placing fill over underground and underslab utilities.
2. Covering exterior walls, interior partitions and chases.
3. Installing hard or suspended ceilings and soffits.

B. The Architect/Engineer will review the installation and provide a written report noting deficiencies requiring correction. The contractor's schedule shall account for these reviews and show them as line items in the approved schedule.

C. Above-Ceiling Final Observation:

1. All work above the ceilings must be complete prior to the Architect/Engineer's review. This includes, but is not limited to:
  - a. All junction boxes are closed and identified in accordance with Section 26 05 53 Electrical Identification.
  - b. Luminaires, including ceiling-mounted exit and emergency lights, are installed and operational.
  - c. Luminaire whips are supported above the ceiling.
  - d. Conduit identification is installed in accordance with Section 26 05 53 Electrical Identification.

- e. Luminaires are suspended independently of the ceiling system when required by these contract documents.
  - f. All wall penetrations have been sealed.
2. To prevent the Above-Ceiling Final Observation from occurring too early, the Contractor shall review the status of the work and certify, in writing, that the work is ready for the Above-Ceiling Final Observation.
  3. It is understood that if the Architect/Engineer finds the ceilings have been installed prior to this review and prior to seven days elapsing, the Architect/Engineer may not recommend further payments to the contractor until full access has been provided.

### 3.4 PROJECT CLOSEOUT

- A. The following paragraphs supplement the requirements of Division 1.
- B. Final Jobsite Observation:
  1. To prevent the Final Jobsite Observation from occurring too early, the Contractor shall review the completion status of the project and certify that the job is ready for the final jobsite observation.
  2. Attached to the end of this section is a typical list of items that represent the degree of job completeness expected prior to requesting a review. The Contractor shall sign the attached certification and return it to the Architect/Engineer so that the final observation can be scheduled.
  3. It is understood that if the Architect/Engineer finds the job not ready for the final observation and additional trips and observations are required to bring the project to completion, the cost of the additional time and expenses incurred by the Architect/Engineer will be deducted from the Contractor's final payment.
  4. Contractor shall notify Architect/Engineer two (2) weeks prior to installation of ceilings or lay-in ceiling tiles.
- C. The following must be submitted before Architect/Engineer recommends final payment:
  1. Operation and maintenance manuals with copies of approved shop drawings.
  2. Record documents including marked-up or reproducible drawings and specifications.
  3. A report documenting the instructions given to the Owner's representatives complete with the number of hours spent in the instruction. The report shall bear the signature of an authorized agent of this Contractor and shall be signed by the Owner's representatives.
  4. Provide spare parts, maintenance, and extra materials in quantities specified in individual specification sections. Deliver to project site and place in location as directed and submit receipt to Architect/Engineer.
  5. Inspection and testing report by the fire alarm system manufacturer.
  6. Start-up reports on all equipment requiring a factory installation or start-up.
- D. Circuit Directories:
  1. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEIPT). Revise directory to reflect circuit changes

required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.

### 3.5 OPERATION AND MAINTENANCE MANUALS

#### A. General:

1. Provide an electronic copy of the O&M manuals as described below for Architect/Engineer's review and approval. The electronic copy shall be corrected as required to address the Architect/Engineer's comments. Once corrected, electronic copies and paper copies shall be distributed as directed by the Architect/Engineer.
2. Approved O&M manuals shall be completed and in the Owner's possession prior to Owner's acceptance and at least 10 days prior to instruction of operating personnel.

#### B. Electronic Submittal Procedures:

1. Distribution: Email the O&M manual as attachments to all parties designated by the Architect/Engineer.
2. Transmittals: Each submittal shall include an individual electronic letter of transmittal.
3. Format: Electronic submittals shall be in PDF format only. Scanned copies, in PDF format, of paper originals are acceptable. Submittals that are not legible will be rejected. Do not set any permission restrictions on files; protected, locked, or secured documents will be rejected.
4. File Names: Electronic submittal file names shall include the relevant specification section number followed by a description of the item submitted, as follows. Where possible, include the transmittal as the first page of the PDF instead of using multiple electronic files.
  - a. O&M file name: O&M.div26.contractor.YYYYMMDD
  - b. Transmittal file name: O&Mtransmittal.div26.contractor.YYYYMMDD
5. File Size: Files shall be transmitted via a pre-approved method. Larger files may require an alternative transfer method, which shall also be pre-approved.
6. Provide the Owner with an approved copy of the O&M manual on compact discs (CD), digital video discs (DVD), or flash drives with a permanently affixed label, printed with the title "Operation and Maintenance Instructions", title of the project and subject matter of disc/flash drive when multiple disc/flash drives are required.
7. All text shall be searchable.
8. Bookmarks shall be used, dividing information first by specification section, then systems, major equipment and finally individual items. All bookmark titles shall include the nomenclature used in the construction documents and shall be an active link to the first page of the section being referenced.

#### C. Operation and Maintenance Instructions shall include:

1. Title Page: Include title page with project title, Architect, Engineer, Contractor, all subcontractors, and major equipment suppliers, with addresses, telephone numbers, website addresses, email addresses and point of contacts. Website URLs and email addresses shall be active links in the electronic submittal.
2. Table of Contents: Include a table of contents describing specification section, systems, major equipment, and individual items.

3. Copies of all final approved shop drawings and submittals. Include Architect's/Engineer's shop drawing review comments. Insert the individual shop drawing directly after the Operation and Maintenance information for the item(s) in the review form.
4. Copies of all factory inspections and/or equipment startup reports.
5. Copies of warranties.
6. Schematic wiring diagrams of the equipment that have been updated for field conditions. Field wiring shall have label numbers to match drawings.
7. Dimensional drawings of equipment.
8. Detailed parts lists with lists of suppliers.
9. Operating procedures for each system.
10. Maintenance schedule and procedures. Include a chart listing maintenance requirements and frequency.
11. Repair procedures for major components.
12. Replacement parts and service material requirements for each system and the frequency of service required.
13. Instruction books, cards, and manuals furnished with the equipment.
14. Include record drawings of the one-line diagrams for each major system. The graphic for each piece of equipment shown on the one-line diagram shall be an active link to its associated Operation & Maintenance data.
15. Copies of all panel schedules in electronic Microsoft Excel spreadsheet (.xlsx) file. Each panelboard shall be a separate tab in the workbook.

### 3.6 INSTRUCTING THE OWNER'S REPRESENTATIVE

- A. Adequately instruct the Owner's designated representatives in the maintenance, care, and operation of the complete systems installed under this contract.
- B. Provide verbal and written instructions to the Owner's representatives by FACTORY PERSONNEL in the care, maintenance, and operation of the equipment and systems.
- C. Contractor shall make a DVD video recording of instructions to the Owner while explaining the system so additional personnel may view the instructions at a later date. The video recording shall be the property of the Owner.
- D. The instructions shall include:
  1. Maintenance of equipment.
  2. Start-up procedures for all major equipment.
  3. Description of emergency system operation.
- E. Notify the Architect/Engineer of the time and place for the verbal instructions to be given to the Owner's representative so a representative can be present if desired.
- F. Minimum hours of instruction time for each item and/or system shall be as indicated in each individual specification section.
- G. Operating Instructions:
  1. Contractor is responsible for all instructions to the Owner's representatives for the electrical and specialized systems.

2. If the Contractor does not have staff that can adequately provide the required instructions, the Contractor shall include in the bid an adequate amount to reimburse the Owner for the Architect/Engineer to perform these services.

### 3.7 RECORD DOCUMENTS

- A. The following paragraphs supplement Division 1 requirements.
- B. Maintain at the job site a separate and complete set of electrical drawings and specifications with all changes made to the systems clearly and permanently marked in complete detail.
- C. Mark drawings and specifications to indicate approved substitutions; Change Orders, and actual equipment and materials used. All Change Orders, RFI responses, Clarifications and other supplemental instructions shall be marked on the documents. Record documents that merely reference the existence of the above items are not acceptable. Should this Contractor fail to complete Record Documents as required by this contract, this Contractor shall reimburse Architect/Engineer for all costs to develop record documents that comply with this requirement. Reimbursement shall be made at the Architect/Engineer's hourly rates in effect at the time of work.
- D. Record changes daily and keep the marked drawings available for the Architect/Engineer's examination at any normal work time.
- E. Upon completing the job, and before final payment is made, give the marked-up drawings to the Architect/Engineer.
- F. Record actual routing of conduits exceeding 2 inches.

### 3.8 PAINTING

- A. Paint all equipment that is marred or damaged prior to the Owner's acceptance. Paint and color shall match original equipment paint and shall be obtained from the equipment supplier if available. All equipment shall have a finished coat of paint applied unless specifically allowed to be provided with a prime coat only.
- B. Equipment in finished areas that will be painted to match the room decor will be painted by others. Should this Contractor install equipment in a finished area after the area has been painted, the Contractor shall have the equipment and all its supports, hangers, etc., painted to match the room decor. Painting shall be performed as described in project specifications.
- C. Equipment cabinets, casings, covers, metal jackets, etc., located in equipment rooms or concealed spaces, shall be furnished in standard finish, free from scratches, abrasions, chippings, etc.
- D. Equipment in occupied spaces, or if standard to the unit, shall have a baked primer with baked enamel finish coat free from scratches, abrasions, chipping, etc. If color option is specified or is standard to the unit, verify with the Architect the color preference before ordering.

- E. Paint all equipment in unfinished areas such as boiler room, mechanical spaces, and storage rooms. Equipment furnished with a suitable factory finish need not be painted; provided the factory applied finish is not marred or spattered. If so, equipment shall be refinished with the same paint as was factory applied.
- F. All electrical conduit and equipment, fittings, hangers, structural supports, etc., in unfinished areas, such as equipment and storage room area, shall be painted two (2) coats of oil paint of colors selected by the Architect.
- G. Do NOT paint electric conduits in crawl spaces, tunnels, or spaces above suspended ceilings except that where conduit is in a damp location give exposed threads at joints two coats of sealer after joint is made up.
- H. After surfaces have been thoroughly cleaned and are free of oil, dirt or other foreign matter, paint all raceway and equipment with the following:
  - 1. Bare Metal Surfaces - Apply one coat of metal primer suitable for the metal being painted. Finish with two coats of Alkyd base enamel paint.
  - 2. Plastic Surfaces - Paint plastic surfaces with two coats of semi-gloss acrylic latex paint.

### 3.9 ADJUST AND CLEAN

- A. Thoroughly clean all equipment and systems prior to the Owner's final acceptance of the project.
- B. Clean all foreign paint, grease, oil, dirt, labels, stickers, etc. from all equipment.
- C. Remove all rubbish, debris, etc., accumulated during construction from the premises.

### 3.10 SPECIAL REQUIREMENTS

- A. Coordinate the installation of all equipment, controls, devices, etc., with other trades to maintain clear access area for servicing.
- B. Install all equipment to maximize access to parts needing service or maintenance. Review the final location, placement, and orientation of equipment with the Owner's representative prior to setting equipment.
- C. Installation of equipment or devices without regard to coordination of access requirements and confirmation with the Owner's representative will result in removal and reinstallation of the equipment at the Contractor's expense.
- D. Raceway and Cable routing restrictions: Raceways and cable are restricted from being routed in the following locations, unless serving the space or permitted by the authority having jurisdiction.
  - 1. Elevator machine rooms and hoistways.
  - 2. Exit enclosures.
  - 3. Other areas restricted by code.
  - 4. Technology, data, server rooms.
  - 5. Fire pump and sprinkler rooms.

6. Normal power in emergency power equipment rooms: Limited to feeders and branch circuits serving the emergency power equipment located in the room.
7. Emergency power in normal power equipment rooms: Limited to feeders and branch circuits serving the normal power equipment located in the room.

### 3.11 SYSTEM STARTING AND ADJUSTING

- A. The electrical systems shall be complete and operating. System startup, testing, adjusting, and balancing to obtain satisfactory system performance is the responsibility of the Contractor. This includes all calibration and adjustment of electrical controls, balancing of loads, troubleshooting and verification of software, and final adjustments that may be needed.
- B. Complete all manufacturer-recommended startup procedures and checklists to verify proper equipment operation and does not pose a danger to personnel or property.
- C. All operating conditions and control sequences shall be tested during the start-up period. Testing all interlocks, safety shut-downs, controls, and alarms.
- D. The Contractor, subcontractors, and equipment suppliers shall have skilled technicians to ensure that all systems perform properly. If the Architect/Engineer is requested to visit the job site for trouble shooting, assisting in start-up, obtaining satisfactory equipment operation, resolving installation and/or workmanship problems, equipment substitution issues or unsatisfactory system performance, including call backs during the warranty period, through no fault of the design; the Contractor shall reimburse the Owner on a time and materials basis for services rendered at the Architect/Engineer's standard hourly rates in effect when the services are requested. The Contractor shall pay the Owner for services required that are product, installation or workmanship related. Payment is due within 30 days after services are rendered.

### 3.12 FIELD QUALITY CONTROL

- A. General:
  1. Conduct all tests required during and after construction. Submit test results in NETA format, or equivalent form, that shows the test equipment used, calibration date, tester's name, ambient test conditions, humidity, conductor length, and results corrected to 40°C.
  2. Supply necessary instruments, meters, etc., for the tests. Supply competent technicians with training in the proper testing techniques.
  3. All cables and wires shall be tested for shorts and grounds following installation and connection to devices. Replace shorted or grounded wires and cables.
  4. Any wiring device, electrical apparatus or luminaire, if grounded or shorted on any integral "live" part, shall have all defective parts or materials replaced.
  5. Test cable insulation of service and panel feeder conductors for proper insulation values. Tests shall include the cable, all splices, and all terminations. Each conductor shall be tested and shall test free of short circuits and grounds and have an insulation value not less than Electrical Code Standards. Take readings between conductors, and between conductors and ground.
  6. If the results obtained in the tests are not satisfactory, make adjustments, replacements, and changes as needed. Then repeat the tests, and make additional tests, as the Architect/Engineer or authority having jurisdiction deems necessary.

B. Ground Resistance:

1. Conduct service ground resistance tests using an approved manufactured ground resistance meter. Submit to the Architect/Engineer a proposed test procedure including type of equipment to be used. (The conventional ohmmeter is not an acceptable device.)
2. Make ground resistance measurements during normal dry weather and not less than 48 hours after a rain.
3. If the ground resistance value obtained is more than the value set forth in Section 26 05 26, the following shall be done to obtain the value given:
  - a. Verify that all connections in the service ground system are secure.
  - b. Increase the depth to which ground rods are driven by adding section lengths to the rods and retest. If the resistance is still excessive increase the depth by adding an additional rod section and retest.
  - c. If the resistance is still excessive, furnish and install additional ground rods, spaced not less than 20 feet from other ground rods unless otherwise noted on plans, and connect into the ground electrode system. Retest.
  - d. Review results with the Architect/Engineer.
4. Before final payment is made to the Contractor submit a written report to the Architect/Engineer including the following:
  - a. Date of test.
  - b. Number of hours since the last rain.
  - c. Soil condition at the time of the test in the ground electrode location. That is: dry, wet, moist, sand, clay, etc.
  - d. Diagram of the test set-up showing distances between test equipment, ground electrode, auxiliary electrodes, etc.
  - e. Make, model, and calibration date of test equipment.
  - f. Tabulation of measurements taken and calculations made.

C. Ground-Fault Equipment Performance Testing:

1. Test: Perform ground-fault performance testing when system is installed. The test process shall use primary current injection per manufacturer instruction and procedures. Perform test for the following:
  - a. Service disconnects
  - b. Solid state molded case circuit breakers and solid-state insulated case circuit breakers equipped with ground fault protection.
  - c. Fusible switches with ground fault relay protection.
  - d. Outside branch circuits and feeders.
  - e. Code required.
2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.

- D. Arc Energy Reduction Equipment Performance Testing:
  - 1. Test: Perform arc energy protection performance testing when system is installed. The test process shall use primary current injection or approved method per manufacturer instructions and procedures. Perform test for the following:
    - a. All arc energy reduction systems installed.
  - 2. Report: Provide copy of test result report with Operation and Maintenance manuals. Provide report to Authority Having Jurisdiction when requested.
- E. Other Equipment:
  - 1. Give other equipment furnished and installed by the Contractor all standard tests normally made to assure that the equipment is electrically sound, all connections properly made, phase rotation correct, fuses and thermal elements suitable for protection against overloads, voltage complies with equipment nameplate rating, and full load amperes are within equipment rating.
- F. If any test results are not satisfactory, make adjustments, replacements and changes as needed and repeat the tests and make additional tests as the Architect/Engineer or authority having jurisdiction deem necessary.
- G. Report shall include color printouts, in binder, of pictures taken to use as a baseline reading after building is occupied.
- H. Upon completion of the project, the Contractor shall provide amperage readings for all panelboards and switchboards and turn the results over to the Owner for "benchmark" amperages.

### 3.13 UTILITY REBATE

- A. Submit utility rebate forms, where offered at project location, with rebate items completed. Rebate may include lighting, lighting controls, variable speed drives, heat pumps, package terminal A/C, air conditioners, chillers, water heaters, programmable thermostats, and motors.
- B. Contractor must submit notification of any value engineering or product substitution that will affect the utility rebate amount prior to approval.

## READINESS CERTIFICATION PRIOR TO FINAL JOBSITE OBSERVATION

To prevent the final job observation from occurring too early, we require that the Contractor review the completion status of the project and, by copy of this document, certify that the job is indeed ready for the final job observation. The following is a typical list of items that represent the degree of job completeness expected prior to your requesting a final job observation.

1. Penetrations of fire-rated construction fire sealed in accordance with specifications.
2. Electrical panels have typed circuit identification.
3. Per Section 26 05 00, cable insulation test results have been submitted.
4. Per Section 26 05 00, ground resistance test results have been submitted.
5. Operation and Maintenance manuals have been submitted as per Section 26 05 00.
6. Bound copies of approved shop drawings have been submitted as per Section 26 05 00.
7. Report of instruction of Owner's representative has been submitted as per Section 26 05 00.
8. Fire alarm inspection and testing report has been submitted as per Sections 26 05 00 and 28 31 00.
9. Start-up reports from factory representative have been submitted as per Section 26 05 00.

Accepted by:

Prime Contractor \_\_\_\_\_

By \_\_\_\_\_ Date \_\_\_\_\_

Upon Contractor certification that the project is complete and ready for a final job observation, we require the Contractor to sign this agreement and return it to the Architect/Engineer so that the final observation can be scheduled.

It is understood that if the Architect/Engineer finds the job not ready for the final observation and that additional trips and observations are required to bring the project to completion, the costs incurred by the Architect/Engineers for additional time and expenses will be deducted from the Contractor's contract retainage prior to final payment at the completion of the job.

END OF SECTION 26 05 00

## SECTION 26 05 03 - THROUGH PENETRATION FIRESTOPPING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Through-Penetration Firestopping.

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in manufacturing products specified in this Section.
- B. Installer: Individuals performing work shall be certified by the manufacturer of the system selected for installation.

#### 1.3 REFERENCES

- A. UL 263 - Fire Tests of Building Construction and Materials
- B. UL 723 - Surface Burning Characteristics of Building Materials
- C. ANSI/UL 1479 - Fire Tests of Through Penetration Firestops
- D. UL 2079 - Tests for Fire Resistance of Building Joint Systems
- E. UL Fire Resistance Directory Through Penetration Firestop Systems (XHEZ)
- F. Intertek / Warnock Hersey - Directory of Listed Products
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials
- H. ASTM E814 - Standard Test Method for Fire Tests of Through-Penetration Firestops
- I. 2015 International Building Code

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store, protect and handle products on site. Accept material on site in factory containers and packing. Inspect for damage. Protect from deterioration or damage due to moisture, temperature changes, contaminants, or other causes. Follow manufacturer's instructions for storage.
- B. Install material prior to expiration of product shelf life.

#### 1.5 PERFORMANCE REQUIREMENTS

- A. General: For penetrations through the following fire-resistance-rated constructions, including both empty openings and openings containing penetrating items, provide through-penetration firestop systems that are produced and installed to resist spread of fire according to requirements indicated, resist passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated.

1. Fire-resistance-rated walls including fire partitions, fire barriers, and smoke barriers.
  2. Fire-resistance-rated horizontal assemblies including floors, floor/ceiling assemblies, and ceiling membranes of roof/ceiling assemblies.
- B. Rated Systems: Provide through-penetration firestop systems with the following ratings determined per UL 1479:
1. L-Rated Systems: Provide through-penetration firestop systems with L-ratings of not more than 5.0 cfm/sq.ft. at both ambient temperature and 400°F.
- C. For through-penetration firestop systems exposed to light, traffic, moisture, or physical damage, provide products that, after curing, do not deteriorate when exposed to these conditions both during and after construction.
- D. For through-penetration firestop systems exposed to view, provide products with flame-spread and smoke-developed indexes of less than 25 and 450, respectively, as determined per ASTM E 84.
- E. For through-penetration firestop systems in air plenums, provide products with flame-spread and smoke-developed indexes of less than 25 and 50, respectively, as determined per ASTM E 84.

## 1.6 MEETINGS

- A. Pre-installation meeting: A pre-installation meeting shall be scheduled and shall include the Construction Manager, General Contractor, all Subcontractors associated with the installation of systems penetrating fire barriers, Firestopping Manufacturer's Representative, and the Owner.
1. Review foreseeable methods related to firestopping work.
  2. Tour representative areas where firestopping is to be installed; inspect and discuss each type of condition and each type of substrate that will be encountered, and preparation to be performed by other trades.

## 1.7 WARRANTY

- A. Provide one year warranty on parts and labor.
- B. Warranty shall cover repair or replacement of firestop systems which fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, general durability, or appear to deteriorate in any manner not clearly specified by the manufacturer as an inherent quality of the material.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the through-penetration firestop systems indicated for each application that are produced by one of the following manufacturers. All firestopping systems installed shall be provided by a single manufacturer.

1. 3M; Fire Protection Products Division
2. Hilti, Inc.
3. RectorSeal Corporation, Metacaulk
4. Tremco; Sealant/Weatherproofing Division
5. Johns-Manville
6. Specified Technologies Inc. (S.T.I.)
7. Spec Seal Firestop Products
8. AD Firebarrier Protection Systems
9. Wiremold/Legrand: FlameStopper
10. Dow Corning Corp
11. Fire Trak Corp
12. International Protective Coating Corp

## 2.2 THROUGH PENETRATION FIRESTOP SYSTEMS

- A. Provide materials and systems classified by or listed by Intertek / Warnock Hersey to provide firestopping equal to time rating of construction being penetrated.
- B. All firestopping materials shall be free of asbestos, lead, PCB's, and other materials that would require hazardous waste removal.
- C. Firestopping shall be flexible to allow for normal penetrating item movement due to expansion and contraction.
- D. Provide firestopping systems capable of supporting floor loads where systems are exposed to possible floor loading or traffic.
- E. Provide firestopping systems allowing continuous insulation for all insulated pipes.
- F. Provide firestopping systems classified by UL or listed by Intertek / Warnock Hersey for penetrations through all fire rated construction. Firestopping systems shall be selected from the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory Category XHEZ based on substrate construction and penetrating item size and material and shall fall within the range of numbers listed:

### 1. Combustible Framed Floors and Chase Walls - 1 or 2 Hour Rated:

#### a. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	FC 0000-0999*
Metallic Pipe or Conduit	FC 1000-1999
Non-Metallic Pipe or Conduit	FC 2000-2999
Electrical Cables	FC 3000-3999
Cable Trays	FC 4000-4999
Insulated Pipes	FC 5000-5999
Bus Duct and Misc. Electrical	FC 6000-6999
Duct without Damper and Misc. Mechanical	FC 7000-7999
Multiple Penetrations	FC 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

2. Non-Combustible Framed Walls - 1 or 2 Hour Rated:

a. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	WL 0000-0999*
Metallic Pipe or Conduit	WL 1000-1999
Non-Metallic Pipe or Conduit	WL 2000-2999
Electrical Cables	WL 3000-3999
Cable Trays	WL 4000-4999
Insulated Pipes	WL 5000-5999
Bus Duct and Misc. Electrical	WL 6000-6999
Duct without Damper and Misc. Mechanical	WL 7000-7999
Multiple Penetrations	WL 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

3. Concrete or Masonry Floors and Walls - 1 or 2 Hour Rated:

a. L Rating = Penetrations in Smoke Barriers

Penetrating Item	UL System No.
No Penetrating Item	CAJ 0000-0999*
Metallic Pipe or Conduit	CAJ 1000-1999
Non-Metallic Pipe or Conduit	CAJ 2000-2999
Electrical Cables	CAJ 3000-3999
Cable Trays	CAJ 4000-4999
Insulated Pipes	CAJ 5000-5999
Bus Duct and Misc. Electrical	CAJ 6000-6999
Duct without Damper and Misc. Mechanical	CAJ 7000-7999
Multiple Penetrations	CAJ 8000-8999

\*Alternate method of firestopping is patching opening to match original rated construction.

- G. Any opening in walls or floors not covered by the listed series of numbers shall be coordinated with the firestopping manufacturer.
- H. Any openings in floors or walls not described in the UL or listed by Intertek / Warnock Hersey Fire Resistance Directory, or outlined in manufacturer's information shall be sealed in a manner agreed upon by the Firestopping Manufacturer, Owner, and the Authority Having Jurisdiction.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Ensure all surfaces that contact seal materials are free of dirt, dust, grease, oil, rust, or loose materials. Clean and repair surfaces as required. Remove laitance and form-release agents from concrete.
- B. Ensure substrate and penetrating items have been permanently installed prior to installing firestopping systems. Ensure penetrating items have been properly spaced and have proper clearance prior to installing firestopping systems.
- C. Surfaces to which sealing materials are to be installed must meet the selected UL or Intertek / Warnock Hersey system substrate criteria.
- D. Prime substrates where recommended in writing by through-penetration firestop system manufacturer. Confine primer to area of bond.

### 3.2 INSTALLATION

- A. In existing construction, provide firestopping of openings prior to and after installation of penetrating items. Remove any existing coatings on surfaces prior to firestopping installation. Temporary firestopping shall consist of packing openings with fire resistant mineral wool for the full thickness of substrate, or an alternate method approved by the Authority Having Jurisdiction. All openings shall be temporarily firestopped immediately upon their installation and shall remain so until the permanent UL or listed by Intertek / Warnock Hersey listed firestopping system is installed.
- B. Install penetration seal materials in accordance with printed instructions of the UL or Intertek / Warnock Hersey Fire Resistance Directory and with the manufacturer's printed application instructions.
- C. Install dams as required to properly contain firestopping materials within openings and as required to achieve required fire resistance rating. Remove combustible damming after appropriate curing.

### 3.3 CLEANING AND PROTECTING

- A. Clean excess fill materials adjacent to openings as Work progresses by methods and with cleaning materials that are approved in writing by through-penetration firestop system manufacturers and that do not cause damage.
- B. Provide final protection and maintain conditions during and after installation that ensure that through-penetration firestop systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, remove damaged or deteriorated through-penetration firestop systems immediately and install new materials to produce systems complying with specified requirements.

### 3.4 IDENTIFICATION

- A. Provide and install labels adjacent to each firestopping location. Label shall be provided by the firestop system supplier and contain the following information in a contrasting color:
  - 1. The words "Warning - Through Penetration Firestop System - Do Not Disturb. Notify Building Management of Any Damage."
  - 2. Firestop System Supplier; UL or listed by Intertek / Warnock Hersey system number; date installed; contractor name and phone number; manufacturer's representative name, address, and phone number.

### 3.5 INSPECTION

- A. All penetrations shall be inspected by the manufacturer's representative to ensure proper installation.
- B. Access to firestop systems shall be maintained for examination by the Authority Having Jurisdiction at their request.
- C. Proceed with enclosing through-penetration firestop system with other construction only after inspection reports are issued and firestop installations comply with requirements.
- D. The contractor shall allow for visual destructive review of 5% of installed firestop systems (minimum of one) to prove compliance with specifications and manufacturer's instructions and details. Destructive system removal shall be performed by the contractor and witnessed by the Architect/Engineer and manufacturer's factory representative. The Architect/Engineer shall have sole discretion of which firestop system installations will be reviewed. The contractor is responsible for all costs associated with this requirement including labor and material for removing and replacing the installed firestop system. If any firestop system is found to not be installed per manufacturer's specific instructions and details, all firestop systems are subject to destructive review and replacement at the Architect/Engineer's discretion and the contractor's expense.

END OF SECTION 26 05 03

## SECTION 26 05 05 - ELECTRICAL DEMOLITION FOR REMODELING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Electrical demolition

### PART 2 - PRODUCTS

#### 2.1 MATERIALS AND EQUIPMENT

- A. Materials and equipment for patching and extending work shall be as specified in individual Sections.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. THE DRAWINGS ARE INTENDED TO INDICATE THE SCOPE OF WORK REQUIRED AND DO NOT INDICATE EVERY BOX, CONDUIT, OR WIRE THAT MUST BE REMOVED. THE CONTRACTOR SHALL VISIT THE SITE PRIOR TO SUBMITTING A BID AND VERIFY EXISTING CONDITIONS.
- B. Where walls, ceilings, structures, etc., are indicated as being removed on general or electrical drawings, the Contractor shall be responsible for the removal of all electrical equipment, devices, fixtures, raceways, wiring, systems, etc., from the removed area.
- C. Where ceilings, walls, structures, etc., are temporarily removed and replaced by others, this Contractor shall be responsible for the removal, storage, and replacement of equipment, devices, fixtures, raceways, wiring, systems, etc.
- D. Where mechanical or technology equipment is indicated as being removed on electrical, mechanical, or technology drawings, the Contractor shall be responsible for disconnecting the equipment and removing all starters, VFD, controllers, electrical equipment, raceways, wiring, etc. associated with the device.
- E. Verify that abandoned wiring and equipment serve only abandoned equipment or facilities. Extend conduit and wire to facilities and equipment that will remain in operation following demolition. Extension of conduit and wire to equipment shall be compatible with the surrounding area. Extended conduit and conductors to match existing size and material.
- F. Coordinate scope of work with all other Contractors and the Owner at the project site. Schedule removal of equipment and electrical service to avoid conflicts.
- G. Bid submittal shall mean the Contractor has visited the project site and has verified existing conditions and scope of work.

### 3.2 PREPARATION

- A. The Contractor shall obtain approval from the Owner before turning off power to circuits, feeders, panels, etc. Coordinate all outages with Owner.
- B. Coordinate utility service outages with Utility Company.
- C. Provide temporary wiring and connections to maintain existing systems in service during construction. When work must be performed on energized equipment or circuits, use personnel experienced in such operations. Assume all equipment and systems must remain operational unless specifically noted otherwise on drawings.
- D. Disconnect electrical systems in walls, floors, structures, and ceilings scheduled for removal.
- E. Existing East High School Electrical Service: Maintain 2000A, 208/120V, 3ph, 4W existing system in service until new 3000A, 480/277V, 3ph, 4w system is ready to backfeed the existing 208V service. Disable system only to make switchovers and connections. Obtain permission from Owner at least two (2) weeks hours before partially or completely disabling system. Minimize outage duration. Make temporary connections to maintain service in areas adjacent to work area. Service changeover shall be completed on an overtime basis.

### 3.3 DEMOLITION AND EXTENSION OF EXISTING ELECTRICAL WORK

- A. Demolish and extend existing electrical work under provisions of Division 1 of Specifications and this Section.
- B. Remove, relocate, and extend existing installations to accommodate new construction.
- C. Remove abandoned wiring and raceway to source of supply. Existing conduit in good condition may be reused in place by including an equipment ground conductor in reused conduit. Reused conduit and boxes shall have supports revised to meet current codes. Relocating conduit shall not be allowed.
- D. Remove exposed abandoned raceway, including abandoned raceway above accessible ceiling finishes. Cut raceway flush with walls and floors, and patch surfaces. Remove all associated clamps, hangers, supports, etc. associated with raceway removal.
- E. Disconnect and remove outlets and devices that are to be demolished. Remove conduit, supports, and conductors back to source. Devices' back box and conduit mounted in walls that are to remain can be abandoned in place. Provide appropriate cover plate for all abandoned back boxes. Cover plates shall match existing plates used in the adjacent areas.
- F. Disconnect and remove abandoned panelboards and distribution equipment.
- G. Disconnect and remove electrical devices and equipment serving utilization equipment that has been removed.

- H. Disconnect and remove abandoned luminaires. Remove brackets, stems, hangers, and other accessories. Ballasts in light fixtures installed prior to 1980 shall be incinerated in EPA approved incinerator or disposed of in EPA certified containers and deposited in an EPA landfill certified for PCB disposal or recycled by permitted ballast recycler. Punctured or leaking ballasts must be disposed of according to Federal Regulations under the Toxic Substance Control Act. Provide Owner and Architect/Engineer with a Certificate of Destruction to verify proper disposal.
- I. Repair adjacent construction and finishes damaged during demolition and extension work. Patch openings to match existing surrounding finishes.
- J. Maintain access to existing electrical installations that remain active. Modify installation or provide junction boxes and access panel as appropriate.
- K. Extend existing installations using materials and methods compatible with existing electrical installations, or as specified. Extended conduit and conductors to match existing size and material.
- L. HID and fluorescent lamps, determined by the Toxicity Characteristic Leachate procedure (TCLP), to be hazardous waste shall be disposed of in an EPA-permitted hazardous waste disposal facility or by a permitted lamp recycler.
- M. Regulatory Requirements: Comply with governing EPA notification regulations before beginning demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- N. Floor slabs may contain conduit systems. This Contractor is responsible for taking any measures required to ensure no conduits or other services are damaged. This includes x-ray or similar non-destructive means. Where conduit is in concrete slab, cut conduit flush with floor, pull out conductors, and plug conduit ends.
- O. This Contractor is responsible for all costs incurred in repair, relocations, or replacement of any cables, conduits, or other services if damaged without proper investigation.

#### 3.4 CLEANING AND REPAIR

- A. Clean and repair existing materials and equipment that remain or are to be reused.
- B. Panelboards: Clean exposed surfaces and check tightness of electrical connections. Replace damaged circuit breakers and provide closure plates for vacant positions. Provide typed circuit directory showing revised circuiting arrangement.
- C. Luminaires: Remove existing luminaires for cleaning as indicated on the drawings. Use mild detergent to clean all exterior and interior surfaces; rinse with clean water and wipe dry. Replace lamps, ballasts, and broken electrical parts. Replacement parts shall match specified components for new luminaires of same type when applicable. Reinstall luminaire and connect to circuiting as indicated on drawings.

- D. ELECTRICAL ITEMS (E.G., LIGHTING FIXTURES, RECEPTACLES, SWITCHES, CONDUIT, WIRE, ETC.) REMOVED AND NOT RELOCATED REMAIN THE PROPERTY OF THE OWNER. CONTRACTOR SHALL PLACE ITEMS RETAINED BY THE OWNER IN A LOCATION COORDINATED WITH THE OWNER. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE DISPOSAL OF MATERIAL THE OWNER DOES NOT WANT.

3.5 INSTALLATION

- A. Install relocated materials and equipment under the provisions of Division 1 of Specifications.

END OF SECTION 26 05 05

## SECTION 26 05 13 - WIRE AND CABLE

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Building wire
- B. Cabling for remote control, signal, and power limited circuits

#### 1.2 RELATED WORK

- A. Section 26 05 53 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

#### 1.3 REFERENCES

- A. NEMA WC 70 - Power Cables Rated 2,000V or Less for the Distribution of Electrical Energy
- B. NFPA 70 - National Electrical Code (NEC)
- C. UL 44 - Thermoset-Insulated Wires and Cables
- D. UL 83 - Thermoplastic-Insulated Wires and Cables
- E. UL 854 - Service-Entrance Cables
- F. UL 1581 - Standard for Electrical Wires, Cables, and Flexible Cords
- G. UL 2196 - Fire Resistive, Fire Resistant and Circuit Integrity Cables

### PART 2 - PRODUCTS

#### 2.1 BUILDING WIRE

- A. Feeders and Branch Circuits 8 AWG and larger: Copper, stranded conductor, 600-volt insulation, THHN/THWN or XHHW-2.
- B. Feeders and Branch Circuits 8 AWG and larger in Underground Conduit: Copper, stranded conductor, 600-volt insulation, THWN or XHHW-2.
- C. Feeders and Branch Circuits 10 AWG and Smaller: Copper, solid or stranded conductor, 600-volt insulation, THHN/THWN, unless otherwise noted on the drawings.
- D. Motor Feeder from Variable Frequency Drives: Copper conductor, 600-volt XHHW-2 insulation, stranded conductor, unless otherwise noted on the drawings.
- E. Control Circuits: Copper, stranded conductor 600-volt insulation, THHN/THWN.

- F. Each 120 and 277-volt branch circuit shall have a dedicated neutral conductor. Neutral conductors shall be considered current-carrying conductors for wire derating.

## 2.2 CABLING FOR REMOTE CONTROL, SIGNAL, AND POWER LIMITED CIRCUITS

- A. Wire for the following specialized systems shall be as designated on the drawings, or elsewhere in these specifications. If not designated on the drawings or specifications, the system manufacturer's recommendations shall be followed.
  - 1. Fire alarm
  - 2. Low voltage switching
  - 3. Building automation systems and control
- B. Control Cable for Class 1 Remote Control and Signal Circuits: Copper conductor, 600-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket.
- C. Control Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a PVC jacket; UL listed.
- D. Plenum Cable for Class 2 or Class 3 Remote Control and Signal Circuits: Copper conductor, 300-volt insulation, rated 60°C, individual conductors twisted together, shielded, and covered with a nonmetallic jacket; UL listed for use in air handling ducts, hollow spaces used as ducts, and plenums.

## PART 3 - EXECUTION

### 3.1 WIRE AND CABLE INSTALLATION SCHEDULE

- A. Above Accessible Ceilings:
  - 1. Building wire shall be installed in raceway.
  - 2. Metal clad cable, Type MC, 1/2" size with minimum #12 conductors and ground, shall be allowed for flexible whips to individual luminaires on non-essential circuits. The flexible whips shall be between 18" to 72" in length per Electrical Code.
- B. All Other Locations: Building wire in raceway.
- C. Above Grade: All conductors installed above grade shall be type "THHN".
- D. Underground or In Slab: All conductors shall be type "THWN".
- E. Low Voltage Cable (less than 100 volts): Low voltage cables in ducts, plenums, and other air handling spaces shall be plenum listed. Low voltage cables in non-accessible areas shall be installed in conduit. Low voltage cable may be installed without conduit in accessible areas using the following types of cable supports. Cable support types/systems shall comply with the warranty requirements of the low voltage cable manufacturer.
  - 1. J-hooks

2. Bridle rings with saddle supports

3.2 CONTRACTOR CHANGES

- A. The basis of design is copper conductors installed in raceway based on ambient temperature of 30°C, NEC Table 310.16 (2011 - 2017 edition 310.15(B)(16)). Service entrance conductors are based on copper conductor installed in underground electrical ducts, NEC Table B.2(7) (2011 - 2017 edition Table B310.15(B)(2)(7); 2008 or later edition B.301.7) or calculated in accordance with Annex B Application Information for Ampacity Calculation..
- B. The Contractor shall be responsible for derating and sizing conductors and conduits to equal or exceed the ampacity of the basis of design circuits, if he/she chooses to use methods or materials other than the basis of design.
- C. Underground electrical duct ampacity rating shall be in accordance with NEC Table B.2(7) (2011 - 2017 edition Table B310.15(B)(2)(7); 2008 or later edition B.301.7) or calculated in accordance with Annex B Application Information for Ampacity Calculation.. The calculations and a sketch of the proposed installation shall be submitted prior to any conduit being installed.
- D. Record drawing shall include the calculations and sketches.

3.3 GENERAL WIRING METHODS

- A. Use no wire smaller than 12 AWG for power and lighting circuits, and no smaller than 14 AWG for control wiring.
- B. Use no wire smaller than 18 AWG for low voltage control wiring below 100 volts.
- C. Use 10 AWG conductor for 20 ampere, 120-volt branch circuit home runs longer than 75 feet, and for 20 ampere, 277-volt branch circuit home runs longer than 200 feet.
- D. Use no wire smaller than 8 AWG for outdoor lighting circuits.
- E. The ampacity of multiple conductors in one conduit shall be derated per the Electrical Code. In no case shall more than 4 conductors be installed in one conduit to such loads as motors larger than 1/4 HP, panelboards, motor control centers, etc.
- F. Where installing parallel feeders, place an equal number of conductors for each phase of a circuit in same raceway or cable.
- G. Splice only in junction or outlet boxes.
- H. Neatly train and lace wiring inside boxes, equipment, and panelboards.
- I. Make conductor lengths for parallel circuits equal.
- J. All conductors shall be continuous in conduit from last outlet to their termination.
- K. Terminate all spare conductors on terminal blocks, and label the spare conductors.
- L. Cables or wires shall not be laid out on the ground before pulling.

- M. Cables or wires shall not be dragged over earth or paving.
- N. Care shall be taken so as not to subject the cable or wire to high mechanical stresses that would cause damage to the wire and cable.
- O. At least six (6)-inch loops or ends shall be left at each outlet for installation connection of luminaires or other devices.
- P. All wires in outlet boxes not connected to fixtures or other devices shall be rolled up, spliced if continuity of circuit is required, and insulated.

### 3.4 WIRING INSTALLATION IN RACEWAYS

- A. Pull all conductors into a raceway at the same time. Use UL listed wire pulling lubricant for pulling 4 AWG and larger wires.
- B. Install wire in raceway after interior of building has been physically protected from the weather and all mechanical work likely to injure conductors has been completed.
- C. Pulling shall be continuous without unnecessary stops and starts with wire or cable only partially through raceway.
- D. Where reels of cable or wire are used, they shall be set up on jacks close to the point where the wire or cable enters the conduit or duct so that the cable or wire may be unreeled and run into the conduit or duct with a minimum of change in the direction of the bend.
- E. Conductors shall not be pulled through conduits until plastering or masonry work is completed and conduits are free from moisture. Care shall be taken so that long pulls of wire or pulls around several bends are not made where the wire may be permanently stretched and the insulation damaged.
- F. Only nylon rope shall be permitted to pull cables into conduit and ducts.
- G. Completely and thoroughly swab raceway system before installing conductors.
- H. Conductor Supports in Vertical Raceways:
  - 1. Support conductors in vertical raceways in accordance with the Electrical Code Spacing of Conductors Supports.
  - 2. Supports shall be of insulated wedge type (OZ Gedney Type S, or equal) and installed in a tapered insulated bushing fitting or a metal woven mesh with a support ring that fits inside conduit fitting installed in an accessible junction box (Hubbell Kellems support grip or equal).

### 3.5 CABLE INSTALLATION

- A. Provide protection for exposed cables where subject to damage.
- B. Use suitable cable fittings and connectors.

- C. Run all open cable parallel or perpendicular to walls, ceilings, and exposed structural members. Follow the routing as illustrated on the drawings as closely as possible. Cable routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatical, unless noted otherwise. The correct routing, when shown diagrammatically, shall be chosen by the Contractor based on information in the contract documents; in accordance with the manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", recognized industry standards; and coordinated with other contractors.
- D. Open cable shall be supported by the appropriate size J-hooks or other means if called for on the drawings. Wire and cable from different systems shall not be installed in the same J-hook. J-hooks shall be sized with 20% spare capacity. J-hooks shall provide proper bend radius support for data cable and fiber cables.
- E. Open cable installed above suspended ceilings shall not rest on the suspended ceiling construction, nor utilize the ceiling support system for wire and cable support.
- F. J-hook support spans shall be based on the smaller of the manufacturer's load ratings and code requirements. In no case shall horizontal spans exceed 5 feet and vertical spans exceed 4 feet. All J-hooks shall be installed where completely accessible and not blocked by piping, ductwork, inaccessible ceilings, etc. J-hooks shall be independently rigidly attached to a structural element. J-hooks shall be installed to provide 2" horizontal separation and 6" vertical separation between systems.
- G. Open cable shall only be installed where specifically shown on the drawings, or permitted in these specifications.

### 3.6 WIRING CONNECTIONS AND TERMINATIONS

- A. Splice and tap only in accessible junction boxes.
- B. Use solderless, tin-plated copper, compression terminals (lugs) applied with circumferential crimp for conductor terminations, 8 AWG and larger.
- C. Use solderless, tin-plated, compression terminals (lugs) applied with indenter crimp for copper conductor terminations, 10 AWG and smaller.
- D. Use solderless pressure connectors with insulating covers for copper wire splices and taps, 8 AWG and smaller. For 10 AWG and smaller, use insulated spring wire connectors with plastic caps.
- E. Use compression connectors applied with circumferential crimp for conductor splices and taps, 6 AWG and larger. Tape uninsulated conductors and connectors with electrical tape to 150 percent of the insulation value of conductor.
- F. Thoroughly clean wires before installing lugs and connectors.
- G. Make splices, taps and terminations to carry full ampacity of conductors without perceptible temperature rise.

- H. Phase Sequence: All apparatus shall be connected to operate in the phase sequence A-B-C representing the time sequence in which the phase conductors so identified reach positive maximum voltage.
- I. As a general rule, applicable to switches, circuit breakers, starters, panelboards, switchgear and the like, the connections to phase conductors are intended thus:
  - 1. Facing the front and operating side of the equipment, the phase identification shall be:
    - a. Left to Right - A-B-C
    - b. Top to Bottom - A-B-C
- J. Connection revisions as required to achieve correct rotation of motors shall be made at the load terminals of the starters or disconnect switches.

### 3.7 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Division 1.
- B. Building Wire and Power Cable Testing: Perform an insulation-resistance test on each conductor with respect to ground and adjacent conductors. Test shall be made by means of a low-resistance ohmmeter, such as a "Megger". The applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable. The test duration shall be one minute. Insulation resistance must be greater than 100 mega-ohm for 600 volt and 25 mega-ohm for 300 volt rated cables per NETA Acceptance Testing Standard. Verify uniform resistance of parallel conductors.
- C. Inspect wire and cable for physical damage and proper connection.
- D. Torque test conductor connections and terminations to manufacturer's recommended values.
- E. Perform continuity test on all power and equipment branch circuit conductors. Verify proper phasing connections.
- F. Documentation indicating that the torque wrench has been calibrated not more than 30 days prior to tightening of lugs shall be provided.
- G. Protection of wire and cable from foreign materials:
  - 1. It is the Contractor's responsibility to provide adequate physical protection to prevent foreign material application or contact with any wire or cable type. Foreign material is defined as any material that would negatively impact the validity of the manufacturer's performance warranty. This includes, but is not limited to, overspray of paint (accidental or otherwise), drywall compound, or any other surface chemical, liquid, or compound that could come in contact with the cable, cable jacket, or cable termination components.
- H. Overspray of paint on any wire or cable will not be accepted. It shall be the Contractor's responsibility to replace any component containing overspray, in its entirety, at no additional cost to the project. Cleaning of the cables with harsh chemicals is not allowed.

END OF SECTION 26 05 13

## SECTION 26 05 15 - MEDIUM-VOLTAGE CABLE AND ACCESSORIES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Medium voltage power cable
- B. Cable terminations
- C. Medium voltage cable accessories
- D. Medium voltage testing

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in medium voltage cable and accessories with minimum five (5) years documented experience.
- B. Installer: The installing company shall employ personnel with a minimum of five (5) years documented experience in medium voltage cable installation. Resumes shall be submitted documenting the experience of all personnel pulling, splicing, terminating and testing the medium voltage cable.
- C. Installer Certification: The installing company shall submit manufacturer's training certificates for the installing personnel for the splices and terminations being installed.

#### 1.3 REFERENCES

- A. AEIC CS8 (Association of Edison Illuminating Companies) - Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46 KV
- B. ANSI/IEEE C2 - National Electrical Safety Code
- C. ICEA S-93-639 (Insulated Cable Engineers Association) / NEMA WC74 - 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy
- D. ICEA S-94-649 - Standard for Concentric Neutral Cables Rated 5 Through 46 KV
- E. ICEA S-97-682 - Standard for Utility Shielded Power Cables Rated 5 Through 46 KV
- F. IEEE 48 - Standard for Test Procedures and Requirements Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV
- G. IEEE 386 - Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V
- H. IEEE 404 - Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2.5 kV to 500 kV

- I. International Electrical Testing Association Ó Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems (refer to the medium voltage cable DC testing requirements)
  - J. NFPA 70 - National Electrical Code (NEC)
  - K. UL 1072 - Standard for Medium-Voltage Power Cables
- 1.4 DELIVERY, STORAGE, AND HANDLING
- A. Deliver products to site under provisions of Section 26 05 00.
  - B. Store and protect products under provisions of Section 26 05 00.
  - C. Accept cable and accessories on site in manufacturer's packages and inspect for damage.
  - D. Protect cable and accessories from weather by covering with opaque plastic or canvas; provide ventilation to prevent condensation.
- 1.5 PROJECT RECORD DOCUMENTS
- A. Submit record documents under provisions of Section 26 05 00.
  - B. Accurately record exact sizes and locations of cables.
- 1.6 REGULATORY REQUIREMENTS
- A. Conform to ANSI/IEEE C2 and the Electrical Code.

## PART 2 - PRODUCTS

### 2.1 MANUFACTURERS

- A. Cable product supplied shall be stated by its manufacturer to be suitable for the application for which it will be installed and used, as indicated on project drawings. This includes, but is not limited to, the following applications as permitted by the National Electric Code.
  - 1. Use indoors and/or outdoors.
  - 2. Installation in wet and/or dry locations.
  - 3. Use in conduits and duct banks. Where installed in conduits or underground ducts, the cable manufacturer's product supplied shall be suitable for the conduit sizes specified on the project drawings. Where a manufacturer's cable size is recommended by a given manufacturer to be installed in a larger conduit or underground duct and other acceptable manufacturers' cables are available and the other acceptable manufacturers allow installation of their cables within the drawing conduit sizes and underground duct sizes, cables that work with the conduit sizes and underground duct sizes shown on project drawings shall be supplied.
  - 4. Direct buried installations of cable.
  - 5. Installations in cable trays.
  - 6. Messenger-supported aerial installations in industrial facilities.

- B. Manufacturers:
  - 1. The Okonite Company
  - 2. Southwire
  - 3. Prysmian (USA)
  - 4. General Cable
  - 5. The Kerite Company
  - 6. Aetna Insulated Wire

## 2.2 MEDIUM VOLTAGE POWER CABLE

- A. Cable: Insulated, shielded cable rated 5 KV.
- B. Electrical Code medium voltage, solid dielectric "Type Letter" shall be MV-105.
- C. "Single" or "multi-conductor" cables shall be supplied as indicated on project drawings. Multi-conductor cables shall include full size ground conductors.
- D. Conductors shall be copper compact stranded or compressed stranded..
- E. The cable shall have a semi-conducting shield layer between the metal conductor and insulation layer as a strand screen.
- F. Insulation: Ethylene-propylene rubber (EPR), 133% insulation level. 5 KV rated cable shall have a minimum of 115 mils of insulation for 100 percent insulated cable and a minimum of 140 mils for 133 percent insulated cable. 15 KV rated cable shall have a minimum of 175 mils of insulation for 100 percent insulated cable and a minimum of 220 mils for 133 percent insulated cable.
- G. The cable shall have a semi-conducting shield layer over the insulation. The cable shall have a helically applied copper tape metallic shield over previously described layers. The tape shield shall be a minimum of 5 mils thick with a 25 percent overlap.
- H. The cable shall have an overall outer moisture and sunlight resistant PVC jacket.

## 2.3 MANUFACTURERS - CABLE TERMINATIONS AND CABLE SPLICES

- A. 3M Company
- B. Tyco Electronics (TE Connectivity, Raychem)
- C. Elastimold / Thomas & Betts
- D. Cooper
- E. Prysmian Group

## 2.4 CABLE TERMINATIONS

- A. Medium voltage cable termination types shall be provided as specified on the project drawings and listed in this specification. If no specific type of termination is specified on the drawings, a cable termination type suitable for the equipment or device to which the medium voltage cable is being terminated may be selected from the types described in this specification, given the suitable type is acceptable per the equipment or device manufacturer to which the cable is being terminated. The supplied termination shall be rated for the indoor or outdoor location in which it is being installed and applied. The supplied termination shall also be rated by its manufacturer for the exact type and size of cable to which the termination shall be applied.
- B. Cold Shrink Terminations: Termination kits shall meet the requirements of IEEE Standard 48 for Class 1 terminations. Termination shall be installed per the manufacturer's instructions by certified installers who have received authorized training from the manufacturer. Terminations installed on type MC armored cable shall include re-jacketing materials to cover any exposed cable shield from the point where the outer MC armor sheath terminates to where the medium voltage termination kit is applied.
- C. Heat Shrink Terminations: Termination kits shall meet the requirements of IEEE Standard 48 for Class 1 terminations. Termination shall be installed per the manufacturer's instructions by installers who have received certified training from the manufacturer. Terminations installed on type MC armored cable shall include re-jacketing materials over the cable shields from the point where the outer armor terminates to where the medium voltage termination kit is applied.
- D. 200 Amp Loadbreak Cable Connectors: IEEE 386 type termination. Cable termination loadbreak elbow connectors, one per each single conductor phase cable. Connectors rated at 200 amps and, as a minimum, rated for the voltage class of the cable and equipment/devices to which the cable is connected. 15 KV rated terminations may be shown and required for 5KV equipment applications. 25 KV rated terminations may be shown and required for 15 KV equipment applications. The loadbreak elbow shall be installed per the manufacturer's instructions. The loadbreak elbow shall work with a corresponding 200-amp loadbreak, IEEE 386 type bushing insert that has been factory supplied and installed. The equipment bushing inserts shall be provided as part of the cable terminations and field installed on the equipment/device if not factory furnished.
- E. 600 Amp Deadbreak Cable Connectors: IEEE 386 type termination. Cable termination deadbreak connector, one per each single conductor phase cable. Connectors rated at 600 amps and rated for the voltage class of the cable and equipment/devices to which the cable is connected. **THIS CONNECTOR IS NOT INTENDED TO BE DISCONNECTED WHILE ENERGIZED.** Connector shall be installed per the manufacturer's instructions. The deadbreak connector shall work with a corresponding 600-amp, IEEE 386 type deadbreak equipment bushing that has been factory supplied and installed. The IEEE 386 type, 600-amp equipment bushings shall be provided as part of the cable terminations and field installed on the equipment/device if not factory furnished.

## 2.5 CABLE ACCESSORIES

- A. Lightning Surge Arresters: For use with IEEE 386 cable terminations. Elbow construction, rated 15 KV, MCOV rating of 15.3 KV, duty cycle rating of 18 KV.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that conduit, duct banks, cable trays, trenches, or other raceways, as may be applicable to the project, are ready for cable installation.
- B. Beginning of installation means installer accepts existing conditions.

### 3.2 PREPARATION

- A. Thoroughly swab conduits to remove foreign material before pulling cables.

### 3.3 INSTALLATION

- A. Install cable and terminations in accordance with manufacturer's instructions and to ANSI/IEEE C2.
- B. Ground cable shield at each termination and splice with a shield adapter kit consisting of braided ground lead and a shrink tube cover.
- C. Pull cables using suitable water-based lubricants and cable pulling equipment. Do not exceed cable pulling tensions and bending radius recommended by manufacturer.
- D. Install cable in manholes along those walls providing the longest route and most spare cable lengths. Arrange cable to avoid interferences with duct entrances into manhole.
- E. Avoid abrasion and other damage to cables during installation.
- F. Fireproof cables in manholes using fireproofing tape in half-lapped wrapping extended one inch into ducts.
- G. Loop cables around manhole where terminations are not required.
- H. Medium voltage cables shall be continuous between junction boxes, pull boxes, manholes, or equipment terminal cabinets. No splices will be permitted in medium voltage cables except at junction boxes, pull boxes, manholes, or equipment terminal cabinets.
- I. Provide park stands in equipment adjacent to each load break cable termination if not supplied with the equipment.
- J. Install lightning arresters where shown on the one-line diagram.

### 3.4 FIELD QUALITY CONTROL - VERY LOW FREQUENCY (VLF) TESTING

- A. Field inspection and testing shall be performed under provisions of Section 26 05 00.
- B. Inspect exposed cable sections for physical damage. Verify that cable is connected according to drawings and that shield grounding, cable support, and terminations are properly installed.
- C. Contractor shall inform Architect/Engineer of testing schedule to be performed one week prior to commencing testing should they want to witness testing.

D. Cable Testing: The Contractor shall verify this test procedure with the cable manufacturer, the cable termination manufacturers, and the cable splice manufacturers to receive their approval for conducting the following tests. The Contractor shall ensure that the maximum test voltage does not exceed the limits for terminations or splices specified in ANSI/IEEE48, IEEE 386, or the manufacturer's specifications. The medium voltage cable testing shall be performed in accordance with the IEEE Standard 400.2-2013 covering VLF cable testing and the International Electrical Testing Association (NETA) Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems, specifically the sections relevant to VLF medium voltage cable testing, plus the information contained in this specification. Performance of the test by the Contractor shall constitute acceptance has been received and approved.

1. Perform VLF "acceptance" withstand testing and VLF-TD "tangent delta" power dissipation factor tests on each new medium voltage shielded cable segment after all splice connectors and cable termination stress cones have been completed, but with the cables disconnected from circuit breakers, switches, junction boxes, and equipment. Apply test potential between each conductor and its grounded insulation shield, with the other two circuit conductors and shields grounded. On armored cable, ground the armor and interstice conductors during tests on interlocked armor cable.
2. The VLF "acceptance test voltage" shall be per IEEE Standard 400.2-2013 or the latest version, Table-3, relative to testing with a sinusoidal wave form at 0.1 hertz. Acceptance testing time shall be for 60 minutes on new cable, but if the cable test is stable for at least 15 minutes and no failures occur, the withstand test may be for just 30 minutes. Check cable, termination kits, and splice kit manufacturer's recommended test voltages and never exceed cable manufacturer's recommended test voltages:

a. VLF withstanding test voltages for sinusoidal waveforms; refer to IEEE 400.2.

Cable System Rating KV	Installation (phase to ground)		Acceptance (phase to ground)		Maintenance (phase to ground)	
	KV (rms)	KV peak	KV (rms)	KV peak	KV (rms)	KV peak
5	9	13	10	14	7	10
8	11	16	13	18	10	14
15	19	27	21	30	16	22

b. VLF-TD, "tangent delta", dissipation factor" testing shall be done in accordance with IEEE Standard 400.2-2013, Section 5.4. The tangent delta shall be measured at  $0.5U_0$ ,  $U_0$ , and  $1.5U_0$ , where " $U_0$ " is the normal phase-to-ground operating voltage. The VLF-DTD, "differential tangent delta" shall be calculated, and the VLF-TDTS, "tangent delta temporal stability" shall also be calculated. All readings shall be recorded for the cable under test at the test voltages. Relative to new cable, per IEEE Standard 400.2-2013, Section 5.4.5, the diagnostic test results for the new cable should not be absolutely compared to the standard aged figures of merit for test results, but the cable data will be available for future comparison on any subsequent tests. Relative comparisons between phases should be able to be made. Significantly high dissipation factors associated with a phase in comparison to other phases could be cause for concern.

3. VLF Testing:
    - a. VLF testing shall be done with calibrated VLF cable test equipment.
    - b. The testing shall be done in full accordance with the test equipment manufacturer's instructions for proper and safe use of the equipment.
    - c. Test results shall be recorded for each cable / conductor tested, with the date and time of the test as part of the recorded information.
    - d. The test results shall be summarized in a test report, of which an electronic copy shall be submitted to Architect/Engineer. The report shall indicate whether the test result is satisfactory and the conductor should be accepted for service.
    - e. The Contractor shall notify the Architect/Engineer upon failed test results and not acceptable for service. The failed cable shall be replaced under warranty at no additional cost to the Owner.
  4. Cables shall pass the specified withstand tests without breakdown. When a subsequent test is required, it shall similarly withstand the test voltage specified by Architect/Engineer. Do not exceed the published test values recommended by the cable manufacturer, termination kit manufacturer, or cable splice kit manufacturer. The Electrical Contractor is responsible for verifying and documenting the written test value limits from the various component manufacturers.
  5. Obtain Architect/Engineer acceptance on cable test report(s) per submittal review process prior to energizing the cables.
- E. Test Report Format: An example VLF test report has been included as an example at the end of this section. The Contractor may submit a similar standard form that includes the same information.

END OF SECTION 26 05 15

## EXAMPLE VLF TEST REPORT

Company		Location	
Customer PO#		Owner	
Job #		Owner Representative	
Date		Temperature	
Tested by		Humidity	
Substation		Position	
Circuit ID			

### Device Under Test is Cable

Rated Voltage		Operating Voltage	
Manufacturer		Model	
Insulation Type		Insulation Thickness	
Shield Type		Grounding	
Conductor Size		Conductor Material	
# of Conductors		Length	
Installed in		Age	
Cable Test End		Cable Far End	
Termination near		Termination far	
# of Splices		Splice Locations	
Jacket		Jacket Integrity	

### Equipment

Equipment Used		Serialnumber	
----------------	--	--------------	--

### Test Setup

Type of HV Test		Test Voltage	
Waveform		Planned Test Duration	
Frequency		Current Limit	

### Measurements / Results

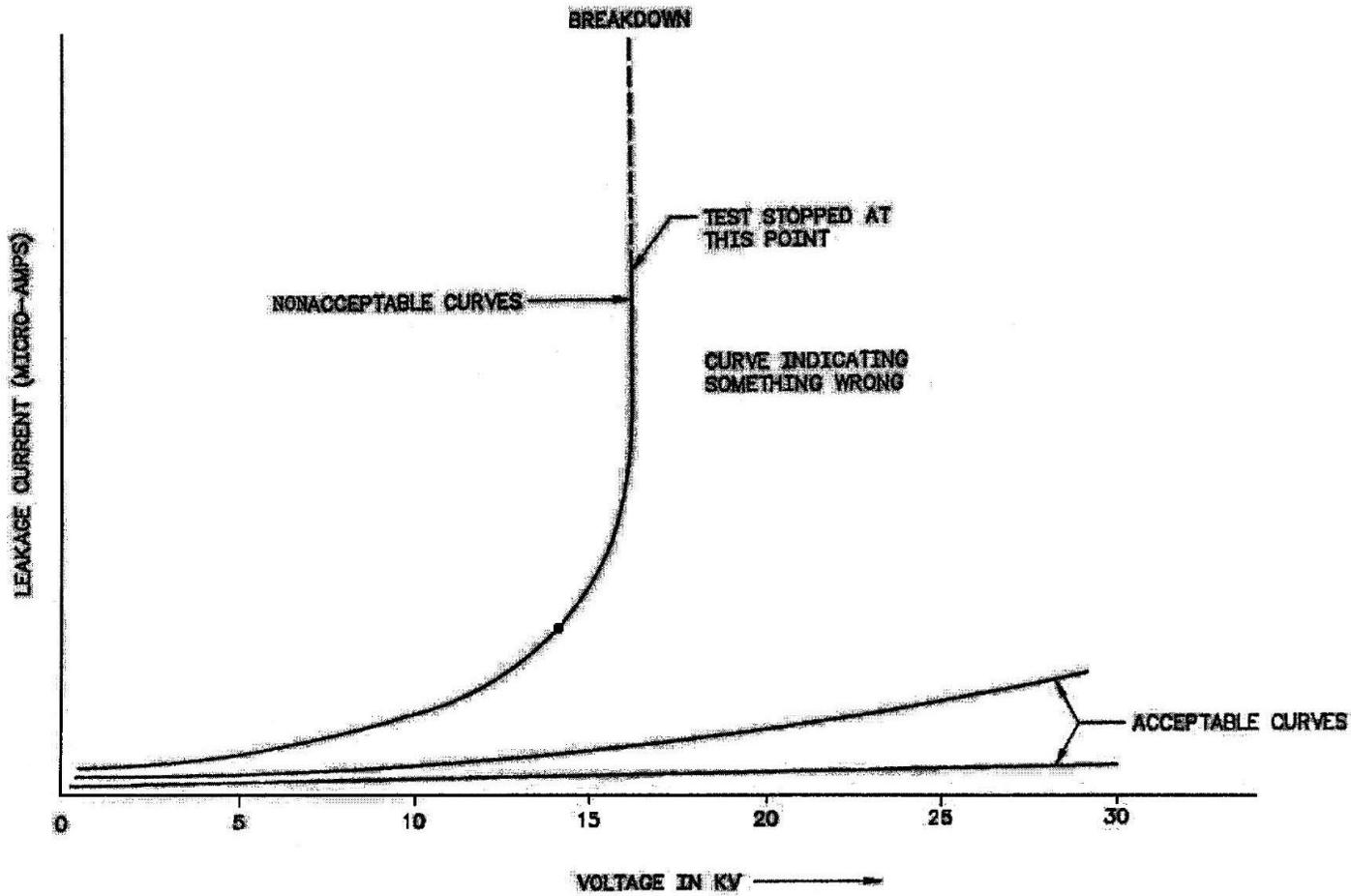
Breakdown		Breakdown Voltage	
Time to Failure			

Ste	Voltage	Current	Capacitance	Leakage Curr.	Frequency	TD (SD) [E-3]
1						
2						
3						
4						
5						

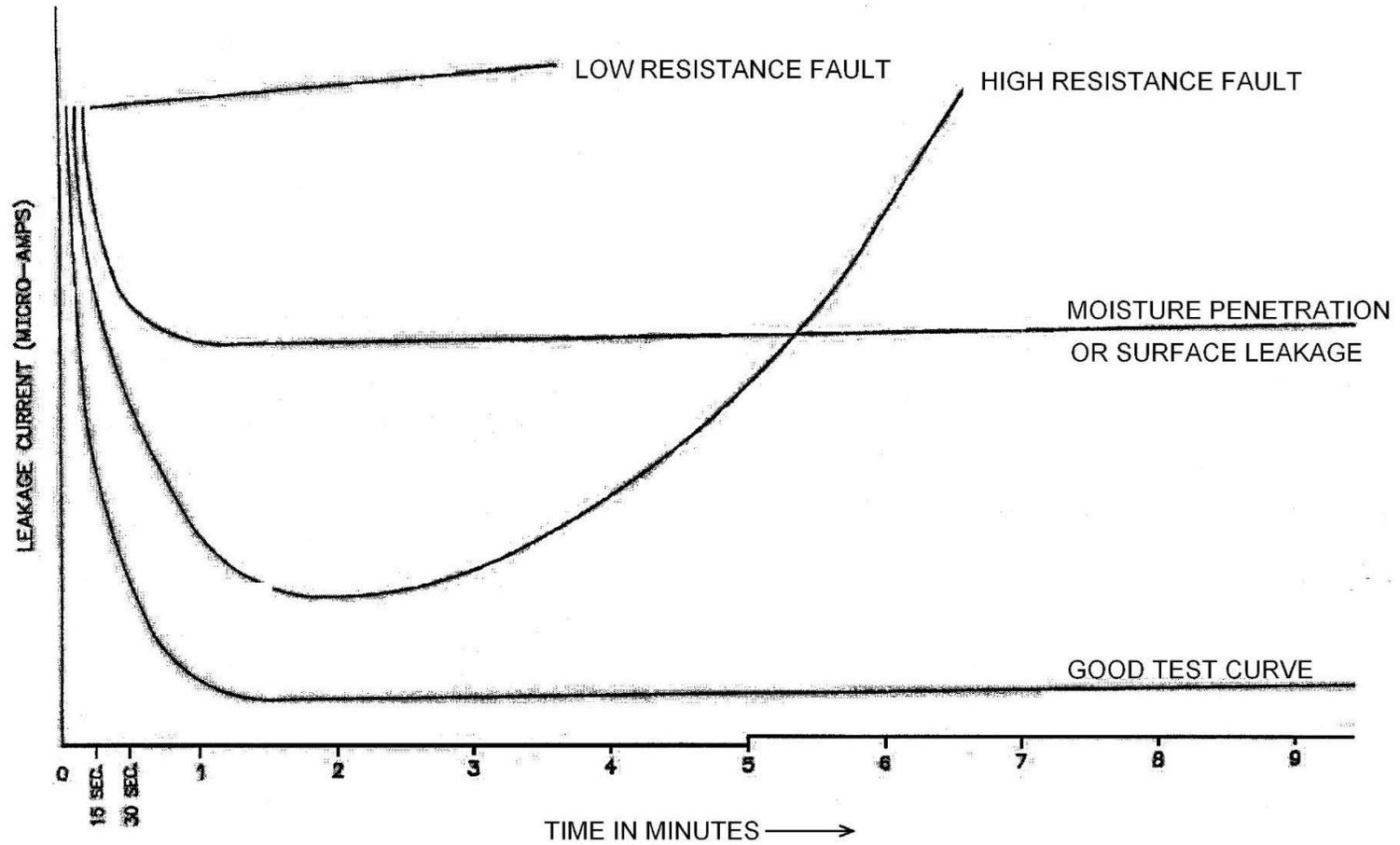
Test is Acceptable Unacceptable

### Comments

# LEAKAGE CURRENT AT INCREASING VOLTAGE



# LEAKAGE CURRENT AT TEST VOLTAGE



## SECTION 26 05 26 - GROUNDING AND BONDING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Equipment grounding system
- B. Bonding system
- C. Grounding electrode system
- D. Grounding of systems over 1kV

#### 1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in Electrical Code, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with UL 467 Grounding and Bonding Equipment.

#### 1.3 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)

#### 1.4 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.

### PART 2 - PRODUCTS

#### 2.1 GROUNDING CONDUCTORS

- A. For insulated conductors, comply with Division 26 Section 26 05 13 "Wire and Cable".
- B. Material: Copper.
- C. Equipment Grounding Conductors: Insulated. Refer to Section 26 05 53 for insulation color.
- D. Grounding Electrode Conductors: Stranded cable.
- E. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.
- F. Copper Bonding Conductors: As follows:

1. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
2. Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
3. Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
4. Tinned Bonding Jumper: Tinned-copper tape, braided copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

G. GB; Grounding Bar:

1. Bare, annealed copper bars of rectangular cross section, with insulators. 1/4" x 2", length of technology or applicable room.

H. IBT; Intersystem Bonding Termination:

1. Copper bar, 1/4" x 2" x 24". Provide with wall mounting brackets, insulators and pre-tapped holes.
2. Manufacturers:
  - a. Harger GBI Series.
  - b. Erico EGB Series.

## 2.2 CONNECTOR PRODUCTS

- A. Comply with UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
- B. Connectors: Hydraulic compression type Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.
- C. Bolted Connectors: Bolted-pressure-type connectors.

## 2.3 GROUNDING ELECTRODES

- A. Ground Rods Copper-clad steel.
- B. Concrete-Encased Grounding Electrode (Ufer): Fabricate according to Electrical Code, using a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG or 20 feet of 1/2" steel reinforcing bar.

## PART 3 - EXECUTION

### 3.1 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.
  3. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.
  4. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
  5. 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. 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.
  - D. 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.
  - E. 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 non-continuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated.
  - F. Structural Steel Connection: Exothermic-welded connections to structural steel. Coordinate with structure to provide physical protection.
  - G. Underground Connections: Exothermic-welded connections. Use for underground connections, except those at test wells.
  - H. Connections at back boxes, junction boxes, pull boxes, and equipment terminations: The equipment grounding conductor(s) associated with all circuits in the box shall be connected together and to the box using a suitable grounding screw. The removal of the respective receptacle, luminaire, or other device served by the box shall not interrupt the grounding continuity. The connection to the non-metallic boxes shall be made to any metallic fitting or device requiring grounding.
  - I. 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.
  - J. 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.

### 3.2 INSTALLATION

- A. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.

- 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. Each grounding conductor that passes through a below grade wall must be provided with a waterstop.
- C. Grounding electrode conductor (GEC) shall be protected from physical damage by rigid polyvinyl chloride conduit (PVC) in exposed locations.
- D. 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.
- E. In raceways, use insulated equipment grounding conductors.
- F. Underground Grounding Conductors: Use copper conductor, No. 2/0 AWG minimum. Bury at least 24 inches below grade or bury 12 inches above duct bank when installed as part of the duct bank.
- G. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment, below access floors, and elsewhere as indicated, with bolted connections to form a continuous ground path.

### 3.3 EQUIPMENT GROUNDING SYSTEM

- A. Comply with Electrical Code, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by Electrical Code are indicated.
- B. Install equipment grounding conductors in all feeders and circuits. Terminate each end on a grounding lug or bus.
- C. Busway Supply Circuits: Install insulated equipment grounding conductor from the grounding bus in the switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.

### 3.4 BONDING SYSTEM

- A. At building expansion joints, provide flexible bonding jumpers to connect to columns or beams on each side of the expansion joint.
- B. Exterior Metallic Pull and Junction Box Covers, Metallic Hand Rails: Bond to grounding system using flexible grounding conductors.
- C. Water Heater, Heat-Tracing, Metal Well Casing, and Heating Cables: Install a separate equipment grounding conductor to each electric water heater, heat-tracing, and anti-frost heating cable. Bond conductor to heater units, piping, well casing, connected equipment, and components.

- D. Connect bonding conductors to metal water pipe using a suitable ground clamp. Make connections to flanged piping at street side of flange. Provide bonding jumper around water meter.
- E. Terminal Cabinets: Terminate bonding conductor on cabinet grounding terminal.
- F. Remote control, signaling, and fire alarm circuits shall be bonded in accordance with the most recent version of the National Electric Code.

### 3.5 GROUNDING ELECTRODE SYSTEM

- A. Ground Ring (Counterpoise):
  - 1. Ground the steel framework of the building with a driven ground rod at the base of every corner column and at intermediate exterior columns at average distances not more than 60 feet apart. Provide a grounding conductor, electrically connected to each ground rod and to each steel column, extending around the perimeter of the building. Use tinned-copper conductor not less than No. 2 AWG for ground ring and for tap to building steel. Bury conductor not less than 30 inches below grade, 24 inches from building foundation, and 18 inches outside of roof drip line.
- B. Supplementary Grounding Electrode: Use driven ground rod on exterior of building.
- C. Provide bonding at Utility Company's metering equipment and pad mounted transformer.
- D. Ground Rods: Install at least two rods spaced at least 20 feet from each other and located at least the same distance from other grounding electrodes.
  - 1. Drive ground rods until tops are 12 inches 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.
- 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 Piping: Use braided-type bonding jumpers to electrically bypass water meters, filtering devices, and similar equipment. Connect to pipe with grounding clamp connectors.
- G. Natural Gas Service Piping: Bond to natural gas main service with grounding clamp connectors. Bonding conductor shall be connected to the main service ground bar. Provide grounding jumpers around all breaks in metallic continuity.

- H. Natural Gas Equipment Piping: Bond each aboveground portion of natural gas metallic piping system at each equipment location with grounding clamp connectors. Bonding shall be performed after any flexible attachment nearest the equipment. The equipment grounding conductors may serve as the bonding means.
- I. Concrete-Encased Grounding Electrode (Ufer): Install concrete-encased grounding electrode encased in at least 2 inches of concrete horizontally within the foundation that is in contact with the earth. If concrete foundation is less than 20 feet 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.

### 3.6 FIELD QUALITY CONTROL

- A. Inspect grounding and bonding system conductors and connections for tightness and proper installation.
  - 1. Measure ground resistance from system neutral connection at service entrance to convenient ground reference points using suitable ground testing equipment. Resistance shall not exceed 5 ohms.

### 3.7 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 2. Maintain restored surfaces. Restore disturbed paving.

END OF SECTION 26 05 26

## SECTION 26 05 27 - SUPPORTING DEVICES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Conduit and equipment supports
- B. Fastening hardware
- C. Concrete housekeeping pads

#### 1.2 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

#### 1.3 COORDINATION

- A. Coordinate size, shape and location of concrete pads with section on Cast-in-Place Concrete or Concrete Topping.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Allied Support Systems
- B. Cooper B-Line
- C. Erico, Inc.
- D. Hilti
- E. Power Fasteners
- F. Orbit Industries

#### 2.2 MATERIAL

- A. Support Channel: Hot-dip galvanized for wet/damp locations; painted steel for interior/dry locations. All field cut ends shall be touched up with matching finish to inhibit rusting.
- B. Hardware: Corrosion resistant.
- C. Anchorage and Structural Attachment Components:
  - 1. Strength: Defined in reports by ICBO Evaluation Service or another agency acceptable to Authorities Having Jurisdiction.

- a. Structural Safety Factor: Strength in tension and shear of components used shall be at least two times the maximum seismic forces to which they will be subjected.
2. Through Bolts: Structural type, hex head, high strength. Comply with ASTM A 325.
3. Welding Lugs: Comply with MSS-SP-69, Type 57.
4. Beam clamps for Steel Beams and Joists: Double sided or concentric open web joist hangars. Single-sided type is not acceptable.
5. Bushings for Floor-Mounted Equipment Anchors: Neoprene units designed for seismically rated rigid equipment mountings, and matched to the type and size of anchor bolts and studs used.
6. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for seismically rated rigid equipment mountings, and matched to the type and size of attachment devices used.
7. Concrete Anchors: Fasten to concrete using cast-in or post-installed anchors designed per the requirements of Appendix D of ACI 318-14. Post-installed anchors shall be qualified for use in cracked concrete by ACI-355.2.
8. Masonry Anchors: Fasten to concrete masonry units with expansion anchors or self-tapping masonry screws. For expansion anchors into hollow concrete block, use sleeve-type anchors designed for the specific application. Do not fasten in masonry joints. Do not use powder actuated fasteners, wooden plugs, or plastic inserts.

D. Conduit Sleeves and Lintels:

1. Each Contractor shall provide, to the General Contractor for installation, lintels for all openings required for the Contractor's work in masonry walls and conduit sleeves for floors, unless specifically shown as being by others.
2. Refer to Structural General Notes for lintel requirements in masonry construction.
3. Fabricate all lintels from structural steel shapes or as indicated on the drawings. All lintels and grouped wall openings shall be approved by the Architect or Structural Engineer.
4. Fabricate all sleeves from standard weight black steel pipe. Provide continuous sleeve. Cut or split sleeves are not acceptable. Sleeves through concrete walls may be high density polyethylene pipe penetration sleeve with a water stop collar, suitable for use with Link-Seal mechanical seals. Century-Line Model CS.
5. Sleeves through the floors on exposed risers shall be flush with the ceiling, with planed squared ends extending 1" above the floor in unfinished areas, and flush with the floor in finished areas, to accept spring closing floor plates.
6. Sleeves shall not penetrate structural members without approval from the Structural Engineer.
7. Openings through unexcavated floors and/or foundation walls below the floor shall have a smooth finish with sufficient annular space around material passing through opening so slight settling will not place stress on the material or building structure.
8. Install all sleeves concentric with conduits. Secure sleeves in concrete to wood forms. This Contractor is responsible for sleeves dislodged or moved when pouring concrete.
9. Where conduits rise through concrete floors that are on earthen grade, provide 3/4" resilient expansion joint material (asphalt and cork) wrapped around the pipe, the full depth of concrete, at the point of penetration. Secure to prevent shifting during concrete placement and finishing.
10. Size sleeves large enough to allow expansion and contraction movement.

E. Concrete Housekeeping Pads:

1. Concrete bases for all floor mounted equipment and wall mounted equipment which is surface mounted and extends to within 6" of the finished floor, unless shown otherwise on the drawings, shall be 3-1/2" thick concrete.
2. Bases shall extend 3" on all sides of the equipment (6" larger than factory base).
3. Where the base is less than 12" from a wall, the base shall be carried to the wall to prevent a "dirt-trap".
4. Concrete materials and workmanship required for the Contractor's work shall be provided by the Contractor. Materials and workmanship shall conform to the applicable standards of the Portland Cement Association. Reinforce with 6" x 6", W1.4-W1.4 welded wire fabric. Concrete shall withstand 3,000 pounds compression per square inch at twenty-eight days.

F. Rooftop Support System:

1. Provide pre-fabricated roof supports for all conduit and equipment installed above the roof. Support all conduit and equipment a minimum of 4" above roof.
2. Support system shall be compatible with single ply, bituminous, metal, and spray foam roof systems. The base shall be rounded to prevent damage to the roof, and drainage holes shall prevent ponding of water in the support.
3. All metal components shall be hot dipped galvanized. Mounting hardware shall be stainless steel or hot dipped galvanized. Support shall be UV, corrosion, and freeze/thaw resistant. Support shall include orange paint, reflective safety orange accents, or similar markings for increased visibility.
4. Products:
  - a. Anvil International HBS-Base Series
  - b. Cooper B-Line Dura-Blok
  - c. Erico Caddy Pyramid 50, 150, 300, or 600 (to match load).

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors in concrete and beam clamps on structural steel.
- B. Use toggle bolts or hollow wall fasteners in hollow masonry, plaster, or gypsum board partitions and walls; expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- C. Do not fasten supports to ceiling systems, piping, ductwork, mechanical equipment, or conduit, unless otherwise noted.
- D. Do not use powder-actuated anchors without specific permission.
- E. Do not drill structural steel members.

- F. Fabricate supports from structural steel or steel channel, rigidly welded or bolted to present a neat appearance. Use hexagon head bolts with spring lock washers under all nuts.
- G. In wet locations and on all building floors below exterior earth grade install free-standing electrical equipment on concrete pads.
- H. Install cabinets and panelboards with minimum of four anchors. Provide horizontal backing/support framing in stud walls for rigid mounting. Provide steel channel supports to stand surface-mounted panelboard or cabinet one inch off wall.
- I. Bridge studs top and bottom with channels to support flush-mounted cabinets and panelboards in stud walls.
- J. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- K. Refer to Section 26 05 33 for special conduit supporting requirements.

### 3.2 FINISH

- A. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
- B. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

END OF SECTION 26 05 27

## SECTION 26 05 33 - CONDUIT AND BOXES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Rigid metallic conduit and fittings (RMC)
- B. Intermediate metallic conduit and fittings (IMC)
- C. Electrical metallic tubing and fittings (EMT)
- D. Flexible metallic conduit and fittings (FMC)
- E. Liquidtight flexible metallic conduit and fittings (LFMC)
- F. Rigid polyvinyl chloride conduit and fittings (PVC)
- G. High density polyethylene conduit and fittings (HDPE)
- H. Wall and ceiling outlet boxes
- I. Electrical connection
- J. Pull and junction boxes
- K. Rough-ins
- L. Accessories

#### 1.2 RELATED WORK

- A. Section 26 05 53 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

#### 1.3 REFERENCES

- A. American National Standards Institute (ANSI):
  - 1. ANSI C80.1 - Rigid Steel Conduit, Zinc-Coated
  - 2. ANSI C80.3 - Electrical Metallic Tubing, Zinc-Coated and Fittings
  - 3. ANSI C80.4 - Fittings for Rigid Metal Conduit and Electrical Metallic Tubing
  - 4. ANSI C80.6 - Intermediate Metal Conduit, Zinc Coated
  - 5. ANSI/NEMA OS 1 - Sheet-Steel Outlet Boxes, Device Boxes, Covers and Box Supports
  - 6. ANSI/NEMA OS 2 - Nonmetallic Outlet Boxes, Device Boxes, Covers and Box Supports
- B. Federal Specifications (FS):
  - 1. A-A-50553A - Fittings for Conduit, Metal, Rigid, (Thick-Wall and Thin-Wall (EMT) Type

2. A-A-55810 - Specification for Flexible Metal Conduit
- C. NECA "Standards of Installation"
- D. National Electrical Manufacturers Association (NEMA):
1. ANSI/NEMA FB 1 - Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable
  2. TC 2 - Electrical Polyvinyl Chloride (PVC) Conduit
  3. TC 9 - Fittings for PVC Plastic Utilities Duct for Underground Installation
- E. NFPA 70 - National Electrical Code (NEC)
- F. Underwriters Laboratories (UL): Applicable Listings
1. UL 1 - Flexible Metal Conduit
  2. UL 6 - Rigid Metal Conduit
  3. UL 360 - Liquid Tight Flexible Steel Conduit
  4. UL514-B - Conduit Tubing and Cable Fittings
  5. UL651-A - Type EB and a PVC Conduit and HDPE Conduit
  6. UL651-B - Continuous Length HDPE Conduit
  7. UL746A - Standard for Polymeric Materials - Short Term Property Evaluations
  8. UL797 - Electrical Metal Tubing
  9. UL1242 - Intermediate Metal Conduit
- G. American Standard of Testing and Materials (ASTM):
1. ASTM D 570 - Standard Test Method for Water Absorption of Plastics
  2. ASTM D 638 - Standard Test Method for Tensile Properties of Plastics
  3. ASTM D 648 - Standard Test Method for Deflection Temperature of Plastics under Flexural Load in the Edge Wise Position
  4. ASTM D 2412 - Standard Test Method for Determination of External Loading Characteristics of Plastic Pipe by Parallel-Plate Loading
  5. ASTM D 2447 - Standard Specification for Polyethylene (PE) Plastic Pipe, Schedules 40 and 80, Based on Outside Diameter
  6. ASTM D 3350 - Standard Specification for Polyethylene Plastic Pipe and Fittings Material
- H. Definitions:
1. Fittings: Conduit connection or coupling.
  2. Body: Enlarged fittings with opening allowing access to the conductors for pulling purposes only.
  3. Mechanical Spaces: Enclosed areas, usually kept separated from the general public, where the primary use is to house service equipment and to route services. These spaces generally have exposed structures, bare concrete and non-architecturally emphasized finishes.
  4. Finished Spaces: Enclosed areas where the primary use is to house personnel and the general public. These spaces generally have architecturally emphasized finishes, ceilings and/or floors.

5. Concealed: Not visible by the general public. Often indicates a location either above the ceiling, in the walls, in or beneath the floor slab, in column coverings, or in the ceiling construction.
6. Above Grade: Not directly in contact with the earth. For example, an interior wall located at an elevation below the finished grade shall be considered above grade but a wall retaining earth shall be considered below grade.
7. Slab: Horizontal pour of concrete used for a floor or sub-floor.

## PART 2 - PRODUCTS

### 2.1 RIGID METALLIC CONDUIT (RMC) AND FITTINGS

#### A. Manufacturers:

1. Allied
2. LTV
3. Steelduct
4. Calbond Calpipe
5. Wheatland Tube Co
6. O-Z Gedney
7. or approved equal.

#### B. Manufacturers of RMC Conduit Fittings:

1. Appleton Electric
2. O-Z/Gedney Co.
3. Electroline
4. Raco
5. Bridgeport
6. Midwest
7. Regal
8. Thomas & Betts
9. Crouse-Hinds
10. Killark
11. Orbit Industries
12. or approved equal.

#### C. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.

#### D. Fittings and Conduit Bodies:

1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.

4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

## 2.2 INTERMEDIATE METALLIC CONDUIT (IMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted.
- B. Manufacturers:
  1. Allied
  2. LTV
  3. Steelduct
  4. Wheatland Tube Co
  5. O-Z Gedney
  6. or approved equal.
- C. Fittings and Conduit Bodies:
  1. End Bell Fittings: Malleable iron, hot dip galvanized, threaded flare type with provisions for mounting to form.
  2. Expansion Joints: Malleable iron and hot dip galvanized providing a minimum of 4 inches of movement. Fitting shall be watertight with an insulating bushing and a bonding jumper.
  3. Expansion Joint for Concrete Encased Conduit: Neoprene sleeve with bronze end coupling, stainless steel bands and tinned copper braid bonding jumper. Fittings shall be watertight and concrete-tight.
  4. Conduit End Bushings: Malleable iron type with molded-on high impact phenolic thermosetting insulation. Where required elsewhere in the contract documents, bushing shall be complete with ground conductor saddle and clamp. High impact phenolic threaded type bushings are not acceptable.
  5. All other fittings and conduit bodies shall be of malleable iron construction and hot dip galvanized.

## 2.3 ELECTRICAL METALLIC TUBING (EMT) AND FITTINGS

- A. Minimum Size Electrical Metallic Tubing: 3/4 inch, unless otherwise noted.
- B. Manufacturers of EMT Conduit:
  1. Allied
  2. Calbond Calpipe
  3. LTV
  4. Steelduct
  5. Wheatland Tube Co
  6. or approved equal.

C. Fittings and Conduit Bodies:

1. 2" Diameter or Smaller: steel set screw type of steel designed for their specific application.
2. 1/2" and 3/4" Conduit: Push-on connectors and couplers with locking ring and washer of zinc plated steel, listed for use in dry locations.
3. Larger than 2": Compression type of steel designed for their specific application.
4. Manufacturers of EMT Conduit Fittings:
  - a. Appleton Electric
  - b. O-Z/Gedney Co.
  - c. Electroline
  - d. Raco
  - e. Bridgeport
  - f. Midwest
  - g. Regal
  - h. Thomas & Betts
  - i. Orbit Industries
  - j. or approved equal.

2.4 FLEXIBLE METALLIC CONDUIT (FMC) AND FITTINGS

- A. Minimum Size Galvanized Steel: 3/4 inch, unless otherwise noted. Lighting branch circuit wiring to an individual luminaire may be a manufactured, UL listed 3/8" flexible metal conduit and fittings with #14 AWG THHN conductors and an insulated ground wire. Maximum length of 3/8" FMC shall be six (6) feet.
- B. Manufacturers:
  1. American Flex
  2. Alflex
  3. Electri-Flex Co
  4. or approved equal.
- C. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel. Provide a separate equipment grounding conductor when used for equipment where flexibility is required.
- D. Fittings and Conduit Bodies:
  1. Threadless hinged clamp type, galvanized zinc coated cadmium plated malleable cast iron or screw-in type, die-cast zinc.
  2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
  3. Manufacturers:
    - a. O-Z/Gedney Co.
    - b. Thomas & Betts
    - c. Appleton Electric
    - d. Electroline
    - e. Bridgeport

- f. Midwest
- g. Regal
- h. Orbit Industries
- i. or approved equal.

## 2.5 LIQUIDTIGHT FLEXIBLE METALLIC CONDUIT (LFMC) AND FITTINGS

### A. Manufacturers:

- 1. Anaconda Type UA
- 2. Electri-Flex Type LA
- 3. Alflex
- 4. Carlon (Lamson & Sessions)
- 5. or approved equal.

### B. Construction: Flexible steel, approved for conduit ground, zinc coated, threadless type formed from a continuous length of spirally wound, interlocked zinc coated strip steel and an extruded PVC cover.

### C. Fittings and Conduit Bodies:

- 1. Watertight, compression type, galvanized zinc coated cadmium plated malleable cast iron, UL listed.
- 2. Fittings and conduit bodies shall include plastic or cast metal inserts supplied by the manufacturer to protect conductors from sharp edges.
- 3. Manufacturers:
  - a. Appleton Electric
  - b. O-Z/Gedney Co.
  - c. Electroline
  - d. Bridgeport
  - e. Thomas & Betts
  - f. Midwest
  - g. Regal
  - h. Carlon (Lamson & Sessions)
  - i. Orbit Industries
  - j. or approved equal.

## 2.6 RIGID NON-METALLIC CONDUIT (PVC) AND FITTINGS

### A. Minimum Size Rigid Smooth-Wall Nonmetallic Conduit: 3/4 inch, unless otherwise noted.

### B. Acceptable Manufacturers:

- 1. Carlon (Lamson & Sessions) Type 40
- 2. Cantex, J.M. Mfg.
- 3. or approved equal.

### C. Construction: Schedule 40 and Schedule 80 rigid polyvinyl chloride (PVC), UL labeled for 90°C.

- D. Fittings and Conduit Bodies: NEMA TC 3; sleeve type suitable for and manufactured especially for use with the conduit by the conduit manufacturer.
- E. Plastic cement for joining conduit and fittings shall be provided as recommended by the manufacturer.

## 2.7 HIGH DENSITY POLYETHYLENE (HDPE)

- A. Minimum Size: 2 inch, unless noted otherwise.
- B. Acceptable Manufacturers:
  - 1. Carlon
  - 2. Chevron Phillips Chemical Company
  - 3. or approved equal.
- C. Materials used for the manufacture of polyethylene pipe and fittings shall be extra high molecular weight, high-density polyethylene resin. The material shall be listed by PPI (Plastic Pipe Institute) and shall meet the following resin properties:
- D. The pipe shall contain no recycled compound except that generated in the manufacturer's own plant from resin of the same raw material, including both the base resin and coextruded resin. The pipe shall be homogeneous throughout and free of visible cracks, holes, voids, foreign inclusions, or other defects that may affect the wall integrity.
- E. Fitting and Conduit Bodies:
  - 1. Directional Bore and Plow Type Installation: Electrofusion or Universal Aluminum threaded couplings. Tensile strength of coupled pipe must be greater than 2,000 lbs.
  - 2. For all other type of installation: Coupler must provide a water tight connection. The tensile strength of coupled pipe must be greater than 1,000 lbs.
  - 3. E-loc type couplings are not acceptable in any situations.
  - 4. Acceptable Manufacturers:
    - a. ARCON
    - b. Carlon
    - c. or approved equal.

## 2.8 OUTLET BOXES

- A. Sheet Metal Outlet Boxes: ANSI/NEMA OS 1; galvanized steel, 16 gauge (approximately 0.0625 inches), with 1/2-inch male fixture studs where required.
- B. Nonmetallic Outlet Boxes: ANSI/NEMA OS 2.
- C. Cast Boxes: NEMA FB1, Type FD, Aluminum, cast fer alloy, or stainless steel deep type, gasketed cover, threaded hubs.
- D. Outlet boxes for luminaires to be not less than 1-1/2" deep, deeper if required by the number of wires or construction. The box shall be coordinated with surface luminaires to conceal the box from view or provide a finished trim plate.

- E. Switch outlet boxes for local light control switches, dimmers and occupancy sensors shall be 4 inches square by 2-1/8 inches deep, with raised cover to fit flush with finish wall line. Multiple gang switch outlets shall consist of the required number of gang boxes appropriate to the quantity of switches comprising the gang. Where walls are plastered, provide a plaster raised cover. Where switch outlet boxes occur in exposed concrete block walls, boxes shall be installed in the block cavity with a raised square edge tile cover of sufficient depth to extend out to face of block or masonry boxes.
- F. Outlet boxes for telephone substations in walls and columns shall be 4 inches square and 2-1/8 inches deep with single gang raised cover to fit flush with finished wall line equipped with flush telephone plate.
- G. Wall or column receptacle outlet boxes shall be 4 inches square with raised cover to fit flush with finished wall line. Boxes in concrete block walls shall be installed the same as for switch boxes in block walls.

## 2.9 ECONN; ELECTRICAL CONNECTION

- A. Electrical connection to equipment and motors, sized per Electrical Code. Coordinate requirements with contractor furnishing equipment or motor. Refer to specifications and general installation notes for terminations to motors.

## 2.10 JB; PULL AND JUNCTION BOXES

- A. Sheet Metal Boxes: ANSI/NEMA OS 1; galvanized steel.
- B. Sheet metal boxes larger than 12 inches in any dimension that contain terminations or components: Continuous hinged enclosure with 1/4 turn latch and white back panel for mounting terminal blocks and electrical components.
- C. Cast Metal Boxes for Outdoor and Wet Location Installations: NEMA 250; Type 4 and Type 6, flat-flanged, surface-mounted junction box, UL listed as raintight. Galvanized cast iron box and cover with ground flange, neoprene gasket, and stainless steel cover screws.
- D. Cast Metal Boxes for Underground Installations: NEMA 250; Type 4, inside flanged, recessed cover box for flush mounting, UL listed as raintight. Galvanized cast iron box and plain cover with neoprene gasket and stainless steel cover screws.
- E. Flanged type boxes shall be used where installed flush in wall.

## 2.11 ROUGH-IN

- A. Provide with one (1) flush mount double gang box with single gang plaster ring and appropriate cover plate,
- B. Conduit stubbed to above the lay-in ceiling.
- C. RI-TECH; Technology Rough-in:
  1. Rough-in shall have one (1) 1" conduit.

- D. RI-TECH-W; Technology Rough-in - Wall Phone:
  - 1. Mount on wall +54" or as noted in plans. Rough-in shall have one (1) 1" conduit.
- E. RI-TECH-C; Technology Rough-in - Ceiling Flush Mounted:
  - 1. Mount flush in finished ceiling or as noted in plans. Rough-in shall have one (1) 1" conduit.

## 2.12 ACCESSORIES

- A. Fire Rated Moldable Pads: UL #9700, moldable sheet putty at required thickness on all five sides of back boxes. Kinetics Noise Control - IsoBacker Pad, SpecSeal - SSP Putty and Pads, 3M #MPP-4S or equal.
- B. Sound Barrier Insulation Pads: Mastic, non-hardening, sheet material, minimum 1/8" thickness applied to all five sides of back boxes. Kinetics Noise Control - SealTight Backer Pad, L.H. DOTTIE Co., #68 or equal.

## PART 3 - EXECUTION

### 3.1 CONDUIT INSTALLATION SCHEDULE AND SIZING

- A. In the event the location of conduit installation represents conflicting installation requirements as specified in the following schedule, a clarification shall be obtained from the Architect/Engineer. If this Contractor is unable to obtain a clarification as outlined above, concealed rigid galvanized steel conduit installed per these specifications and the Electrical Code shall be required.
- B. Installation Schedule: Refer to drawings.
- C. Size conduit as shown on the drawings and specifications. Where not indicated in the contract documents, conduit size shall be according to the Electrical Code. Conduit and conductor sizing shall be coordinated to limit conductor fill to less than 40%, maintain conductor ampere capacity as required by the Electrical Code (to include enlarged conductors due to temperature and quantity derating values) and to prevent excessive voltage drop and pulling tension due to long conduit/conductor lengths.
- D. Minimum Conduit Size (Unless Noted Otherwise):
  - 1. Above Grade: 3/4 inch. (The use of 1/2 inch would be allowed for installation conduit to individual light switches, individual receptacles and individual fixture whips from junction box.)
  - 2. Below Grade 5' or less from Building Foundation: 1 inch.
  - 3. Below Grade More than 5' from Building Foundation: 1 inch.
  - 4. Telecommunication Conduit: 1 inch.
  - 5. Controls Conduit: 1/2 inch.
- E. Conduit sizes shall change only at the entrance or exit to a junction box, unless specifically noted on the drawings.

### 3.2 CONDUIT ARRANGEMENT

- A. In general, conduit shall be installed concealed in walls, in finished spaces and where possible or practical, or as noted otherwise. Conduit shall be installed parallel or perpendicular to walls, ceilings, and exposed structural members. In unfinished spaces, mechanical and utility areas, conduit may run either concealed or exposed as conditions dictate and as practical unless noted otherwise on drawings. Installation shall maintain headroom in exposed vicinities of pedestrian or vehicular traffic.
- B. Exposed conduit on exterior walls or above roof will not be allowed without prior written approval of Architect/Engineer. A drawing of the proposed routing and a photo of the location shall be submitted 14 days prior to start of conduit rough-in. Routing shall be shown on coordination drawings.
- C. Conduit shall not share the same cell as structural reinforcement in masonry walls.
- D. Conduit runs shall be routed as shown on large scale drawings. Conduit routing on drawings scaled 1/4"=1'-0" or less shall be considered diagrammatic, unless noted otherwise. The correct routing, when shown diagrammatically shall be chosen by the Contractor based on information in the contract documents, in accordance with manufacturer's written instructions, applicable codes, the NECA's "Standard of Installation", in accordance with recognized industry standards, and coordinated with other contractors.
- E. Contractor shall adapt Contractor's work to the job conditions and make such changes as required and permitted by the Architect/Engineer, such as moving to clear beams and joists, adjusting at columns, avoiding interference with windows, etc., to permit the proper installation of other mechanical and/or electrical equipment.
- F. Contractor shall cooperate with all contractors on the project. Contractor shall obtain details of other contractor's work to ensure fit and avoid conflict. Any expense due to the failure of This Contractor to do so shall be paid for in full by Contractor. The other trades involved as directed by the Architect/Engineer shall perform the repair of work damaged as a result of neglect or error by This Contractor. The resultant costs shall be borne by This Contractor.

### 3.3 CONDUIT SUPPORT

- A. Conduit runs installed above a suspended ceiling shall be properly supported. In no case shall conduit rest on the suspended ceiling construction, nor utilize ceiling support system for conduit support.
  - 1. Support wire used to independently support raceway and wiring systems above suspending ceilings shall be supported on both ends, minimum 12 gauge suspended ceiling support wire, and distinguishable from ceiling support systems by color (field paint), tagging, or equivalent means.
- B. Conduit shall not be supported from ductwork, water, sprinkler piping, or other non-structural members, unless approved by the Architect/Engineer. All supports shall be from structural slabs, walls, structural members, and bar joists, and coordinated with all other applicable contractors, unless noted otherwise.

- C. Conduit shall be held in place by the correct size of galvanized one-hole conduit clamps, two-hole conduit straps, patented support devices, clamp back conduit hangers, or by other means if called for on the drawings.
- D. Support individual horizontal raceways with separate, malleable-iron pipe hangers or clamps.
- E. Spring-steel conduit clips specifically designed for supporting single conduits or tubing may be used in lieu of malleable-iron hangers for 1" and smaller raceways serving lighting and receptacle branch circuits above accessible ceilings and for securing raceways to slotted channel and angle supports.
- F. Group conduits in parallel runs where practical and use conduit racks or trapeze hangers constructed of steel channel, suspended with threaded solid rods or wall mounted from metal channels with conduit straps or clamps. Provide space in each rack or trapeze for 25% additional conduits.
- G. Do not exceed 25 lbs. per hanger and a minimum spacing of 2'-0" on center when attaching to metal roof decking (excludes concrete on metal deck). This 25 lbs. load and 2'-0" spacing include adjacent electrical and mechanical items hanging from deck. If the hanger restrictions cannot be achieved, supplemental framing off steel framing will need to be added.
- 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. Supports for metallic conduit shall be no greater than 10 feet. A smaller interval may be used if necessitated by building construction, but in no event shall support spans exceed the Electrical Code requirements. Conduit shall be securely fastened within 3 feet of each outlet box, junction box, device box, cabinet, or fitting.
- J. Supports of flexible conduit shall be within 12 inches of each outlet box, junction box, device box, cabinet, or fitting and at intervals not to exceed 4.5 feet.
- K. Supports for non-metallic conduit shall be at sufficiently close intervals to eliminate any sag in the conduit. The manufacturer's recommendations shall be followed, but in no event shall support spans exceed the Electrical Code requirements.
- L. Where conduit is to be installed in poured concrete floors or walls, provide concrete-tight conduit inserts securely fastened to forms to prevent conduit misplacement.
- M. Finish:
  - 1. Prime coat exposed steel hangers and supports. Hangers and supports in crawl spaces, pipe shafts, and above suspended ceiling spaces are not considered exposed.
  - 2. Trim all ends of exposed field fabricated steel hangers, slotted channel and threaded rod to within 1" of support or fastener to eliminate potential injury to personnel unless shown otherwise on the drawings. Smooth ends and install elastomeric insulation with two coats of latex paint if exposed steel is within 6'-6" of finish floor and presents potential injury to personnel.

### 3.4 CONDUIT INSTALLATION

#### A. Conduit Connections:

1. Shorter than standard conduit lengths shall be cut square using industry standards. The ends of all conduits cut shall be reamed or otherwise finished to remove all rough edges.
2. Metallic conduit connections in slab on grade installation shall be sealed and one coat of rust inhibitor primer applied after the connection is made.
3. Where conduits with tapered threads cannot be coupled with standard couplings, then approved split or Erickson couplings shall be used. Running threads will not be permitted.
4. Install expansion/deflection joints where conduit crosses structure expansion/seismic joints.

#### B. Conduit terminations for all low voltage wiring shall have nylon bushings installed on each end of every conduit run.

#### C. Conduit Bends:

1. Use a hydraulic one-shot conduit bender or factory elbows for bends in conduit 2" in size or larger. All steel conduit bending shall be done cold; no heating of steel conduit shall be permitted.
2. All bends of rigid polyvinyl chloride conduit (PVC) shall be made with the manufacturer's approved bending equipment. The use of spot heating devices will not be permitted (i.e. blow torches).
3. A run of conduit shall not contain more than the equivalent of four (4) quarter bends (360°), including those bends located immediately at the outlet or body.
4. Telecommunications conduits shall have no more than two (2) 90-degree bends between pull points and contain no continuous sections longer than 100 feet. Insert pull points or pull boxes for conduits exceeding 100 feet in length.
  - a. A third bend is acceptable if:
    - 1) The total run is not longer than (33) feet.
    - 2) The conduit size is increased to the next trade size.
5. Telecommunications pull boxes shall not be used in lieu of a bend. Align conduits that enter the pull box from opposite ends with each other. Pull box size shall be twelve (12) times the diameter of the largest conduit. Slip sleeves or gutters can be used in place of a pull box.
6. Telecommunications Conduit(s): Maintain appropriate conduit bend radius at all times. For conduits with an internal diameter of less than 2", maintain a bend radius of at least 6 times the internal diameter. For conduits with an internal diameter 2" or greater, maintain a bend radius of at least 10 times the internal diameter.
7. Use conduit bodies to make sharp changes in direction (i.e. around beams).

D. Conduit Placement:

1. Conduit shall be mechanically continuous from source of current to all outlets. Conduit shall be electrically continuous from source of current to all outlets, unless a properly sized grounding conductor is routed within the conduit. All metallic conduits shall be bonded per the Electrical Code.
2. Route exposed conduit and conduit above suspended ceilings (accessible or not) parallel/perpendicular to the building structural lines, and as close to building structure as possible. Wherever possible, route horizontal conduit runs above water and steam piping.
3. Route conduit through roof openings provided for piping and ductwork where possible. If not provided or routing through provided openings is not possible, route through roof jack with pitch pocket. Coordinate roof penetrations with other trades.
4. Conduits, raceway, and boxes shall not be installed in concealed locations in metal deck roofing or less than 1.5" below bottom of roof decking.
5. Avoid moisture traps where possible. Where unavoidable, provide a junction box with drain fitting at conduit low point.
6. All conduits through walls shall be grouted or sealed into openings. Where conduit penetrates firewalls and floors, seal with a UL listed sealant. Seal penetrations with intumescent caulk, putty, or sheet installed per manufacturer's recommendations. All materials used to seal penetrations of firewalls and floors shall be tested and certified as a system per ASTM E814 Standard for fire tests or through-penetration fire stops as manufactured by 3M or approved equal.
7. **CONTRACTOR SHALL BE RESPONSIBLE FOR ALL OPENINGS REQUIRED IN MASONRY OR EXTERIOR WALLS UNDER THIS DIVISION. A QUALIFIED MASON AT THE EXPENSE OF THIS CONTRACTOR SHALL REPAIR ALL OPENINGS TO MATCH EXISTING CONDITIONS.**
8. Seal interior of conduit at exterior entries, air handling units, coolers/freezers, etc., and where the temperature differential can potentially be greater than 20°F, to prevent moisture penetration. Seal shall be placed where conduit enters warm space. Conduit seal fitting shall be a drain/seal, with sealing compound, identified for use with cable and raceway system, equal to O-Z/Gedney type EYD.
9. Horizontal conduit routing through slabs above grade
  - a. No conduits are allowed to be routed horizontally through slabs above grade.
10. Where rigid polyvinyl chloride conduit (PVC) is used below grade, in a slab, below a slab, etc., a transition to rigid galvanized steel or PVC-coated steel conduit shall be installed before conduit exits earth. The metallic conduit shall extend a minimum of 6" into the surface concealing the non-metallic conduit.
11. Contractor shall provide suitable mechanical protection around all conduits stubbed out from floors, walls or ceilings during construction to prevent bending or damaging of stubs due to carelessness with construction equipment.
12. Contractor shall provide a polypropylene pull cord with 2000 lbs. tensile strength in each empty conduit (indoor and outdoor), except in sleeves and nipples.
13. Telecommunications conduits that protrude through the structural floor shall be installed 1 to 3" above finished floor (AFF).
14. Telecommunications conduits that enter into Telecommunications rooms below the finished ceiling shall terminate a minimum of 4" below ceiling and as close to the wall as possible.

15. Telecommunications conduits that are below grade and enter into a building shall terminate a minimum of 4" above finished floor (AFF) and as close to the wall as possible.

### 3.5 CONDUIT TERMINATIONS

- A. Where conduit bonding is indicated or required in the contract documents, the bushings shall be a grounding type sized for the conduit and ground bonding conductor as manufactured by O-Z/Gedney, Appleton, Thomas & Betts, Burndy, Regal, Orbit Industries or approved equal.
- B. Conduits with termination fittings shall be threaded for one (1) lock nut on the outside and one (1) lock nut and bushing on the inside of each box.
- C. Where conduits terminate in boxes with knockouts, they shall be secured to the boxes with lock nuts and provided with approved screw type tinned iron bushings or fittings with plastic inserts.
- D. Where conduits terminate in boxes, fittings, or bodies with threaded openings, they shall be tightly screwed against the shoulder portion of the threaded openings.
- E. Conduit terminations to all motors shall be made with flexible metallic conduit (FMC), unless noted otherwise. Final connections to roof exhaust fans, or other exterior motors and motors in damp or wet locations shall be made with liquidtight flexible metallic conduit (LFMC). Motors in hazardous areas, as defined in the Electrical Code, shall be connected using flexible conduit rated for the environment. Flexible conduit shall not exceed 6' in length. Route equipment ground conductors from circuit ground to motor ground terminal through flexible conduit.
- F. Rigid polyvinyl chloride conduit (PVC) shall be terminated using fittings and bodies produced by the manufacturer of the conduit, unless noted otherwise. Prepare conduit as per manufacturer's recommendations before joining. All joints shall be solvent welded by applying full even coat of plastic cement to the entire areas that will be joined. Turn the conduit at least a quarter to one half turn in the fitting and let the joint cure for 1-hour minimum or as per the manufacturer's recommendations.
- G. All conduit ends shall be sealed with plastic immediately after installation to prevent the entrance of any foreign matter during construction. The seals shall be removed and the conduits blown clear of all foreign matter prior to any wires or pull cords being installed.

### 3.6 UNDERGROUND CONDUIT INSTALLATION

- A. Conduit Connections:
  1. Conduit joints in a multiple conduit run shall be staggered at least one foot apart.
- B. Conduit Bends (Lateral):
  1. Conduits shall have long sweep radius elbows instead of standard elbows wherever special bends are indicated and noted on the drawings, or as required by the manufacturer of the equipment or system being served.

2. Telecommunications conduit bend radius shall be six times the diameter for conduits under 2" and ten times the diameter for conduits over 2". Where long cable runs are involved, sidewall pressures may require larger radius bends. Coordinate with Architect/Engineer prior to conduit installation to determine bend radius.
- C. Conduit Elbows (vertical):
1. Minimum metal or RTRC elbow radiuses shall be 30 inches for primary conduits (greater than 600V) and 18 inches for secondary conduits (less than 600V). Increase radius, as required, based on pulling tension calculation requirements.
- D. Conduit Placement:
1. Conduit runs shall be pitched a minimum of 4" per 100 feet to drain toward the terminations. Duct runs shall be installed deeper than the minimum wherever required to avoid any conflicts with existing or new piping, tunnels, etc.
  2. For parallel runs, use suitable separators and chairs installed not greater than 4' on centers. Band conduit together with suitable banding devices. Securely anchor conduit to prevent movement during concrete placement or backfilling.
  3. Where concrete is required, the materials for concreting shall be thoroughly mixed to a minimum f'c = 2500 and immediately placed in the trench around the conduits. No concrete that has been allowed to partially set shall be used.
  4. Before the Contractor pulls any cables into the conduit, Contractor shall have a mandrel 1/4" smaller than the conduit inside diameter pulled through each conduit and if any concrete or obstructions are found, the Contractor shall remove them and clear the conduit. Spare conduit shall also be cleared of all obstructions.
  5. Conduit terminations in manholes, masonry pull boxes, or masonry walls shall be with malleable iron end bell fittings.
  6. All spare conduits not terminated in a covered enclosure shall have its terminations plugged as described above.
  7. Ductbanks and conduit shall be installed a minimum of 24" below finished grade, unless otherwise noted on the drawings or elsewhere in these specifications.
  8. All non-metallic conduit installed underground outside of a slab shall be rigid.
- E. Horizontal Directional Drilling:
1. Entire drill path shall be accurately surveyed, with entry and exit stakes placed and coordinated with other contractors. If using a magnetic guidance system, entire drill path shall be surveyed for any surface geo-magnetic variations or anomalies.
  2. Any utility locates within 20 feet of the bore path shall have the exact location physically verified by hand digging or vacuum excavation. Restore inspection holes to original condition after verification.
- F. Raceway Seal:
1. Where a raceway enters a building or structure, it shall be sealed with a sealing bushing or duct seal to prevent the entry of liquids or gases. Seal must be compatible with conductors and raceway system. Spare or unused raceway shall also be sealed.
  2. All telecommunications conduits and innerducts, including those containing cables, shall be plugged at the building and vault with "JackMoon" or equivalent duct seal, capable of withstanding a 10-foot head of water (5 PSI).

### 3.7 BOX INSTALLATION SCHEDULE

- A. Galvanized steel boxes may be used in:
  - 1. Concealed interior locations above ceilings and in hollow studded partitions.
  - 2. Exposed interior locations in mechanical rooms and in rooms without ceilings; higher than 8' above the highest platform level.
  - 3. Direct contact with concrete except slab on grade.
- B. Cast boxes shall be used in:
  - 1. Exterior locations.
  - 2. Exposed interior locations within 8' of the highest platform level.
  - 3. Direct contact with earth.
  - 4. Direct contact with concrete in slab on grade.
  - 5. Wet locations.

### 3.8 COORDINATION OF BOX LOCATIONS

- A. Provide electrical boxes as shown on the drawings, and as required for splices, taps, wire pulling, equipment connections, and code compliance.
- B. Electrical box locations shown on the Contract Drawings are approximate, unless dimensioned. Verify location of floor boxes and outlets in offices and work areas prior to rough-in.
- C. Locate and install boxes to allow access. Avoid interferences with ductwork, piping, structure, equipment, etc. Recessed luminaires shall not be used as access to outlet, pull, and junction boxes. Where installation is inaccessible, provide access doors. Coordinate locations and sizes of required access doors with the Architect/Engineer and General Contractor.
- D. Locate and install to maintain headroom and to present a neat appearance.
- E. Coordinate locations with Heating Contractor to avoid baseboard radiation cabinets.

### 3.9 OUTLET BOX INSTALLATION

- A. Do not install boxes back-to-back in walls.
  - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.
  - 2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.

- B. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.
- C. The Contractor shall anchor switch and outlet box to wall construction so that it is flush with the finished masonry, paneling, drywall, plaster, etc. The Contractor shall check the boxes as the finish wall surface is being installed to assure that the box is flush. (Provide plaster rings as necessary.)
- D. Mount at heights shown or noted on the drawings or as generally accepted if not specifically noted.
- E. Locate boxes in masonry walls to require cutting of masonry unit corner only. Coordinate masonry cutting to achieve neat openings for boxes.
- F. Provide knockout closures for unused openings.
- G. Support boxes independently of conduit.
- H. Use multiple-gang boxes where more than one device is mounted together; do not use sectional boxes. Provide barriers to separate wiring of different voltage systems.
- I. Install boxes in walls without damaging wall insulation.
- J. Coordinate mounting heights and locations of outlets mounted above counters, benches, backsplashes, and below baseboard radiation.
- K. Position outlets to locate luminaires as shown on reflected ceiling drawings.
- L. Provide recessed outlet boxes in finished areas; secure boxes to interior wall and partition studs, accurately positioned to allow for surface finish thickness. Use stamped steel stud bridges for flush outlets in hollow stud wall, and adjustable steel channel fasteners for flush ceiling outlet boxes.
- M. Align wall-mounted outlet boxes for switches, thermostats, and similar devices.
- N. Provide cast outlet boxes in exterior locations and wet locations, and where exposed rigid or intermediate conduit is used.

### 3.10 PULL AND JUNCTION BOX INSTALLATION

- A. Locate pull boxes and junction boxes above accessible ceilings or in unfinished areas.
- B. Support pull and junction boxes independent of conduit.
- C. Do not install boxes back-to-back in walls.
  - 1. Provide a minimum horizontal separation of 6 inches between boxes installed on opposite sides of non-rated stud walls. When the minimum separation cannot be maintained, install sound insulation pads on all five sides of the back box in accordance with the manufacturer's instructions.

2. Provide a minimum horizontal separation of 24 inches between boxes installed on opposite sides of fire-rated walls. When the minimum separation cannot be maintained, the box is greater than 16 square inches or the total box area (all trades) per 100 square feet is greater than or equal to 100 square inches, install fire-rated moldable pads to all five sides of the back box to maintain the fire rating of the wall. Install moldable pads in accordance with UL listing for the specific product. Sound insulation pads are not acceptable for use in fire-rated wall applications unless the product carries the necessary fire rating.
- D. Install sound insulation pads on all five sides of the back of all boxes in sound-rated wall assemblies. Sound-rated wall assemblies are defined as partition types carrying a Sound Transmission Class (STC) rating.

### 3.11 EXPOSED BOX INSTALLATION

- A. Boxes shall be secured to the building structure with proper size screws, bolts, hanger rods, or structural steel elements.
- B. On brick, block and concrete walls or ceilings, exposed boxes shall be supported with no less than two (2) Ackerman-Johnson, Paine, Phillips, or approved equal screw anchors or expansion shields and round head machine screws. Cast boxes shall not be drilled.
- C. On steel structures, exposed boxes shall be supported to the steel member by drilling and tapping the member and fastening the boxes by means of round head machine screws.
- D. Boxes may be supported on steel members by APPROVED beam clamps if conduit is supported by beam clamps.
- E. Boxes shall be fastened to wood structures by means of a minimum of two (2) wood screws adequately large and long to properly support. (Quantity depends on size of box.)
- F. Wood, plastic, or fiber plugs shall not be used for fastenings.
- G. Explosive devices shall not be used unless specifically allowed.

END OF SECTION 26 05 33

## SECTION 26 05 35 - SURFACE RACEWAYS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Architectural surface raceways
- B. Surface metal raceways

#### 1.2 REFERENCES

- A. FS W-C-582 - Conduit, Raceway, Metal, and Fitting; Surface

#### 1.3 SUBMITTALS

- A. Submit shop drawings under provisions of Section 26 05 00.
- B. Include product data for surface metal raceways, and accessories.

### PART 2 - PRODUCTS

#### 2.1 ARCHITECTURAL SURFACE RACEWAY

- A. Surface Metal Raceway: Steel channel with fitted cover, size per circuit requirements.
- B. Finish: Color selection by Architect.
- C. Fittings: Couplings, elbows, and connectors designed for use with the raceway system.
- D. Boxes and Extension Rings: Designed for use with the raceway system.
- E. Manufacturers:
  - 1. Wiremold V500/V700 series
  - 2. Mono-Systems SMS500/SMS700 series
  - 3. Hubbell HBL500/HBL700 series.

#### 2.2 SURFACE METAL RACEWAY

- A. Surface Metal Raceway: FS W-C-582; sheet metal channel with fitted cover, suitable for use as a continuous surface metal raceway.
- B. Finish: Rust inhibiting primer coat for field painting. Coordinate paint color with Architect.
- C. Fittings: Couplings, elbows, and connectors designed for use with raceway system.
- D. Boxes and Extension Rings: Designed for use with raceway systems.

- E. Coverplates shall be same material and finish as raceway.
- F. Normal power receptacles shall be same color as raceway. Coordinate color with Architect.
- G. Receptacles and outlets shown on raceway on drawings shall be mounted with overlapping faceplates in the raceway and shall not be mounted in boxes unless specifically noted otherwise.
- H. WW-1; Surface metal raceway, metallic cover, minimum 2" opening, minimum 3 square inch capacity.
  - 1. Manufacturers:
    - a. Wiremold G3000
    - b. Mono-Systems SMS3200
    - c. Hubbell HBL3000 Series.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION - SURFACE METAL RACEWAY ASSEMBLY

- A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.
- B. Use suitable insulating bushings and inserts at connections to outlets and corner fittings.
- C. Maintain grounding continuity between raceway components to provide a continuous grounding path.
- D. Fastener: Use clips and straps suitable for the purpose.
- E. Field cuts to be clean and straight and use the proper tools as recommended by the system manufacturer to prohibit damage to factory finish or raceway. Joints to be matched so there are no gaps or spaces in the cover. Furnish and install manufacturer's raceway accessories as needed.
- F. Provide conduits to technology raceway per drawings or provide a minimum of one (1) 1-1/4" conduit per six feet of assembly (minimum 2) to above ceiling for technology requirements if assembly has technology raceway (Contractor shall provide quantities of conduits that provide maximum capacity to assembly). Provide conduits equally spaced within entire length of assembly.

#### 3.2 INSTALLATION - ARCHITECTURAL SURFACE RACEWAY

- A. Use flat-head screws to fasten channel to surfaces. Mount plumb and level.
- B. Maintain grounding continuity between raceway components to provide a continuous grounding path.
- C. Fastener: Use clips and straps suitable for the purpose.

- D. Field cuts to be clean and straight and use the proper tools as recommended by the system manufacturer to prohibit damage to factory finish or raceway. Joints to be matched so there are no gaps or spaces in the cover. Furnish and install manufacturer's raceway accessories as needed.
- E. Routing and Planning: Coordinate routings with existing vertical/horizontal building lines and features (doorways, wall trim, at wall/ceiling interface, etc.). Match the square / parallel lines of other existing features. Do not route raceway across large open spaces of the wall unless required by the application.

END OF SECTION 26 05 35

## SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Adhesive Markings and Field Labels
- B. Nameplates and Signs
- C. Product Colors

#### 1.2 REFERENCES

- A. NFPA 70E - National Electrical Safety Code
- B. NFPA 70 - National Electrical Code (NEC)
- C. ANSI A13.1 - Standard for Pipe Identification
- D. ANSI Z535.4 - Standard for Product Safety Signs and Labels

### PART 2 - PRODUCTS

#### 2.1 ADHESIVE MARKINGS AND FIELD LABELS

- A. Adhesive Marking Labels for Raceway: Pre-printed, flexible, self-adhesive vinyl labels with legend indicating voltage and service (Emergency, Lighting, Power, HVAC, Communications, Control, Fire).
  - 1. Label Size as follows:
    - a. Raceways: Kroy or Brother labels 1-inch high by 12-inches long (minimum).
  - 2. Color: As specified for various systems.
- B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.
- C. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.
- D. Cable Ties: Fungus-inert, self-extinguishing, one-piece, self-locking nylon cable ties, 0.18-inch minimum width, 50-lb minimum tensile strength, and suitable for a temperature range from -40°F to 185°F (-40°C to 85°C), type 2/2S or type 21/21S based on application. Provide ties in specified colors when used for color coding. Cable ties shall be listed and identified for the application, securement, and support.

- E. Underground Plastic Markers: Bright colored continuously printed plastic ribbon tape of not less than 6 inches wide by 4 mil thick, printed legend indicating type of underground line, manufactured for direct burial service. Tape shall contain a continuous metallic wire to allow location with a metal detector.
- F. Indoor/Outdoor Number and Letters: Outdoor grade vinyl label with acrylic adhesive designed for permanent application in severe indoor and outdoor environments.

## 2.2 NAMEPLATES AND SIGNS

- A. Engraved, Plastic-Laminated Labels, Signs and Instruction Plates: Engraving stock melamine plastic laminate, 1/16-inch minimum thick for signs up to 20 square inches, or 8 inches in length; 1/8 inch thick for larger sizes. Labels shall be punched for mechanical fasteners.
- B. Baked-Enamel Signs for interior Use: Preprinted aluminum signs, punched, or drilled for fasteners, with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- C. Exterior, Metal-Backed, Butyrate Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396 inch galvanized-steel backing: and with colors, legend, and size required for application. Mounting 1/4" grommets in corners.
- D. Safety Signs: Comply with 29 CFR, Chapter XVII, Part 1910.145.
- E. Fasteners for Plastic-Laminated Signs; Self-tapping stainless steel screws or number 10/32 stainless steel machine screws with nuts and flat and lock washers.

## 2.3 PRODUCT COLORS

- A. Adhesive Markings and Field Labels:
  - 1. All Labels: Black letters on white or clear face
  - 2. Normal Power and General Labels: Black letters on white face or black letters on clear face
  - 3. Control Labels: Black letters on white face or black letters on clear face
  - 4. Fire Alarm: Red letters on white face or red letters on clear face
- B. Nameplates and Signs:
  - 1. NORMAL POWER: Black letters on white face
  - 2. Control Labels: Black letters on white face
  - 3. GROUNDING: White letters on green face.
- C. Raceways and Conduit:
  - 1. Provide color coded conduit as indicated below. Conduit shall be colored by the manufacturer:
    - a. Normal Power and General Distribution: Silver
    - b. Fire Alarm System: Red
    - c. Temperature Controls: Refer to mechanical cover sheet for color

- d. Ground: Green
- e. Low Voltage and Telephone: Purple
- f. Clock, Sound, Security System, and Intercom: Black

D. Box Covers:

- 1. Box cover colors shall match conduit colors listed above.

E. Conductor Color Identification: Refer to Part 3 for additional information.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Lettering and Graphics: Coordinate names, abbreviations, colors, and other designations used in electrical identification work with corresponding designations specified or indicated. Install numbers, lettering, and colors as required by code.
- B. Install identification devices in accordance with manufacturer's written instruction and requirements of Electrical Code.
- C. Sequence of Work: Where identification is to be applied to surfaces that require finish, install identification after completion of finish work. All mounting surfaces shall be cleaned and degreased prior to identification installation.
- D. Circuit Identification: Tag or label conductors as follows:
  - 1. Multiple Power or Lighting Circuits in Same Enclosure: Where multiple branch circuits are terminated or spliced in a box or enclosure, label each conductor with source and circuit number.
  - 2. Multiple Control Wiring and Communication/Signal Circuits in Same Enclosure: For control and communications/signal wiring, use wire/cable marking tape at terminations in wiring boxes, troughs, and control cabinets. Use consistent letter/number conductor designations throughout on wire/cable marking tape.
  - 3. Match identification markings with designations used in panelboards shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.
- E. Apply warning, caution and instruction signs as follows:
  - 1. Install warning, caution or instruction signs where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect. Install engraved plastic-laminated instruction signs with approved legend where instructions or explanations are needed for system or equipment operation. Install metal-backed butyrate signs for outdoor items.

2. Emergency Operating Signs: Install, where required by Electrical Code, where indicated, or where reasonably required to assure safe operation and maintenance of electrical systems and of the items to which they connect, engraved laminate signs with white legend on red background with minimum 3/8-inch high lettering for emergency instructions on power transfer, load shedding, or other emergency operations.
- F. Apply circuit/control/item designation labels of engraved plastic laminate for pushbuttons, pilot lights, alarm/signal components, and similar items, except where labeling is specified elsewhere.
  - G. Install labels parallel to equipment lines at locations as required and at locations for best convenience of viewing without interference with operation and maintenance of equipment.
  - H. Install ARC FLASH WARNING signs on all switchboards, panelboards, industrial control panels, and motor control centers.
    1. Sample Label:
 

! WARNING  
ARC FLASH AND SHOCK HAZARD  
APPROPRIATE PPE REQUIRED  
FAILURE TO COMPLY CAN RESULT IN DEATH OR INJURY  
REFER TO NFPA 70E
  - I. Circuits with more than 600V: Identify raceway and cable with "DANGER-HIGH VOLTAGE" in black letters 2 (50mm) inches high on orange background at 10'-0 foot intervals.
    1. Entire floor area directly above conduits running beneath and within 12 inches of a basement or ground floor that is in contact with earth or is framed above unexcavated space.
    2. Wall surfaces directly external to conduits concealed within wall.
    3. All accessible surfaces of concrete envelope around conduits in vertical shafts, exposed in building, or concealed above suspended ceilings.
  - J. Underground Electrical Lines: For exterior underground power, control, signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 (150mm) to 8 (205mm) inches below grade. A single plastic line marker is permitted when the width of the common trench does not exceed 16 inches; provide a second plastic line marker to mark each edge of the trench when 16 inches of width is exceeded. Install line marker for underground wiring, both direct-buried cables and cables in raceway.

### 3.2 LIGHTING CONTROL AND RECEPTACLE COVER PLATES

- A. Product:
  1. Adhesive labels and field markings
- B. Identification material to be a clear, 3/8-inch Kroy tape or Brother self-laminating vinyl label with black letters. Embossed Dymo-Tape labels are not acceptable. Permanently affix identification label to cover plates, centered above the receptacle openings.

- C. Provide identification on all switch and receptacle cover plates. Identification shall indicate source and circuit number serving the device (e.g. "C1A #24"). Identification for switch cover plates shall be installed on the inside cover.

### 3.3 BOX LABELING

- A. Products:
  - 1. Adhesive labels and field markings
- B. Identify Junction, Pull and Connection Boxes: Labeling shall be 3/8-inch Kroy tape or Brother self-laminating vinyl label, letters/numbers color coded same as conduits. In rooms that are painted out, provide labeling on inside of cover.
- C. All junction, pull, and connection boxes shall be identified as follows:
  - 1. For power and lighting circuits, indicate system voltage and identity of contained circuits ("120V, 1LA1-3,5,7").
  - 2. For other wiring, indicate system type and description of wiring ("FIRE ALARM NAC #1").

### 3.4 CONDUCTOR COLOR CODING

- A. Products:
  - 1. All wire and cables shall be color coded by the manufacturer.
- B. Color coding shall be applied at all panels, switches, junction boxes, pull boxes, vaults, manholes etc., where the wires and cables are visible and terminations are made. The same color coding shall be used throughout the entire electrical system, therefore maintaining proper phasing throughout the entire project.
- C. Colored cable ties shall be applied in groups of three ties of specified color to each conductor at each terminal or splice point starting 3 inches from the termination and spaced at 3- inches centers. Tighten to a snug fit, and cut off excess length.
- D. Where more than one nominal voltage system exists in a building or facility, each ungrounded conductor of a multi-wire branch circuit, where accessible, shall be identified by phase and system.
- E. Conductors shall be color coded as follows:
  - 1. 208Y/120 Volt, 4-Wire:
    - a. A-Phase - Black
    - b. B-Phase - Red
    - c. C-Phase - Blue
    - d. Neutral - White
    - e. Ground Bond - Green

2. 480Y/277 Volt, 4-Wire:
  - a. A-Phase - Brown
  - b. B-Phase - Orange
  - c. C-Phase - Yellow
  - d. Neutral - Gray
  - e. Ground Bond - Green
3. Grounding Conductors:
  - a. Equipment grounding conductors, main/system/supply-side bonding jumpers: Green.
4. Cabling for Remote Control, Signal, and Power Limited Circuits:
  - a. Fire Alarm: Refer to Fire Alarm and Automatic Detection Section 28 31 00 for cable color requirements.
  - b. Low Voltage Switching: Per manufacturer recommendations and code requirements.
  - c. Building Automation Systems and Control: Refer to the Temperature Control Contactor notes located on the mechanical cover sheet.
  - d. Electronic Control: Per manufacturer recommendations and code requirements.

### 3.5 CONTROL EQUIPMENT IDENTIFICATION

- A. Products:
  1. Nameplates and signs
- B. Provide identification on the front of all control equipment such as combination starters, starters, VFDs, contactors, motor control centers, etc.
- C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner.
- D. Labeling shall include:
  1. Equipment type and contract documents designation of equipment being served.
  2. Location of equipment being served if it is not located within sight.
  3. Voltage and phase of circuit(s).
  4. Panel and circuit number(s) serving the equipment.
  5. Method of automatic control, if included ("AUTO CONTROL BY FMCS").
  6. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
  7. Date of fault current study, refer to one-line diagram

8. Sample Label:

EXHAUST FAN EF-1 ("LOCATED ON ROOF")  
480V, 3-PHASE  
FED FROM "1HA1-1"  
AUTO CONTROL BY FMCS  
22,000 AMPS AVAILABLE FAULT CURRENT  
DATE OF STUDY: 1 JAN 2017

3.6 EQUIPMENT CONNECTION IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification for hard wired electrical connections to equipment such as disconnects switches, starters, etc. Plug and cord type connections do not require this specific label.

C. Identification shall be provided for all connections to equipment furnished by this Contractor, other contractors, or the Owner. The following list of equipment is specifically being listed to receive an equipment connection label; this list does not limit the equipment that shall receive a label:

1. Mechanical heating, ventilation, and air conditioning equipment; chillers, boilers, pumps, air handling ventilation units, condensing units, unit heaters, and similar equipment

D. Labeling shall include:

1. Equipment type and contract documents designation of equipment being served
2. Location of equipment being served if it is not located within sight.
3. Voltage and rating of the equipment.
4. Panel and circuit numbers(s) serving the equipment
5. Available fault current; refer to one-line diagram or panel schedule of panel serving equipment.
6. Date of fault current study; refer to one-line diagram
7. Sample Label:

UNIT HEATER UH-1 ("LOCATED IN STORAGE ROOM 200")  
480V: 3-PHASE  
FED FROM "1HA1-1"  
22,000 AMPS AVAILABLE FAULT CURRENT  
DATE OF STUDY: 1 JAN 2017

3.7 POWER DISTRIBUTION EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all power distribution equipment such as panelboards, switchboards, switchgear, motor control centers, generators, UPS, storage battery disconnects, transfer switches, etc. Labels shall be visible on the exterior of the gear, correspond to the one-line diagram nomenclature, and identify each cubicle of multi-section gear.

1. Interior Equipment: The identification material shall be engraved plastic-laminated labels.
2. Exterior Equipment: The identification material shall be engraved vinyl labels.
3. Labeling shall include:
  - a. Equipment type and contract documents designation of equipment.
  - b. Voltage of the equipment.
  - c. Name of the upstream equipment and location of the upstream equipment if it is not located within sight.
  - d. Rating and type of the overcurrent protection device serving the equipment if it is not located within sight ("FED BY 400A/3P BREAKER").
  - e. Sample Label:

DISTRIBUTION PANEL DP-H1  
480Y/277V  
FED FROM SWITCHBOARD "SB-1" (LOCATED IN MAIN ELEC ROOM)

4. Provide the following on a separate label, installed below the label above:
  - a. Available fault current; refer to one-line diagram or panel schedules
  - b. Date of fault current study; refer to one-line diagram
  - c. Sample Label:

22,000 AMPS AVAILABLE FAULT CURRENT  
DATE OF STUDY: 1 JAN 2017

C. Service Equipment Label: A separate nameplate for the service entrance equipment and include:

1. Nominal system voltage, service wire size, quantity, material, distance
2. Maximum available fault current; refer to one-line diagram for values
3. Clearing time of overcurrent protection devices based on available fault current. Refer to calculations and report from Section 26 05 73 for value.
4. Date of fault current study; refer to one-line diagram
5. Date of label
6. Sample Label:

480Y/277V, 6 SETS 4#750KCM CU, 75FT  
39,800 AMPS AVAILABLE FAULT CURRENT  
0.07 SECOND CLEARING TIME  
DATE OF STUDY: 1 JAN 2017  
DATE OF LABEL: 4 JUL 2017

D. Arc Energy Reduction Label:

1. Provide a separate engraved plastic laminate label centered at the top of each vertical section of the electrical gear indicating the following when applicable.
  - a. Label: "This equipment is designed with a system listed below".
  - b. Applicable Systems:
    - 1) Arc energy reducing maintenance switch

E. Nominal System Voltage Label:

1. Where more than one nominal voltage system exists in a building or facility, the identification of color coding used in the panelboard or equipment shall be permanently posted on the interior of the door or cover.

F. Distribution panelboards and switchboards shall have each overcurrent protection device identified with name and location of the load being served ("AHU-1 LOCATED IN PENTHOUSE 1"). Provide a separate engraved plastic laminate label adjacent to each overcurrent protection device with feeder wire size, feeder wire quantity, conductor material and distance in feet. Provide label separate from load identification label and adjustable trip settings label.

1. Sample Labels for Feeders:

4#3/0 CU & 1#6 CU GND, 125FT  
4#250KCM AL & 1#6 GND CU, 125FT  
2 SETS 4#400KCM CU & 1#1 GND CU, 125FT

G. Branch panelboards shall be provided with typed panel schedules upon completion of the project. Existing panelboards shall have their existing panel schedules typed, with all circuit changes, additions or deletions also typed on the panel schedules. A copy of all panel schedules for the project shall be turned over as part of the O&M Manuals. Refer to Section 26 05 00 for other requirements.

### 3.8 TRANSFORMER EQUIPMENT IDENTIFICATION

A. Products:

1. Nameplates and signs

B. Provide identification on the front of all transformers. The identification nameplate shall be an engraved plastic-laminated label.

C. Labeling shall include:

1. Equipment type and contract documents designation of equipment
2. Name of the upstream equipment.
3. Voltage and rating of the equipment.
4. Location of the upstream equipment if it is not located within sight.

5. Sample Label:

TRANSFORMER TR-15  
480V: 208Y/120V 15KVA  
FED FROM SWITCHBOARD "SB-1" (LOCATED IN ELEC 123)

3.9 ELECTRICAL WORKING CLEARANCE IDENTIFICATION

A. Products:

1. Safety Yellow paint and custom stencils

B. Provide custom identification of electrical equipment working clearances in mechanical, electrical, storage, janitorial, and similar non-public areas.

C. Identification shall include a painted rectangular box (on the finished floor) in front of the electrical equipment to define the code-required working clearance. Provide additional diagonal stripping inside the rectangle box. All painted stripping shall be safety yellow paint with 3 inch wide stripes.

1. Width of area: Width of equipment or as required by code
2. Depth of area: Depth as required by code

END OF SECTION 26 05 53

## SECTION 26 09 33 - LIGHTING CONTROL SYSTEMS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Line and low voltage standalone lighting controls
- B. Automatic load control relay (ALCR3)
- C. Automatic load control relay (ALCR20)
- D. Distributed lighting control

#### 1.2 RELATED SECTIONS

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
  - 1. 26 51 19 LED Lighting
  - 2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details

#### 1.3 RELATED WORK

- A. Section 23 09 00 - Facility Management Control System (FMCS)
- B. Section 26 51 00 - Lighting

#### 1.4 QUALITY ASSURANCE

- A. Manufacturers shall be regularly engaged in the manufacture of lighting control equipment and ancillary equipment, of types and capacities required, whose products have been in satisfactory use in similar service for not less than five (5) years.
- B. All components and assemblies are to be factory pre-tested prior to delivery and installation.
- C. Comply with Electrical Code as applicable to electrical wiring work.
- D. Comply with applicable portions of NEMA standards pertaining to types of electrical equipment and enclosures.

- E. Panels and accessory devices are to be UL listed under UL 916 Energy Management Equipment. Panels and accessories used for control of life safety and critical branch circuits shall be listed under UL 924 Emergency Lighting and Power Equipment.
- F. All assemblies are to be in compliance with FCC emissions standards specified in Part 15 Subpart J for Class A applications.

#### 1.5 REFERENCES

- A. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference
- B. FS W S 896 Switch, Toggle
- C. International Energy Conservation Code (IECC)
- D. NEMA WD 1 - General Color Requirements for Wiring Devices
- E. NEMA WD 7 - Occupancy Motion Sensors
- F. NFPA 70 - National Electrical Code (NEC)
- G. UL Standard 916 Energy Management Equipment
- H. UL 924 - Emergency Lighting and Power Equipment
- I. UL 1472 - Solid-State Dimming Controls

#### 1.6 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Submit a comprehensive package including devices, hardware, software, product specification, finishes, dimensions, installation instructions, warranty, system software requirements, and roles and responsibilities of all persons and groups involved in installation, execution, and commissioning.
- C. Provide floor plan showing location, orientation, and coverage area of each control device, sensor, and controller/interface. For areas requiring multiple sensor devices for appropriate coverage, submit specific manufacturer-approved sensor layout as an overlay directly on the project drawings, either in print or approved electronic form.
- D. Submit a list of devices and equipment that will be installed for each sequence of operation.
- E. Submit project specific control wiring diagrams showing all equipment, line voltage, and control wiring requirements for all components including, but not limited to, dimmers, relays, low voltage switches, occupancy sensors, control stations, and communication interfaces and programming instructions for each sequence of operation. Include network cable specification and end-of-line termination details, if required.

#### 1.7 EXTRA STOCK

- A. Provide extra stock under provisions of Section 26 05 00.

- B. Sensors, Controls, Power Supplies, and Relays: Five (5) percent of quantity installed. Minimum of two (2) of each configuration and type.
- C. Control Stations: One (1) of each configuration and type, except for LCD touch screens requiring factory setup prior to installation.

#### 1.8 PROJECT RECORD DOCUMENTS

- A. Submit project record documents under provisions of Section 26 05 00.
- B. Accurately record location of all controls and devices. Include description of switching sequences and circuiting arrangements.

#### 1.9 OPERATION AND MAINTENANCE DATA

- A. Submit emergency, operation, and maintenance data under provisions of Section 26 05 00. Data shall also include the following:
  - 1. Schedule for routine maintenance, inspection, and calibration of all lighting control devices and system components. Recommended schedule for inspection and recalibration of sensors.
  - 2. Complete narrative describing intended operation and sequence for each control scenario and system component, updated to reflect all changes resulting from commissioning of systems. Narrative shall indicate recommended settings for devices where applicable.
  - 3. Replacement part numbers for all system components.
- B. Identify installed location and labeling for each luminaire controlled by automated lighting controls.
- C. Submit software operating and maintenance manuals, program software backup on compact disc or compatible media with data files, device address list, and a printout of software application and graphic screens, where applicable.

#### 1.10 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying lighting design documents describe the minimum material quality, required features, and operational requirements of the lighting control system (LCS). These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the performance required of the system, as presented in these documents, the Contractor and system manufacturer/vendor are solely responsible for determining all equipment, wiring, and programming required for a complete and operational system.
- B. Provide an integrated lighting controls system consisting of panels, power supplies, controllers, sensors, relays, switches, devices, wiring, etc. necessary to perform the Lighting Control Sequence of Operation as defined on the plans and specifications. Contractor is responsible for confirming that all components and luminaires interoperate as a single system.
  - 1. Sequence of Operation: Describes the required operation and performance for lighting control in each space. Sequences of operation are indicated on the drawings.

2. Drawings: The drawings include sequences of operation, locations of control interface devices, sensors, and control zones. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted with the shop drawings.
- C. The following control types and features are acceptable. Acceptable control locations are shown on the drawings.
1. Line Voltage Control: Control equipment consists of traditional line voltage wiring devices and equipment such as switches, dimmers and combination occupancy/vacancy sensor switches, etc.
  2. Distributed Control: Control equipment is in the space/zone being controlled; not reliant on centralized controllers.
    - a. All locations shall have the ability to be networked for remote control and monitoring, but network connections are not required.

#### 1.11 COMMISSIONING

- A. The Contractor shall provide all services necessary for compliance with the IECC Section C408 Commissioning. The commissioning shall include, but not be limited to, a commissioning plan, preliminary commissioning report, construction documents, manuals, final commissioning report, and lighting system functional testing.
- B. The system shall be functionally tested by a factory-authorized engineer and comply with the Sequence of Operation. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system.

#### 1.12 WARRANTY

- A. Manufacturer shall warrant products under normal use and service to be free from defects in materials and workmanship for a period of two (2) years from date of commissioning.
- B. Occupancy, vacancy, daylight sensors and controls shall have a five (5) year warranty from date of Substantial Completion.

### PART 2 - PRODUCTS

#### 2.1 LIGHTING CONTROLS

- A. All items of material having a similar function (e.g., switches, dimmers, sensors, contactors, relays, etc.) shall be of the same manufacturer, unless specifically stated otherwise on drawings or elsewhere in the specifications. Lighting control switches, systems, and components shall be listed.
- B. Color of lighting controls and sensors shall match the receptacle wiring devices specified in the space.

- C. The functions described in the lighting sequence of operation shall dictate the actual lighting control device required to accomplish the functions described for the space.

## 2.2 LIGHTING CONTROL STATION

- A. SW; The lighting control station shall contain the controls required by the lighting sequence of operation in a common coverplate. The controls may consist of switches, dimmers, occupancy sensors, pushbuttons, etc.
  - 1. In spaces where the wall control station is shown in multiple locations, the sequence of operation shall be the same at all locations, unless noted otherwise.
  - 2. The controls supplier shall prepare control station shop drawings showing arrangement of controls, dimensioned elevations, wiring diagram, and recommended backboxes. The shop drawing submittal should be identified with the lighting sequence that the station provides. Submit data sheets on the switches, dimmers, sensors, buttons, etc. contained in the control station.

## 2.3 DEVICE COLOR

- A. All switch, lighting controls, and coverplate colors shall be the same as wiring devices, unless indicated otherwise.

## 2.4 COVERPLATES

- A. All switches and lighting controls shall be complete with coverplates that match material and color of the wiring device coverplates in the space.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 26 05 53.
- D. Plate-securing screws shall be metal with head color matching the wall plate finish.

## 2.5 WALL SWITCHES

- A. Refer to Electrical Symbols List for device type.
- B. SW-1P; Single Pole Switch:
  - 1. Single throw, 120/277-volt, 20-amp maintained contact. Toggle handle, side and back wired.
  - 2. Manufacturers:
    - a. Hubbell HBL1221
    - b. Leviton 1221-2
    - c. Pass & Seymour PS20AC1
    - d. Cooper AH1221

C. SW-1P-K; Key Lock Single Pole Switch:

1. Single throw, 120/277-volt, 20-amp maintained contact. Side and back wired. Provide key to Owner.
2. Manufacturers:
  - a. Hubbell HBL1221L
  - b. Leviton 1221-2L
  - c. Pass & Seymour PS20AC1-L
  - d. Cooper AH1221L

D. SW-3W; Three-way Switch:

1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:
  - a. Hubbell 1223
  - b. Leviton 1223-2
  - c. Pass & Seymour PS20AC3
  - d. Cooper AH1223

E. SW-4W; Four-way Switch:

1. 120/277 volt, 20 amp. Toggle handle, side and back wired.
2. Manufacturers:
  - a. Hubbell 1224
  - b. Leviton 1224-2
  - c. Pass & Seymour PS20AC4
  - d. Cooper AH1224

2.6 WALL DIMMERS

- A. UL listed with integral air-gap switch for on/off control.
- B. Integral EMI/RFI suppression.
- C. Non-viewable heat sink.
- D. Dimmer compatibility and wiring with the load being controlled shall be verified by Contractor prior to purchase and installation.
- E. Dimmer to match device color.
- F. SW-D-LED; LED Electronic Driver Dimmer:
  1. 120 -volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60629 Annex E.

2. Manufacturers:
  - a. Compatible with provided LED driver.

G. SW-D3-LED; LED Electronic Driver Three-Way Dimmer:

1. 120-volt, decora style linear slider operator with positive off. Color to match adjacent devices. Luminaire manufacturer shall list compatible dimmer manufacturers and models. 0-10V dimmers shall comply with IEC 60929 Annex E.
2. Manufacturers:
  - a. Compatible with provided LED driver.

H. SW-OD; Wall 0-10V Dimmer / Occupancy sensor:

1. Wall switch with manual on/auto off. 120VAC load rating of 0-800 W for electronic ballast, LED. 277VAC load rating of 0-1,800 W for electronic ballast, LED. adjustable OFF delay. 0-10V dimming with up to 30ma sink. Automatic ON/OFF, manual ON/automatic OFF, or occupancy on to predetermined dimming level go to last dimming setting upon occupancy.
2. Manufacturers:
  - a. Sensor Switch WSX D Series

## 2.7 INDOOR OCCUPANCY AND VACANCY SENSORS

A. General Description: Wall- or ceiling-mounting, solid-state units with a separate power supply/relay unit.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied, with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes. Vacancy sensors require a manual switch operation to turn lights on and off, with a time delay for turning lights off when unoccupied.
2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
3. Relay Unit: Dry contacts rated for 20 A ballast load at 120 and 277 VAC, for 13-amp tungsten at 120 VAC, and for 1 hp at 120 VAC. Power supply to sensor shall be 24 V dc, 150-mA, Class 2 power source as defined by Electrical Code.
4. Mounting:
  - a. Sensor: Suitable for mounting in any position on a standard outlet box.
  - b. Relay: Externally mounted through a 1/2-inch knockout in a standard electrical enclosure. Mount relay above accessible ceiling near entry door to room or area.
  - c. Time Delay and Sensitivity Adjustments: Recessed and concealed.
5. Indicator: LED to show when motion is being detected during testing and normal operation of the sensor.
6. Bypass Switch: Override the on function in case of sensor failure.

7. Power Supply and Child Packs: Provide as required for sensor quantity and switching scheme. Mount to standard 1/2" knockout on electrical box above accessible ceiling near entry door to room or area. Sensor power shall be from emergency circuit if emergency lighting is in the area.
  8. Detection Coverage (Room): Detect occupancy anywhere in an area based on hand motion.
  9. Detection Coverage (Corridor): Detect occupancy based on a half-step motion.
  10. Warranty: Five (5) year warranty.
- B. Dual-Technology Type: Detect occupancy by using a combination of PIR and ultrasonic or acoustic detection methods in area of coverage. Particular technology or combination of technologies that controls on and off functions shall be selectable in the field by operating controls on unit.
1. SW-VS-D or SW-OC-D; 360 Degree Coverage Pattern:
    - a. Frequency greater than 40 KHz. Dual sensing verifications (requires both technologies to activate), either technology maintains on status. Integrated ambient light level sensor (2 to 200 FC range), adjustable sensitivity and time delay, integrated isolated relay contact. Sensor shall control all circuits in area, unless noted otherwise. Initial settings: ambient sensor 40 FC.
    - b. Manufacturers:
      - 1) Watt Stopper DT 300 Series
      - 2) Hubbell OMNI-DT2000 or ATD2000C
      - 3) Greengate OAC-DT
      - 4) Leviton OSC##-MOW
      - 5) Sensor Switch CM PDT 10
  2. SW-O; Wall Switch:
    - a. Wall switch with manual on/auto off. 120/277 VAC load rating of 0-800 W for ballast, LED or tungsten. 5-, 15-, 30-minute adjustable OFF delay. Coverage of minor motion in 12' x 15' pattern.
    - b. Manufacturers:
      - 1) Watt Stopper DW-100 Series
      - 2) Hubbell LHMTS, Leviton OSSMT series
      - 3) Sensor Switch WSX-PDT SA Series
  3. Sensitivity Adjustment: Separate for each sensing technology.
  4. Detection Coverage:
    - a. Task Areas: Detect occupancy anywhere in an area based on hand motion.
    - b. Circulation Areas: Detect occupancy anywhere in an area based upon half-step walking motion.
- C. Mask sensors where necessary to prevent nuisance switching from adjacent areas.
- D. Ultrasonic Type: Ceiling mounting. Detect occupancy by sensing a change in pattern of reflected ultrasonic energy in area of coverage.

1. SW-OC-U; 360 Degree 20' x 20' Hand Motion Coverage Pattern:
  - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated 1-amp relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
2. SW-OC-U2; 35' x 30' Hand Motion Coverage Pattern:
  - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
3. SW-OC-U-A; 360 Degree Two-Sided Corridor Coverage Pattern:
  - a. Frequency greater than 32 KHz solid state, adjustable sensitivity and time delay, integral isolated relay contact, temperature and humidity resistant receivers. Sensor shall control all circuits in area, unless noted otherwise.
  - b. Manufacturers:
    - 1) Watt Stopper WT-2250 Series
    - 2) Hubbell OMNI-US or ATU series
    - 3) Greengate ODC-U Series
4. Crystal controlled with circuitry that causes no detection interference between adjacent sensors.

## 2.8 AUTOMATIC LOAD CONTROL RELAY (ALCR) (INDIVIDUAL LUMINAIRE - INTEGRAL)

- A. This section includes information related to factory and field installed ALCR devices intended for individual luminaires.
- B. ALCR3; Automatic Load Control Relay ALCR, 120/277 volt, dry/damp listed, 32°F to 113°F (0°C to 45°C) operating temperature, plenum NEMA 1 rated, test button with visual indicator, remote test and fire alarm control, listed for factory or field installation within luminaire, UL924 listed latest edition, Electrical Code Article 700 compliant.
  1. Rating: 3 Amp LED driver, ballast, or incandescent.
  2. Lighting Control Coordination: Provide ALCR device compatible with designated lighting zone controls. Example: Switched, 0-10 volt dimming, DALI control, 2 wire dimming, or DMX.
  3. Operation:
    - a. ALCR device shall allow the same local lighting control devices to control both the normal lights and emergency designated lighting. Devices that require separate local lighting controls for the normal and designated emergency lighting are NOT allowed.
    - b. ALCR device shall monitor the normal power circuit and shunt/bypass the local lighting controls upon loss of power, remote test switch, or fire alarm override to provide full lumen output for designated emergency lighting.

- c. ALCR device shall return designated emergency lighting to local lighting control after a 15-minute delay upon return of normal power or remote test/fire alarm override release.
- d. Performance Equivalent by Other Components: A limitation of equivalent comparable products may require some of the required functions of the ALCR device to be provided by an alternative component of the lighting control system. The following functions may be performed by alternative components of the lighting control system when the device is listed for the required function and compatible with the lighting control system.
  - 1) Remote test switch / fire alarm override interface.
  - 2) The 15-minute time delay upon return of normal power or remote test/fire alarm override release.

4. Manufacturers:

- a. LVS Controls EPC-2-FM (switched)
- b. EPC-2-D-FM Series (0-10V dimming)
- c. EPC Series (alternative lighting control)
- d. Iota ETS-step (switched)
- e. ETC-DR (0-10V dimming)
- f. ETC Series (alternative lighting control)
- g. Lighting control manufacturer

2.9 AUTOMATIC LOAD CONTROL RELAY (ALCR)

A. ALCR20; Automatic Load Control Relay ALCR, 120/277 volt, dry/damp listed, 32°F to 113°F (0°C to 45°C) operating temperature, plenum NEMA 1 rated, test button with visual indicator, remote test and fire alarm control, UL924 listed latest edition, Electrical Code Article 700 compliant.

1. Rating:

- a. 20 amp (16 A permitted) LED driver and ballast.
- b. 10 A (1,200 watt) incandescent.

2. Lighting Control Coordination: Provide ALCR device compatible with designated lighting zone controls. Example: switched, 0-10 volt dimming, DALI control, 2 wire dimming, or DMX.

3. Operation:

- a. ALCR device shall allow the same local lighting control devices to control both the normal lights and emergency designated lighting. Devices that require separate local lighting controls for the normal and designated emergency lighting are NOT allowed.
- b. ALCR device shall monitor the normal power circuit and shunt/bypass the local lighting controls upon loss of power, remote test switch, or fire alarm override to provide full lumen output for designated emergency lighting.
- c. ALCR device shall return designated emergency lighting to local lighting control after a 15-minute delay upon return of normal power or remote test/fire alarm override release.

- d. Equivalent Facilitation and Performance: A limitation of equivalent comparable products may require some of the required functions of the ALCR device to be provided by an alternative component of the lighting control system. The following functions may be performed by alternative components of the lighting control system when the device is listed for the required function and compatible with the lighting control system:
  - 1) Remote test switch / fire alarm override interface.
  - 2) The 15-minute time delay upon return of normal power or remote test/fire alarm override release.

4. Manufacturers:

- a. LVS Controls EPC-2 (switched)
- b. EPC-2-D Series (0-10V dimming)
- c. EPC-DMX (DMX) EPC Series (alternative lighting control)
- d. Iota ETS-20 (switched)
- e. ETC-20-DR (0-10V dimming)
- f. ETC Series (alternative lighting control)
- g. Myers Emergency Power Systems RLY-SW-2 (switched)
- h. RLY-DIM-2D (0-10V dimming)
- i. RLY Series (alternative lighting control)
- j. Nine24 Inc ELCR-R (switched)
- k. ELCR-Z10 (0-10V dimming)
- l. ELCR Series (alternative lighting control)
- m. Lighting control manufacturer

2.10 DISTRIBUTED LIGHTING CONTROL

- A. Manufacturers: as listed below meet the qualifications as outlined in this specification. Contractor is responsible for verifying that selected manufacturer is capable of furnishing the complete system as specified herein.
  - 1. Acuity Controls nLight Series
  - 2. Legrand Watt Stopper DLM Series
  - 3. Hubbell Automation NX Series
  - 4. Eaton Greengate RC3 Series (room-based system)
  - 5. Osram Encelium Series
  - 6. Lutron
- B. System Description: The lighting control system shall be a network of remote modules System includes all associated wiring, relay modules, photocells, switches, dimmers, time clock, occupancy sensors. System shall utilize distributed relays modules, allowing these relay modules to be located above accessible ceilings in or adjacent to rooms they are controlling.
- C. Control Devices: All occupancy sensors (ultrasonic, IR and dual technology type), photocells, switches, and timers shall be provided with system and designed to operate on system network. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission.

- D. Relay Modules: Mounted in NEMA enclosure with physically separate 120/277-volt wiring compartment from low voltage control wiring. Provide low voltage digital communication to control devices as shown on drawings and schedules. Supplemental power packs shall be provided as required for multiple control devices. This equipment shall be identified in shop drawing submission. Dimmable relay modules shall be provided where indicated. Relay modules shall contain up to four (4) relays. Relay modules shall be labeled with room number that relays control lighting within.
- E. Single-Pole Relays: Mechanically held unless otherwise indicated; split-coil, momentary-pulsed type, rated 20 A, 125-volt AC for tungsten filaments and 20 A, 277-volt AC for electronic ballasts, 50,000 cycles at rated capacity.

## 2.11 CONDUCTORS AND CABLES

### A. Control Wiring:

1. Where installed with the line-voltage wiring, control wiring shall be copper conductors not smaller than No. 16 AWG with insulation voltage rating and temperature rating equal to that of the line-voltage wiring, complying with Division 26 Section 26 05 13 "Wire and Cable."
2. Tap conductors to switches or relays: Stranded copper conductors of 16 AWG or solid 16 or 18 AWG with insulation rating equal to that of the line-voltage wiring.
3. Tap conductors to dimming ballasts: Solid copper conductors of 18 AWG with insulation voltage rating equal to that of the line-voltage wiring and insulation temperature rating not less than 90°C.
4. Network cabling as required by manufacturer.

### B. Splices and Taps:

1. Tapping or wire trap connectors shall be used to splice all Class 1 and Class 2 control wiring. Twist-on, wire-nut type connectors are not allowed.

## PART 3 - EXECUTION

### 3.1 PRE-CONSTRUCTION MEETING

- A. Schedule a pre-construction meeting with the controls representative, installing contractor, Architect/Engineer, and Owner to explain the proposed lighting control centralized, wireless, and distributed systems.

### 3.2 EXAMINATION

- A. Verify that surfaces are ready to receive work.
- B. Verify field dimensions and coordinate physical size of all equipment with the architectural requirements of the spaces into which they are to be installed. Allow space for adequate ventilation and circulation of air.
- C. Verify that required utilities are available, in proper location, and ready for use.

- D. Beginning of installation means installer accepts existing conditions.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions and approved shop drawings.
- B. All wiring shall be installed in conduit.
- C. All branch load circuits shall be live tested before connecting the loads to the lighting control panel.

### 3.4 Automatic Load Control Relays (ALCR20) and Branch circuit emergency lighting transfer switch (bcelts)

- A. Field install per manufacturer requirements.
- B. Remote Test Switch: Provide connection to remote test switch.
- C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

### 3.5 SUPPORT SERVICES

#### A. System Startup:

1. Manufacturer shall provide factory authorized technician to confirm proper installation and operation of all system components.

#### B. Testing:

1. System shall be completely functional tested by a factory-authorized technician. All loads shall be tested live for continuity and freedom from defects, and all control wiring shall be tested for continuity and connections prior to energizing the system components.
2. Programming of initial zones, schedules, lighting levels, control station groups, and sensor settings shall be performed by a factory-authorized technician. Lighting Control Sequence of Operation shall serve as a basis for programming, However, all final decisions regarding groups and schedules shall be at the direction of the Owner. The following procedures shall be performed at a minimum:
  - a. Confirm occupancy sensor placement, sensitivity, and time delay settings to meet specified performance criteria.
  - b. Confirm daylight sensor placement, sensitivity, deadband, and delay settings to meet specified performance criteria.
  - c. Confirm that schedules and time controls are configured to meet specified performance criteria and Owner's operating requirements.
3. Verify occupancy/vacancy and daylight sensor operation is correct after furniture and equipment is installed in each area. Make adjustments to sensor settings and time delays to allow proper operation.
4. Verify occupancy/vacancy sensors are located to provide complete coverage for the area served with no nuisance switching.

- a. Relocate sensors or provide additional sensors as necessary to provide adequate coverage.
  - b. Mask occupancy sensors where necessary to prevent nuisance switching from adjacent areas.
- C. Training:
  - 1. Manufacturer shall provide competent factory-authorized technician to train Owner personnel in the operation, maintenance and programming of the lighting control system. Submit training plan with notification seven (7) days prior to proposed training dates.
  - 2. Training duration shall be no less than three (3) days, with one (1) day being scheduled at least two (2) weeks after initial training.
- D. Documentation:
  - 1. Manufacturer shall provide system documentation including:
    - a. System one-line showing all panels, number and type of control stations and sensors, communication line, and network or BMS/BAS interface unit.
    - b. Drawings for each panel showing hardware configuration and numbering.
    - c. Panel wiring schedules.
    - d. Typical diagrams for each component.

END OF SECTION 26 09 33

## SECTION 26 12 19 - PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Liquid-filled, Pad-Mounted Distribution Transformers **DTR-1**

#### 1.2 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in distribution transformers with three (3) years documented experience.

#### 1.3 REFERENCES (Use the latest revision of referenced standards.)

- A. ANSI C57.12.70 - American National Standard Terminal Markings and Connections for Distribution and Power Transformers
- B. ASTM D877.02e1 - Test Method for Dielectric Breakdown Voltage of Insulating Liquids Using Disk Electrodes
- C. Department of Energy 10 CFR Part 431 - Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
- D. IEEE C57.12.00 - Standard General Requirements for Liquid-Immersed Distribution, Power, & Regulating Transformers
- E. IEEE C57.12.28 - Standard for Pad-Mounted Equipment - Enclosure Integrity
- F. IEEE C57.12.34 - IEEE Standard Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers 5 MVA and Smaller; High Voltage, 34.5 kV Nominal System Voltage and Below; Low Voltage, 15 kV Nominal System Voltage & Below. (combines C57.12.22 and C57.12.26 of past.)
- G. IEEE C57.12.80 - IEEE Standard Terminology for Power and Distribution Transformers
- H. IEEE C57.12.90 - Standard Test Code for Liquid-Immersed Distribution Power, and Regulating Transformers
- I. IEEE C57.106 - Guide for Acceptance and Maintenance of Insulating Oil in Equipment
- J. IEEE C57.111 - Guide for Acceptance of Silicone Insulating Fluid and Its Maintenance in Transformers
- K. IEEE C57.121 - Guide for Acceptance and Maintenance of Less Flammable Hydrocarbon Fluid in Transformers
- L. NEMA 260 - Safety Labels for Pad-Mounted Switchgear and Transformers Sited in Public Areas

- M. NEMA TR 1-1993 (R2000) - Transformers, Regulators and Reactors, Table 0-2 Audible Sound Levels for Liquid-Immersed Power Transformers.
- N. NETA ATS - Acceptance Testing Specifications for Electrical Power Distribution Equipment (International Electrical Testing Association). Sections specific to transformers.
- O. Standards for Component Devices Related to Transformer Installation When Specified:
  - 1. ANSI/IEEE C37.41 - IEEE Standard Design Tests for High-Voltage (>1000 V) Fuses, Fuse and Disconnecting Cutouts, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Fuse Links and Accessories Used with These Devices
  - 2. IEEE 386 - Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600 V
  - 3. IEEE C37.40 - IEEE Service Conditions and Definitions for High-Voltage Fuses, Distribution Enclosed Single-Pole Air Switches, Fuse Disconnecting Switches, and Accessories
  - 4. IEEE C37.48.1 - IEEE Guide for the Operation, Classification, Application and Coordination of Current Limiting Fuses with Rated Voltages 1 - 38 kV
  - 5. IEEE C57.13 - Standard Requirements for Instrument Transformers
  - 6. UL 489 - Molded Case Circuit Breakers

#### 1.4 SUBMITTALS

- A. Submit shop drawings and product data under the provisions of Section 26 05 00.
- B. Shop drawings shall indicate electrical characteristics and field connection details, outline dimensions, connection and support points, weight, specified ratings and materials.
- C. All transformer nameplate information shall be supplied on the submittal drawings. The transformer impedance information shall be part of the submittal information.
- D. Where transformers are being supplied with integral fuses all details as to fuse make, fuse model, fuse ampere rating, and fuse time current curves applicable to transformer high voltage shall be supplied.
- E. Coordination Drawings: Floor plans drawn to scale and coordinating floor penetrations and floor-mounted items. Show the following:
  - 1. Underground primary and secondary conduit stub-up location.
  - 2. Dimensioned concrete base, outline of transformer, and required clearances.
  - 3. Ground rod and grounding cable locations.
- F. Submit manufacturer's installation instructions under provisions of Section 26 05 00.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect products under provisions of Section 26 05 00.
- B. Protect transformers in storage from moisture by using appropriate heaters if instructed by the manufacturer.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Include procedures for sampling and maintaining fluid, cleaning unit, and replacing components.

PART 2 - PRODUCTS

2.1 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

- A. Manufacturers:
  - 1. Cooper Power Systems
  - 2. General Electric
  - 3. Howard Industries, Inc.
  - 4. Schneider/Square D
- B. Installation service conditions:
  - 1. The transformer(s) shall be installed outdoors.
  - 2. The transformer will be used within C57.12.00 usual service conditions as follows:
    - a. The cooling air ambient temperature shall not exceed 40°C (104°F), and the average temperature of the cooling air for any 24-hour period shall not exceed 30°C (86°F).
    - b. The top liquid temperature of the transformer, when it is operating, shall not be lower than minus 20°C (minus 4°F).
    - c. The altitude shall not exceed 1000 meters/3300 feet.
- C. Description: Liquid-filled, pad-mounted, three-phase, two-winding transformers. Construction shall allow installation in locations accessible to the general public without the need for protective fencing or vaults.
- D. The transformer shall be UL listed as follows:
  - 1. The transformer shall have a UL Combination Listing/Classification Mark per UL XPLH. A Listing Mark combined with a Classification Mark shall be provided for transformers with less flammable liquid that have been additionally investigated by UL in accordance with Electrical Code Article 450. This combination shall include the following UL marking: "ALSO CLASSIFIED FOR USE AS LESS-FLAMMABLE LIQUID-INSULATED TRANSFORMER IN ACCORDANCE WITH ELECTRICAL CODE AND MARKED USE RESTRICTIONS ON THE TRANSFORMER."
- E. The transformer electrical power frequency shall be 60 hertz.
- F. Transformer kVA shall be as specified on the project drawings. The transformers shall be self-cooled, and not have any forced cooling means, such as fans.
- G. The transformer coils shall be wound with aluminum conductors.

- H. The transformer primary/high voltage shall be as shown on the project drawings. The primary/high voltage winding configuration as delta or grounded-wye shall be as shown on the project drawings.
- I. The transformer high voltage basic lightning impulse level BIL shall be 60 kV.
- J. The transformer secondary/low voltage shall be as shown on the project drawings. The secondary/low voltage winding configuration as wye or delta shall be as shown on the project drawings. Where wye windings are specified, there shall be provisions for bonding the neutral terminal to ground at the transformer terminations.
- K. The transformer low voltage BIL shall be 30 kV.
- L. The transformer shall have a tap changer with the following full capacity, high voltage taps. The taps shall only be changed with the transformer de-energized. Provide an externally operable tap changer with tap position indicator and a means to padlock the tap changer at each position:
  - 1. Two 2.5% taps above nominal voltage and two, 2.5-percent taps below rated, nominal voltage.
- M. The transformer average winding temperature rise above ambient temperature at the transformer rating shall be as follows. The transformer shall be capable of being operated at rated load in a 30°C average ambient over 24 hours and a 40°C maximum ambient without loss of service life:
  - 1. 65°C rise above ambient.
- N. Transformer percent impedance, as measured at the rated, nominal voltage connection, shall be per the following target impedances: The tolerance on the target impedances shall be  $\pm 7.5\%$  of nominal value for impedance target values greater than 2.5%.
  - 1. Transformers with low voltage less than 600 VAC:
    - a. 750 to 3750 kVA: Impedance target shall be 5.75%. Manufacturer shall submit target impedance on submittal.
- O. The transformer dielectric, liquid coolant shall be as follows:
  - 1. Mineral oil transformer fluid" Mineral oil complying with ASTM D 3487, Type II, and tested according to ASTM D 117.
- P. High Voltage Bushings and Terminals.
  - 1. High voltage bushings shall be installed in the high voltage compartment located on the front left of the transformer.
  - 2. The bushing style shall be:

- a. Dead front rated for 15/25 kV, with currents 200 amps or below. The high voltage bushing shall be 15/25 kV, 200-amp bushing wells with bushing well inserts installed. The bushings shall be externally front removable and shall be supplied with a removable stud. The bushings shall meet IEEE 386 requirements for load-break terminations.

3. High Voltage Bushing Configurations.

- a. 15/25 kV radial feed dead front. The transformer shall have three (3) high voltage bushings for terminating a conductor per phase using IEEE 386 style terminations. Provide a cable "parking stand" by each high-voltage bushing well. Provide an "insulated parking bushing" for parking IEEE 386 style, high-voltage cable terminators for each parking stand.

Q. Low Voltage Bushings and Terminals:

- 1. Low voltage bushings shall be supplied in the low voltage compartment located on the front right of the transformer.
- 2. Transformers with a low voltage of 600 volts or less shall be provided with tin-plated, spade-type bushings. The bushings shall be externally replaceable. The bushings shall be designed for vertical cable takeoff. The quantity of connection holes shall be 4, 6, 8, 12, 16, or 20 holes as necessary for the transformer low voltage conductor terminations. The spacing of the connection 9/16-inch holes shall be 1.75 inches on center per C57.12.34. Standard and maximum bushing hole quantities shall be as follows:

- a. 750-1500 kVA. 480Y/277 V:6-holes standard

- 3. For transformers with a low voltage of 600 volts or less, bushing supports shall be provided for transformers that have ten or more connection holes.
- 4. For transformers with a low voltage of 600 volts or less, the bushing configuration shall be capable of terminating the number of cables allowed by the number of bushing holes specified.

R. Surge Arresters: Provide for each phase, IEEE 386 style, dead front, elbow-type, metal-oxide-varistor (MOV) style surge arresters mounted on one of the loop feed bushing sets. The MOV IEEE 386 arrester ratings shall be per the following table.

High Voltage Line-to-Line	Arrester Max Continuous Operating Voltage in kV rms Delta Windings	Arrester Max Continuous Operating Voltage in kV rms GrdY Windings
4160 VAC	5.10 kV	2.55 kV
12470 VAC	15.30 kV	8.40 kV
13200 VAC	15.30 kV	8.40 kV
13800 VAC	15.30 kV	10.20 kV
22860 GRDY VAC	NA	15.30 kV

High Voltage Line-to-Line	Arrester Max Continuous Operating Voltage in kV rms Delta Windings	Arrester Max Continuous Operating Voltage in kV rms GrdY Windings
24940 GRDY VAC	NA	17 kV
34500 GRDY VAC	NA	24.40 kV

S. Transformer Tank and Cabinet Enclosure:

1. The high voltage and low voltage compartments shall be located side-by-side on one side of the transformer tank. The compartments shall be separated by a metal barrier. The access door to the high voltage compartment shall be provided whereby the high voltage compartment door can only be opened after the door to the low voltage compartment has been opened. There shall be one or more fastening devices that must be removed before the high voltage compartment door can be opened. The low voltage compartment door shall have, as a minimum, a three-point latching system with a handle with provisions for a pad lock. Door hardware shall be made of corrosion resistant material.
2. A recessed, captive, penta-head or hex-head bolt that meets the requirements of C57.12.28 shall secure all access doors. The transformer shall meet all tamper resistance requirements of C57.12.28.
3. The tank base shall be designed to allow skidding or rolling in any direction. Lifting lugs shall be provided on the tank to allow the transformer to be lifted from above. Jacking provisions shall be provided.
4. The transformer shall be of a sealed tank construction. The tank shall be able to withstand a pressure of 7 psi without any permanent deformation and a pressure of 15 psi without rupture.
5. The tank cover shall be welded and the transformer tank hand hole fastenings shall be tamper resistant.
6. The tank shall include a 15 psig pressure relief valve. The pressure relief valve capacity flow rate at 15 psig shall comply with UL listing requirements and, in no case, shall be less than 35 SCFM. The pressure relief device shall be self-sealing with an indicator.
7. The transformer exterior shall be painted olive-green color Munsell 7GY3.29/1.5. The interior of the transformer cabinets shall be painted for corrosion resistance. The cabinet interior shall be painted a light color for ease of viewing. The tank coating/painting shall meet all requirements of ANSI C57.12.28, including salt spray, cross hatch adhesion, humidity, impact, oil resistance, ultraviolet accelerated weathering, and abrasion resistance.

T. Accessories: The following accessories shall be provided on the pad-mounted liquid-filled transformers.

1. Nameplate in the low voltage compartment.
2. 1-inch upper fill plug.
3. 1-inch drain/sampling valve in low voltage compartment.
4. Dial-type thermometer gauge.
5. Liquid-level gauge.
6. Pressure-vacuum gauge.
7. Cover mounted, pressure relief device. Device shall be self-sealing with an indicator.

- U. Optional Accessories: The transformer shall be provided with the additional following options.
  - 1. Complete 304L stainless steel tank and cabinet.
  - 2. Partial 304L stainless steel construction. Stainless steel tank base, cabinet sides, and sill.
  - 3. Liquid-level gauge with auxiliary alarm contacts.
  - 4. Dial-type thermometer gauge with auxiliary alarm contacts.
  - 5. Pressure vacuum gauge with auxiliary alarm contacts.
  - 6. Winding temperature indicator.
  - 7. Sudden pressure relay.
  
- V. Transformer Sound Level: The transformer sound level, as measured by the NEMA audible sound-level test procedure, shall be less than the values specified in NEMA TR 1 for liquid-filled transformers.
  
- W. Factory Standard Tests: The transformer shall be factory tested in accordance with IEEE C57.12.90. Tests include:
  - 1. Ratio tests using all tap settings.
  - 2. Polarity and phase relation tests.
  - 3. No-Load losses tests.
  - 4. Load loss tests.
  - 5. Excitation current tests.
  - 6. Percent Impedance at rated current.
  - 7. Winding resistance measurement tests.
  - 8. Induced and applied potential tests.
  - 9. Full wave and reduced wave impulse test.
  - 10. Mechanical leak test.
  
- X. Certification of Transformer Tests: Provide certification of all design and other tests listed in C57.12.00, including verification that the design has passed short circuit criteria per IEEE C57.12.00 and C57.12.90.

## 2.2 IDENTIFICATION DEVICES (Project equipment tags)

- A. Equipment Tag Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section 26 05 53. (This is not the manufacturer's nameplate but the equipment tag for the specific use on the project.)

## 2.3 SOURCE QUALITY CONTROL - OWNER OR ARCHITECT/ENGINEER WITNESS OF FACTORY TESTS

- A. The Owner or the Architect/Engineer shall witness all required factory tests. Notify Architect at least 14 days before date of tests and indicate their approximate duration.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that the transformer foundation/pads are ready to receive work.

- B. Verify field dimensional measurements are as shown on the transformer shop drawings.
- C. Verify that required utilities are available, in proper location, and ready for use.
- D. Beginning of installation means installer accepts conditions.

### 3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install safety labels to NEMA 260.
- C. Install plumb and level.
- D. Install transformers, except for overhead pole type, on concrete bases.
  - 1. Anchor transformers to concrete bases according to manufacturer's written instructions, seismic codes at the Project, and requirements in Division 26 Section "Seismic Controls for Electrical Work".
  - 2. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit and 4 inches high.
  - 3. Use 3000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete Cast-in-Place Concrete (Limited Applications)".
  - 4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.
  - 5. Install epoxy-coated anchor bolts for supported equipment that extends through concrete base and anchor into structural concrete floor.
  - 6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

### 3.3 FIELD QUALITY CONTROL

- A. Field testing will be performed under provisions of Section 26 05 00.
- B. Inspect and test in accordance with NETA Acceptance Testing Specifications (ATS), except Section 4.
- C. Perform inspections and tests listed in NEMA ATS, Section 7 relative to the NTEA category type "Transformers Liquid-Filled". Include the following optional tests:
  - 1. In addition to the standard electrical tests, perform the following optional tests when applicable:
    - a. Measure the percentage of oxygen in the gas blanket if a nitrogen gas blanket is provided.
  - 2. In addition to insulating liquid standard tests, also include the following optional liquid tests:

- a. Specific gravity: ANSI/ASTM D 1298.
- b. Water in insulating liquids: ASTM D 1533.
- c. Power-factor or dissipation-factor in accordance with ASTM D924.

3.4 ADJUSTING

- A. Adjust primary/high voltage taps so that secondary voltage is within 2% of rated voltage at projected load. Verify the projected load with Architect/Engineer prior to final settings.

END OF SECTION 26 12 19

## SECTION 26 20 00 - SERVICE ENTRANCE

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Arrangement with Utility Company for permanent electric service.
- B. Underground service entrance

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram for additional information.

#### 1.3 QUALITY ASSURANCE

- A. Utility Company: ComEd.
- B. Contact: Alan Corl.
- C. Install service entrance in accordance with Utility Company's rules and regulations.

#### 1.4 SYSTEM DESCRIPTION

- A. System Voltage: 480Y/277 volts, three phase, four-wire, 60 Hertz.

### PART 2 - PRODUCTS

#### 2.1 METERING EQUIPMENT

- A. Meter: Furnished by the Utility Company.
- B. Meter Base: Furnished by the Contractor, as approved by the Utility Company. (Manufacturers: Milbank, Superior, Duncan, or Anchor).
- C. **MC-1**; Exterior Mounted Metering Cabinets: Furnished and installed by the Contractor to Utility Company's specifications. Conduit and conductors between metering cabinets and instrumentation shall be by the Contractor. Connections as required by the Utility Company.

#### 2.2 IDENTIFICATION

- A. Provide a permanent plaque or sign denoting all services, feeders, and branch circuits supplying the building or structure and the area served by each. Install plaque or sign at each service disconnecting means.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Make arrangements with Utility Company to obtain permanent electric service to the Project.
- B. Primary distribution equipment and pad-mounted transformers shall be furnished and installed by the Utility Company.
- C. Primary conductors shall be furnished, installed, and terminated by the Utility Company. Primary conduit shall be furnished and installed by the Contractor, as shown on the drawings, to the Utility Company's requirements.
- D. Underground: Install service entrance conduits in concrete envelope from Utility Company's pad mounted transformer to meter cabinet and building service entrance equipment. Utility Company will connect service conductors to transformer secondary lugs.
- E. Concrete Pad for Transformer: Furnished and installed by the Contractor to Utility Company's specifications.

END OF SECTION 26 20 00

## SECTION 26 22 00 - DRY TYPE TRANSFORMERS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Dry type two winding transformers (**TR-#**)

#### 1.2 REFERENCES

- A. NEMA ST 20 - Dry Type Transformers for General Applications
- B. ANSI/IEEE C57.12.01 - General Requirements for Dry Type Distribution and Power Transformers
- C. ANSI/IEEE C57.12.91 - Test Code for Dry Type Distribution and Power Transformers
- D. Department of Energy 10 CFR Part 431 - Energy Conservation Program for Commercial Equipment: Distribution Transformers Energy Conservation Standards; Final Rule.
- E. NEMA TP 2 - Standard Test Method for Measuring the Energy Consumption of Distribution Transformers
- F. NEMA TP 3 - Standard for the Labeling of Distribution Transformer Efficiency

#### 1.3 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Include outline and support point dimensions of enclosures and accessories, unit weight, voltage, KVA, and impedance ratings and characteristics, loss data, efficiency at 35, 50, 75 and 100 percent rated load, sound level, tap configurations, insulation system type, and rated temperature rise.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

- A. Store and protect products under provisions of Section 26 05 00.
- B. Store in a warm, dry location with uniform temperature. Cover ventilating openings to keep out dust.
- C. Handle transformers using only lifting eyes and brackets provided for that purpose. Protect units against entrance of rain, sleet, or snow if handled in inclement weather.

PART 2 - PRODUCTS

2.1 DRY TYPE TWO WINDING TRANSFORMERS

A. Acceptable Manufacturers:

1. Square D 7400 EX##T / SK300##KB Series
2. Eaton V48M / H48M / B48M Series
3. ABB 9T Series
4. Hammond SG / SMK Series
5. Siemens 3F3 Series

B. Dry Type Transformers: NEMA ST 20, factory-assembled, air-cooled dry type transformers; ratings as shown on the drawings. Transformers supplied under this project shall meet the US Department of Energy (DOE) 2016 Efficiency requirements or the most current DOE CFR in effect.

C. Insulation system and average winding temperature rise for rated KVA as follows:

Ratings	Class	Rise (degree C)
Less than 15	185	As shown on the drawings
or higher	220	As shown on the drawings

D. Case temperature shall not exceed 40°C rise above ambient at its warmest point.

E. Winding Taps, Transformers Less than 15 KVA: Two 5 percent below rated voltage, full capacity taps on primary winding.

F. Winding Taps, Transformers 15 KVA and Larger: Two (2) 2-1/2% below and two (2) 2-1/2% above rated voltage, full capacity taps on primary winding.

G. Sound Levels: Average audible sound level shall not exceed the values given below when tested to NEMA ST 20 standards:

Equivalent Winding kVA Range	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
0-9	40	40	67	45
9.01-30.00	45	45	67	50
30.01-50.00	45	48	67	50
50.01-150.00	50	53	67	55
150.01-300.00	55	58	67	57
300.01-500.00	60	63	67	59

	Average Sound Level, Decibels			
	Self-Cooled Ventilated			Self-Cooled Sealed
Equivalent Winding kVA Range	K-Factor = 1 K-Factor = 4 K-Factor = 9	K-Factor = 13 K-Factor = 20	Forced Air w/ Fans Running	
500.01-700.00	62	65	67	61
700.00-1000.00	64	67	67	63

- H. Ground core and coil assembly to enclosure by means of a visible flexible copper grounding strap.
- I. Mounting: Transformers 75 KVA and less shall be suitable for wall, floor, or trapeze mounting; transformers larger than 75 KVA shall be suitable for floor or trapeze mounting.
- J. Coil Conductors: Continuous windings with terminations brazed or welded.
- K. Enclosure: NEMA ST 20; Type 1. Provide lifting eyes or brackets.
- L. Isolate core and coil from enclosure using vibration-absorbing mounts.
- M. Nameplate: NEMA TP 3; Include transformer connection data and overload capacity based on rated allowable temperature rise.

## 2.2 ACCESSORIES

- A. Electronic Isolation Shield:
  1. Provide electrostatic winding shield with separate insulated grounding connection as shown on the drawings.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Set transformer plumb and level.
- B. Use flexible conduit, 2 feet minimum length, for connections to transformer case. Make conduit connections to side panel of enclosure.
- C. Mount transformers on four 3"x3"x1/2" thick, 50 durometer rubber vibration isolating pads suitable for isolating the transformer noise from the building structure.
- D. Ventilated transformers: Provide factory label on horizontal surface to prohibit storage on top, front, or adjacent to transformer.

3.2 FIELD QUALITY CONTROL

- A. Check for damage and tight connections prior to energizing transformer.
- B. Measure primary and secondary voltages and make appropriate tap adjustments. Adjustments shall be made at completion of project and at approximately 6 months following project acceptance when requested by the Owner.

END OF SECTION 26 22 00

## SECTION 26 24 13 - SWITCHBOARDS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Main and distribution switchboards: SB-MAIN-N, WES-SBHA, LMS-SBHA, FMS-SBHA

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram for size, rating, and configuration.

#### 1.3 REFERENCES

- A. ANSI C12 - Code for Electricity Metering
- B. ANSI C39.1 - Requirements for Electrical Analog Indicating Instruments
- C. ANSI C57.13 - Requirements for Instrument Transformers
- D. NEMA AB 1 - Molded Case Circuit Breakers
- E. NEMA KS 1 - Enclosed Switches
- F. NEMA PB 2 - Dead Front Distribution Switchboards
- G. NEMA PB 2.1 - Instructions for Safe Handling, Installation, Operation and Maintenance of Deadfront Switchboards Rated 600 Volts or less

#### 1.4 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Include front and side views of enclosures with overall dimensions shown; conduit entrance locations and requirements; nameplate legends; size and number of bus bars per phase, neutral, and ground; switchboard instrument details; instructions for handling and installation of switchboard; and electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
- C. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.
- D. Submit manufacturer's instructions under provisions of Section 26 05 00.

#### 1.5 SPARE PARTS

- A. Keys: Furnish four each to the Owner.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to the site under provisions of Section 26 05 00.
- B. Deliver in 48-inch maximum width shipping splits, unless approved otherwise by both the Contractor and Architect/Engineer, individually wrapped for protection, and mounted on shipping skids.
- C. Store and protect products under provisions of Section 26 05 00.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- E. Handle in accordance with NEMA PB2.1 and manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to switchboard internal components, enclosure, and finish.

## 1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

## PART 2 - PRODUCTS

### 2.1 GENERAL

- A. Approved Manufacturers:
  - 1. Square D Class 2700 QED-2, I-Line, Powerstyle
  - 2. ABB Spectra / Evolution
  - 3. Siemens
  - 4. Eaton

### 2.2 RATINGS

- A. Definitions:
  - 1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. Refer to Section 26 05 53 for additional requirements.
  - 2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.
- B. The switchboards for this project shall be fully rated.

## 2.3 SWITCHBOARD CONSTRUCTION AND RATINGS

- A. Factory-assembled, dead front, metal-enclosed, and self-supporting switchboard assembly conforming to NEMA PB2, and complete from incoming line terminals to load-side terminations.
- B. Switchboard electrical ratings and configurations as shown on the drawings.
- C. Line and Load Terminations: Accessible from the front only of the switchboard, suitable for the conductor materials used.
- D. Main Section Devices: Individually mounted and compartmented.
- E. Distribution Section Devices: Individually mounted Group mounted(Washington, Lincoln, Flinn). Group mounted for East High school.
- F. Auxiliary Section Devices: Individually mounted and compartmented.
- G. Bus Material: Aluminum with tin plating, sized in accordance with NEMA PB 2.
- H. Bus Connections: Bolted, accessible from front only for maintenance. Plug-on connections may be utilized with Architect/Engineer's pre-approval by addenda.
- I. Bus bars shall be fully isolated, braced for minimum ampere rms symmetrical rating as indicated on drawings.
- J. The bus shall extend the full height of the distribution sections to provide space for future breakers.
- K. Provide a 1 X 1/4-inch copper ground bus through the length of the switchboard.
- L. Enclosure shall be NEMA PB 2; Type 1 - General-Purpose. Sections shall align at front and rear. Provide removable panel access or hinged door with flush lock and all keyed alike. Door hardware shall provide swing clear operation (180-degree swing).
- M. Switchboard Height: NEMA PB 2; 92 inches, excluding floor sills, lifting members and pull boxes.
- N. Finish: Manufacturer's standard light gray enamel over external surfaces. Coat internal surfaces with minimum one coat corrosion-resisting paint, or plate with cadmium or zinc.
- O. Pull Box: Same construction as switchboard, size as shown on the drawings. Top and sides shall be removable. Insulating, fire-resistive bottom with separate openings for each circuit to pass into switchboard.
- P. Future Provisions: In addition to the spare devices shown, provide a minimum of 15 inches of fully equipped space for future devices with bussing and bus connections, suitably insulated and braced for short circuit currents. Continuous current rating as indicated on the drawings.
- Q. Suitable for use as service entrance equipment. Provide line side (service style) barriers.

## 2.4 SWITCHING, OVER-CURRENT PROTECTIVE DEVICES, AND ARC ENERGY REDUCTION

- A. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole. Provide breaker interrupting ratings as indicated on the plans. Where necessary to meet interrupting ratings, breakers shall be provided with automatically resetting current limiting elements in each pole.
- B. Solid State Molded Case Circuit Breakers: (All breakers identified on plans as solid-state with 2,500 ampere frame sizes and below.) Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover. Provide stationary mounting.. Ground fault sensing shall be breaker integral with circuit breaker. Provide breaker interrupting ratings as indicated on the plans.
- C. Arc Energy Reduction:
  - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
  - 2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch in the first section of the electrical equipment.

## 2.5 INSTRUMENTS AND SENSORS

- A. Current Transformers: ANSI C57.13; 5 ampere secondary, bar or window type, with single secondary winding, unless otherwise required for application, and secondary shorting device, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- B. Potential Transformers: ANSI C57.13; 120-volt single secondary, disconnecting type with integral fuse mountings, primary/secondary ratio as required, burden and accuracy consistent with connected metering and relay devices, 60 Hertz.
- C. Ground Fault Sensor: Zero sequence type.
- D. Ground Fault Relay: Adjustable ground fault sensitivity from 200 to 1200 amperes, time delay adjustable from 0 to 15 seconds. Provide monitor panel with lamp to indicate relay operation, TEST and RESET control switches.
- E. DPM; Digital AC Power Monitor: Capable of measuring, calculating and directly displaying; Volts (L-L, L-N), Amps, KW, KWH. Monitor shall be true RMS measurement with programmable set-up parameters. All set-up parameters data shall be stored in non-volatile memory to protect from power outages.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install switchboard in locations shown on the drawings, in accordance with manufacturer's written instructions and NEMA PB 2.1.
- B. Tighten accessible bus connections and mechanical fasteners after placing switchboard.

### 3.2 FIELD QUALITY CONTROL

- A. Inspect completed installation for physical damage, proper alignment, anchorage, and grounding.
- B. Measure insulation resistance of each bus section phase to phase and phase to ground for one minute each. Test voltage shall be 1000 volts, and minimum acceptable value for insulation resistance is 2 megohms.
- C. Check tightness of accessible bolted bus joints using a calibrated torque wrench. Tightness shall be in accordance with manufacturer's recommended values.
- D. Physically test key interlock systems to ensure proper function.

### 3.3 ADJUSTING AND CLEANING

- A. Adjust all operating mechanisms for free mechanical movement.
- B. Touch up scratched or marred surfaces to match original finish.
- C. Provide time/current trip curves for all adjustable protection devices that require setting. Also provide curves and equipment information for associated new and existing fixed devices that require coordination with new protection devices. Submit time/current curves in hard copy or electronic format.
- D. Adjust trip and time delay settings to values as scheduled, or as instructed by the Architect/Engineer.
- E. Where two levels of ground fault are provided, test ground fault circuit breakers to prove selective coordination in accordance with manufacturer's directions. Provide testing documentation with Operating & Maintenance Manual submittals.

END OF SECTION 26 24 13

## SECTION 26 24 16 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Service and distribution panelboards: **DP-#**,
- B. Lighting and appliance branch circuit panelboards: **Panel '###'**

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to the One-Line Diagram and Panel Schedules for size, rating, and configuration.

#### 1.3 REFERENCES

- A. NEMA AB 1 - Molded Case Circuit Breakers
- B. NEMA FU 1 - Low voltage cartridge fuses
- C. NEMA KS 1 - Enclosed Switches
- D. NEMA PB 1 - Panelboards
- E. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or Less
- F. NEMA PB 1.2 - Application Guide for Ground-fault Protective Devices for Equipment
- G. UL 248 - Low-Voltage Fuses
- H. UL 67 - Panelboards

#### 1.4 SUBMITTALS

- A. Submit shop drawings for equipment and component devices under provisions of Section 26 05 00.
- B. Include outline and support point dimensions, voltage, main bus ampacity, integrated short circuit ampere rating, circuit breaker and fusible switch arrangement and sizes.
- C. Selective Coordination Study: Submit study to prove that all essential electrical systems, emergency systems and legally required standby system panelboards are selectively coordinated with all supply side overcurrent protective devices.
- D. Arc Energy Reduction Documentation: Submit documentation to demonstrate the arc energy reduction system is set to operate at a value below the available arcing current.
- E. Submit manufacturer's instructions under provisions of Section 26 05 00.

## 1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.

## PART 2 - PRODUCTS

### 2.1 RATINGS

#### A. Definitions:

1. Series rated equipment shall be defined as equipment that can achieve a required UL AIC rating with an upstream device such as a main breaker or a combination of devices to meet or exceed a required UL AIC rating. All series rated equipment shall have a permanently attached nameplate indicating that device rating must be maintained. See Section 26 05 53 for additional requirements.
2. Fully rated equipment shall be defined as equipment where all devices in that equipment shall carry a minimum of the AIC rating that is specified.

- B. The panelboards for this project shall be fully rated unless otherwise specifically noted in the Drawings or Specifications.

### 2.2 DISTRIBUTION PANELBOARDS

#### A. General

##### 1. Manufacturers:

- a. Square D QMB, I-Line
- b. ABB ReliaGear Entelleon
- c. Siemens F2, P4
- d. Eaton PRL4, PRL5

- B. Panelboards: NEMA PB 1; type as shown on the drawings.

- C. Enclosure: NEMA PB 1; Type 1.

- D. Provide cabinet front with concealed trim clamps and hinged trim on door to allow access to wiring gutters without removal of trim and flush lock. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.

- E. Provide panelboards with copper bus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.

- F. All spaces shown on the one-line diagram shall be fully prepared spaces for future breakers.

- G. Minimum Integrated Short Circuit Rating: 100,000 amperes rms symmetrical for 240-volt panelboards; 50,000 amperes rms symmetrical for 480-volt panelboards, or as shown on the drawings.

- H. Molded Case Circuit Breakers: Provide circuit breakers with integral thermal and instantaneous magnetic trip in each pole.
- I. Solid State Molded Case Circuit Breakers: (All breakers identified on plans as solid-state with 1,200 ampere frame sizes and below.) Provide molded case switch with electronic sensing, timing, and tripping circuits for fully adjustable time current characteristic settings including ground fault trip, instantaneous trip, long time trip, long time delay, short time trip, and short time delay. Trip setting shall be field programmable with a sealable clear cover.
- J. Arc Energy Reduction:
  - 1. Provide an arc energy reduction system to reduce the clearing time of an arc flash event. The arc energy reduction system shall be provided for overcurrent protection devices rated 1,200 amps or larger.
  - 2. Energy-Reducing Maintenance Switch: Provide an energy-reducing maintenance switch visual status indication when engaged. Install the maintenance switch in the first section of the electrical equipment.

## 2.3 BRANCH CIRCUIT PANELBOARDS

- A. General
  - 1. Manufacturers:
    - a. Square D NQ, NF
    - b. ABB A Series
    - c. Siemens P1
    - d. Eaton PRL1, PRL2
- B. Lighting and Appliance Branch Circuit Panelboards: NEMA PB 1; circuit breaker type.
- C. Enclosure: NEMA PB 1; Type 1.
- D. Provide cabinet front with door-in-door construction, concealed hinge, and flush lock all keyed alike. Door hardware shall provide swing clear operation (180-degree swing). Finish in manufacturer's standard gray enamel.
- E. Provide panelboards with copperbus, ratings as scheduled on the drawings. Provide copper ground bus in all panelboards.
- F. All unlabeled circuits shown on the panelboard schedule shall be fully prepared spaces for future breakers.
- G. All multiple-section panelboards shall have the same dimensional back box and cabinet front size.
- H. Minimum Integrated Short Circuit Rating: As shown on the drawings.
- I. Provide handle lock-on devices for all breakers serving exit sign and lighting circuits with emergency battery units. Provide handle lock-on devices and red handles for breakers serving fire alarm panels.

- J. Molded Case Circuit Breakers: Bolt-on type thermal magnetic trip circuit breakers, with common trip handle for all poles. Provide circuit breakers UL listed as Type SWD for lighting circuits. Provide UL Class A ground fault interrupter circuit breakers where scheduled on the drawings. Do not use tandem circuit breakers.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install panelboards plumb as indicated on the drawings in conformance with NEMA PB 1.1.
- B. Height: 6 feet to handle of highest device.
- C. Provide filler plates for unused spaces in panelboards.
- D. Provide custom typed circuit directory for each branch circuit panelboard. Provide updated custom typed circuit directory for each existing branch circuit panelboard with new or revised circuits per the scope of work. Label shall include equipment name or final approved room name, room number, and load type for each circuit (examples: SUMP SP-1 or ROOM 101 RECEIPT). Revise directory to reflect circuit changes required to balance phase loads. Printed copies of the bid document panel schedules are not acceptable as circuit directories.
- E. Stub five (5) empty one-inch conduits to accessible location above ceiling out of each recessed panelboard.

#### 3.2 FIELD QUALITY CONTROL

- A. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection: Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses.

END OF SECTION 26 24 16

## SECTION 26 24 19 - MOTOR CONTROL

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Manual motor starters
- B. Magnetic motor starters
- C. Combination magnetic motor starters

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule and One-Line Diagram for rating and configuration.

#### 1.3 REFERENCES

- A. ANSI/UL Standard 508. Standard for Industrial Control Equipment
- B. FCC Rules and Regulations, Part 15, Subpart J- Radio Frequency Interference
- C. FS W-C-375 - Circuit Breakers, Molded Case; Branch Circuit and Service
- D. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
- E. FS W-P-115 - Power Distribution Panel
- F. FS W-S-865 - Switch, Box, (Enclosed), Surface-Mounted
- G. IEEE Standard 519-1981 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- H. NEMA AB 1 - Molded Case Circuit Breakers
- I. NEMA ICS 2 - Industrial Control Devices, Controllers, and Assemblies
- J. NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- K. NEMA KS 1 - Enclosed Switches
- L. NEMA PB 1 - Panelboards
- M. NEMA PB 1.1 - Instructions for Safe Installation, Operation and Maintenance of Panelboards Rated 600 Volts or less

#### 1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00.

- B. Indicate on shop drawings, front and side views of motor control center enclosures with overall dimensions. Include conduit entrance locations and requirements; wiring diagrams that differentiate between manufacturer-installed and field-installed wiring; nameplate legends; size and number of bus bars per phase, neutral, and ground; electrical characteristics including voltage, frame size and trip ratings, withstand ratings, and time-current curves of all equipment and components.
- C. Provide product data on motor starters and combination motor starters, relays, pilot devices, and switching and over-current protective devices.
- D. Submit manufacturer's instructions under provisions of Section 26 05 00.

#### 1.5 SPARE PARTS

- A. Keys: Furnish four (4) each to the Owner.
- B. Fuses: Furnish three (3) spare fuses of each type and rating installed to the Owner.
- C. Fuse Pullers: Furnish one (1) fuse puller to the Owner.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site under provisions of Section 26 05 00.
- B. Deliver in 60-inch maximum width shipping splits, individually wrapped for protection, and mounted on shipping skids.
- C. Store and protect products under provisions of Section 26 05 00.
- D. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from fumes, dirt, water, construction debris, traffic, and physical damage.
- E. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage to motor control center components, enclosure, and finish.

#### 1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Include spare parts data listing; source and current prices of replacement parts and supplies; and recommended maintenance procedures and intervals.

### PART 2 - PRODUCTS

#### 2.1 MANUAL MOTOR STARTERS

- A. Acceptable Manufacturers:
  - 1. Square D 2500 Series

2. Eaton MS Series
3. ABB
4. Siemens SMF / MMS Series

- B. Manual Motor Starter: NEMA ICS 2; AC general-purpose Class A manually operated non-reversing full-voltage controller for induction motors rated in horsepower, with overload relay, and toggle operator.
- C. Fractional Horsepower Manual Starter: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, with thermal overload unit, and toggle operator.
- D. Motor Starting Switch: NEMA ICS 2; AC general-purpose Class A manually operated, full-voltage controller for fractional horsepower induction motors, without thermal overload unit, and toggle operator.
- E. Enclosure: NEMA ICS 6; Type 1.

## 2.2 MAGNETIC MOTOR STARTERS

- A. Acceptable Manufacturers:
  1. Square D
  2. Eaton
  3. ABB
  4. Siemens
  5. Franklin Control
- B. Magnetic Motor Starters: NEMA ICS 2; AC general-purpose Class A magnetic controller for induction motors rated in horsepower.
- C. Full Voltage Starting: Non-reversing type, unless otherwise indicated.
- D. Coil Operating Voltage: 120 volts, 60 Hertz, obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating, and control devices, plus 100% spare capacity.
- E. Size: NEMA ICS 2; size as shown on the drawings.
- F. Overload Relay:
  1. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 20 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.
- G. Enclosure: NEMA ICS 6; Type 1.
- H. Combination Motor Starters: Combine motor starters with disconnect switch in common enclosure. Provide with disconnecting means as indicated on drawings.

- I. Auxiliary Contacts: NEMA ICS 2; two normally open, field convertible contacts in addition to seal-in contact.
- J. Pushbuttons: NEMA ICS 2; START/STOP in front cover.
- K. Indicating Lights: NEMA ICS 2; RUN: red in front cover.
- L. Selector Switches: NEMA ICS 2; HAND/OFF/AUTO, in front cover.
- M. Relays: NEMA ICS 2; .
- N. Control Power Transformers: 120 volt fused secondary, fused primary, minimum VA as scheduled:
  - 1. Size 1 - 100 VA
  - 2. Size 2 - 100 VA
  - 3. Size 3 - 150 VA
  - 4. Size 4 - 300 VA
  - 5. Size 5 - 300 VA
  - 6. Size 6 - 300 VA
- O. Provide phase loss protection relay with contacts to de-energize the starter for each starter serving motors 5 HP or greater.

## 2.3 CONTROLLER OVER-CURRENT PROTECTION AND DISCONNECTING MEANS

- A. Acceptable Manufacturers:
  - 1. Starter manufacturer
- B. Non-fusible Switch Assemblies: Quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- C. Fusible Switch Assemblies: NEMA KS 1, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle. Provide interlock to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Provide with Class 'R' rejection clips. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by a nationally recognized testing laboratory.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install motor control equipment in accordance with manufacturer's instructions on concrete bases.
- B. Install fuses in fusible switches.
- C. Select and install heater elements in motor starters to match installed motor characteristics.

- D. Set field-adjustable switches and circuit-breaker trip ranges.
- E. Motor Data: Provide neatly typed label inside each motor starter enclosure door identifying motor served, nameplate horsepower, full load amperes, code letter, service factor, and voltage/phase rating.

END OF SECTION 26 24 19

## SECTION 26 27 26 - WIRING DEVICES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Device plates and box covers
- B. Receptacles

#### 1.2 QUALITY ASSURANCE

- A. Provide similar devices from a single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in the Electrical Code, by a testing agency to Authorities Having Jurisdiction and marked for intended use.
- C. Comply with the Electrical Code.

#### 1.3 REFERENCES

- A. DSCC W-C-896F - General Specification for Electrical Power Connector
- B. FS W-C-596 - Electrical Power Connector, Plug, Receptacle, and Cable Outlet
- C. NEMA WD 1 - General Color Requirements for Wiring Devices
- D. NEMA WD 6 - Wiring Devices - Dimensional Requirements
- E. NFPA 70 - National Electrical Code (NEC)
- F. UL 498 - Standard for Attachment Plugs and Receptacles
- G. UL 943 - Standard for Ground Fault Circuit Interrupters

#### 1.4 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Provide product data showing configurations, finishes, dimensions, and manufacturer's instructions.

#### 1.5 COORDINATION

- A. Receptacles for Owner Furnished Equipment: Match plug configurations.
- B. Cord and Plug Sets: Match equipment requirements.

## PART 2 - PRODUCTS

### 2.1 DEVICE COLOR

- A. All switch, receptacle, outlet, and coverplate colors shall be verified with Architect, unless indicated otherwise.

### 2.2 COVERPLATES

- A. All switches, receptacles, and outlets shall be complete with the following:
  - 1. Unbreakable thermoplastic/thermoset plastic coverplates in finished spaces where walls are finished.
  - 2. Decorator Grade - Public: Decorator #302 stainless steel wallplates in public finished spaces where walls are finished.
    - a. Manufacturer:
      - 1) Leviton Decora
      - 2) Hubbell Decorator
      - 3) Cooper Decorator
      - 4) or approved equal
  - 3. #302 stainless steel coverplates in unfinished spaces for flush boxes.
  - 4. Galvanized steel coverplates in unfinished spaces for surface mounted boxes.
- B. Where several devices are ganged together, the coverplate shall be of the ganged style for the number of devices used.
- C. Install nameplate identification as indicated in Section 26 05 53.
- D. Plate securing screws shall be metal with head color matching the wall plate finish.

### 2.3 RECEPTACLES

- A. Refer to Electrical Symbols List for device type.
- B. Devices that are shaded on the drawings shall be red.
- C. Devices that are shaded on the drawings shall be red and shall have an illuminated face or indicator light to indicate that there is power to the device.
- D. REC-DUP: NEMA 5-20R Duplex Receptacle:
  - 1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with impact resistant thermoplastic face and steel back strap.
    - a. Manufacturers:
      - 1) Hubbell 5352A
      - 2) Leviton, 5362-S
      - 3) Pass & Seymour 5362

4) Cooper 5352

E. REC-DUP-GFI: NEMA 5-20R Ground Fault Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face.
  - a. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
  - b. Manufacturers:
    - 1) Hubbell GF20L
    - 2) Leviton GFNT2
    - 3) Pass & Seymour 2097
    - 4) Cooper SGF20

F. REC-DUP-WP: NEMA 5-20R Weatherproof Ground Fault Duplex Receptacle:

1. 125-volt, 20 amp, 3-wire grounding type with test and reset buttons in impact resistant thermoplastic face, weather resistant WR listed. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
2. Device shall perform self-test of GFCI circuitry in accordance with UL 943.
  - a. Manufacturers:
    - 1) Hubbell GFTWRST20/WP826
    - 2) Leviton GFWT2/M5979
    - 3) Pass & Seymour 2097TRWR/WIUCAST1
    - 4) Cooper WRSGF20/WIUMV-1

G. REC-SUR: NEMA 5-20R Surge Suppression Duplex Receptacle:

1. Standard Grade: 125-volt, 20 amp, 3-wire grounding type with orange impact resistance thermoplastic face, light, and alarm.
  - a. Manufacturers:
    - 1) Hubbell HBL5362OSA
    - 2) Leviton 5380
    - 3) Pass & Seymour 5362-OSP
    - 4) Cooper 5362RNS

H. REC-QUAD: NEMA 5-20R Double Duplex Receptacle:

1. Consists of two duplex receptacles, double gang box, plaster ring and faceplate.
  - a. Manufacturers:
    - 1) Refer to Duplex Receptacle above.

I. REC-QUAD-GFI: NEMA 5-20R Double Duplex GFI Receptacle:

1. Consists of two duplex GFI receptacles, double gang box, plaster ring and faceplate.
  - a. Manufacturers:
    - 1) Refer to Duplex GFI Receptacle above.
  
- J. REC-QUAD-WP: NEMA 5-20R Weatherproof Ground Fault Quad Receptacle:
  1. Consists of two duplex, GFI receptacles. Double gang box. Provide extra-duty NEMA 3R rated while-in-use cast aluminum cover.
    - a. Manufacturers:
      - 1) Receptacle: Refer to GFCI Receptacle above.
      - 2) Cover:
        - a) Intermatic WP1030MXD
        - b) Pass & Seymour WIUCAST2
        - c) Thomas & Betts Red Dot 2CKU
  
- K. Back wired devices shall be complete with eight holes that are screw activated with metal clamps for connection to #12 or #10 copper conductors.
  
- L. Side wired devices shall have four binding screws that are undercut for positive wire retention.
  
- M. Ground fault circuit interrupter (GFCI) receptacles shall comply with UL 943 requiring increased surge immunity, improved corrosion resistance, improved resistance to false tripping and diagnostic indication for miswiring if the line and load conductors are reversed during installation.
  
- N. Integral surge suppression receptacles with integral surge suppression shall comply with the following:
  1. Category A3 listed.
  2. Line to ground, line to neutral, and neutral to ground modes.
  3. Metal-oxide varistors with a nominal clamp level rating of 500 volts and minimum single transient pulse energy dissipation of 210 joules per mode.
  4. Status indication: Light visible in the face of the device and audible alarm to indicate device is no longer active or in service.
  5. Distinctive symbol on device face to denote SPD-type device.
  6. Device shall be blue with stainless coverplate.
  7. NEMA 5-20R duplex receptacle, 125-volt, 20 amp, 3-wire grounding type heavy duty industrial grade with impact resistant thermoplastic face and one-piece brass back strap.
    - a. Manufacturers:
      - 1) Hubbell HBL5362SA
      - 2) Leviton
      - 3) Pass & Seymour
  
- O. Hazardous (Classified) location receptacles shall comply with NEMA FB 11.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install convenience receptacles at elevations indicated in the General Installation Notes on the contract drawings.
- B. Install specific-use receptacles at heights shown on the contract drawings. Install devices level, plumb, and square with building lines. Coordinate installation of adjacent devices of separate systems with common mounting heights, including lighting, power, systems, technology, and temperature control device rough-ins.
- C. Ground Fault Protection: Provide ground fault protection for all branch circuit breakers serving 120/208 receptacle outlets rated 21 - 50 amps single phase and 21-100 amps three phase in the following locations, as shown on drawings, or required by adopted code:
  - 1. Bathrooms, locker rooms, shower rooms
  - 2. Kitchens
  - 3. Rooftops
  - 4. Interior/Exterior locations subject to damp/wet conditions
  - 5. When located within 6 feet of sinks, bathtubs, and shower stalls
  - 6. Garages, accessory buildings, service bays
- D. Install receptacles vertically with ground slot up or where indicated on the drawings, horizontally with ground slot to the left.
- E. Install decorative plates on switch, receptacle, and blank outlets in finished areas, using jumbo size plates for outlets installed in masonry walls.
- F. Install galvanized steel plates on outlet boxes and junction boxes in unfinished areas, above accessible ceilings, and on surface-mounted outlets.
- G. Install devices and wall plates flush and level.
- H. Install nameplate identification to receptacle cover plates indicated. Identification shall identify panel name and circuit number. Refer to Specification Section 26 05 53 - Electrical Identification.
- I. Test receptacles for proper polarity, ground continuity and compliance with requirements.

END OF SECTION 26 27 26

## SECTION 26 28 13 - FUSES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fuses

#### 1.2 REFERENCES

- A. UL 198E - Class R Fuses
- B. FS W-F-870 - Fuseholders (For Plug and Enclosed Cartridge Fuses)
- C. NEMA FU 1 - Low Voltage Cartridge Fuses
- D. NFPA 70 - National Electrical Code (NEC)

#### 1.3 EXTRA MATERIALS

- A. Provide three of each size and type of fuse installed.

#### 1.4 PROJECT CONDITIONS

- A. Where ambient temperature to which fuses are directly exposed is less than 40°F or more than 100°F, apply manufacturer's ambient temperature adjustment factors to fuse ratings.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS - FUSES

- A. Bussman, Division of Eaton
- B. Edison Fuse, Division of Cooper Industries
- C. Mersen
- D. Littelfuse Inc

#### 2.2 FUSES

- A. Dimensions and Performance: NEMA FU 1, Class as specified or indicated.
- B. Voltage: Provide fuses with voltage rating suitable for circuit phase-to-phase voltage.
- C. Fuses with ratings larger than 600 amperes: Class L (time delay), unless otherwise noted on the drawings.

- D. Fuses with ratings larger than 200 amperes but equal to or less than 600 amperes: Class RK-1 (time delay), unless otherwise noted on the drawings.
- E. Fuses with ratings less than or equal to 200 amperes (not including control transformer fuses): Class RK-5, unless otherwise noted on the drawings.
- F. Control transformer fuses: Class CC (time delay).
- G. Fuses for packaged equipment: Size and type as recommended by equipment manufacturer.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Install fuses where indicated on the drawings and specifications.
- B. Install fuses in accordance with manufacturer's instruction.
- C. Install fuses in packaged equipment as required by equipment manufacturer.
- D. Install fuse with label oriented such that manufacturer, type, and size are easily read.

END OF SECTION 26 28 13

## SECTION 26 28 16 - DISCONNECT SWITCHES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fusible switches
- B. Non-fusible switches

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to the Disconnect and Starter Schedule for rating and configuration.

#### 1.3 REFERENCES

- A. NEMA KS 1 - Enclosed Switches

#### 1.4 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Product Data: For each type of enclosed switch, circuit breakers, accessory and component indicated, include dimensions, weights, and manufacturer's technical data on features, performance, and ratings.
- C. Electrical Characteristics: For each type of enclosed switch, enclosure types, current and voltage ratings, short-circuit current ratings, UL listing for series rating of installed devices, features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

#### 1.5 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with other construction, including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

### PART 2 - PRODUCTS

#### 2.1 FUSIBLE AND NON-FUSIBLE SWITCHES

- A. Acceptable Manufacturers:
  - 1. Square D 3110 Series
  - 2. Eaton DH Series
  - 3. ABB TH Series
  - 4. Siemens HNF / HF Series

- B. FDS-#; Fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position. Fuse Clips: Class 'R' fuse clips only, unless indicated otherwise on the drawings.
- C. DS-#; Non-fusible Switch Assemblies: NEMA KS 1; Type heavy duty, quick-make, quick-break, load interrupter enclosed knife switch with externally operable handle interlocked to prevent opening front cover with switch in ON position. Handle lockable in OFF position.
- D. Enclosures: Type as indicated on the disconnect schedule.
- E. Accessories: As indicated on the disconnect schedule.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION

- A. Install disconnect switches where indicated on the drawings.
- B. Install fuses in fusible disconnect switches.
- C. Provide adhesive label on inside door of each switch indicating UL fuse class and size for replacement.

END OF SECTION 26 28 16

## SECTION 26 29 23 - VARIABLE FREQUENCY DRIVES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Variable frequency drives (VFD-#)

#### 1.2 RELATED SECTIONS AND WORK

- A. Refer to the Variable Frequency Drive Schedule for rating and configuration.

#### 1.3 REFERENCES

- A. ANSI/UL Standard 508
- B. ANSI/NEMA ICS 6 - Enclosures for Industrial Controls and Systems
- C. IEEE Standard 519-1992 - Guide for Harmonic Control and Reactive Compensation of Static Power Converters
- D. FCC Rules and Regulations, Part 15, Subpart J - Radio Frequency Interference

#### 1.4 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00.
- B. Shop Drawings: Include front and side views of enclosures with overall dimensions and weights shown; conduit entrance locations and requirements; and nameplate legends.
- C. Product Data: Provide catalog sheets showing PWM configuration (6, 12, 18 pulse, Active Front End AFE), voltage, controller size, ratings and size of switching and overcurrent protective devices, short circuit ratings, dimensions, and enclosure details.
- D. Product Data for Accessories and Options: Provide catalog sheets showing voltage, dimensions, ratings, for accessories and options. Include information for passive harmonic filters, active harmonic filters, line reactors, shielded VFD cabling, output filters, etc. as an inclusive submittal package provided by the VFD supplier. The VFD supplier shall act as a single contact of responsibility.
- E. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by Product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of Product.
- F. VFD Harmonic Analysis:
  - 1. Provide harmonic analysis of each individual variable frequency drive based on the latest IEEE 519 for voltage (THD) and current (TDD) distortion limits at the input terminals of the VFD.

2. Provide a summary of the individual harmonic analysis for each VFD in tabular form to document compliance with the minimum harmonic distortion criteria. Example:
  - a. VFD - TAG
  - b. Current distortion (TDD): percent at terminals of VFD
  - c. Input Line reactor, DC link choke, or LCL filter rating: percent
  - d. Leading Power Factor Control management applied: Yes or No
  - e. Filtering: List application specific options and accessories included for compliance with the contract documents and manufacturer recommendations including filters and shielded VFD cabling.

#### 1.5 EXTRA MATERIAL

- A. Furnish under provisions of Section 26 05 00.
- B. Provide two of each air filter.
- C. Provide three of each fuse size and type.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Section 26 05 00.
- B. Accept controllers on site in original packing. Inspect for damage.
- C. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.
- D. Handle in accordance with manufacturer's written instructions. Lift only with lugs provided for the purpose. Handle carefully to avoid damage.

#### 1.7 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data under provisions of Section 26 05 00.
- B. Maintenance Data: Include spare parts data listing, source and current prices of replacement parts and supplies, and recommended maintenance procedures and intervals.
- C. Operation Data: Include instructions for starting and operating controllers, and describe operating limits that may result in hazardous or unsafe conditions.
- D. Shop Drawings: For each VFD.
  1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
    - a. Each installed unit's type and details.
    - b. Nameplate legends.
    - c. Short-circuit current rating of integrated unit.

- d. Features, characteristics, ratings, and factory settings of each motor-control center unit.
2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

## PART 2 - PRODUCTS

### 2.1 ACCEPTABLE MANUFACTURERS

- A. Variable Torque Applications:
  1. Toshiba Q9 Series
- B. The Variable Frequency Drive Schedule and drawings use equipment tags to define the scope of the project. The equipment tag (example: VFD-5) may be representative of multiple similar applications. Additional options and accessories may be required by the specifications and manufacturer recommendations due to the specific application but not represented in the Variable Frequency Drive Schedule. Refer to the Options, Accessories, and minimum performance requirements of this specification for a complete list of requirements (example: output filters and shielded VFD cables).
- C. Motor Nameplate (Drive Output) Voltage: Refer to Variable Frequency Drive Schedule and Mechanical Schedules when applicable.

### 2.2 MINIMUM PERFORMANCE, REQUIRED OPTIONS, AND ACCESSORIES

- A. The following minimum performance requirements, options, and accessories supplement the requirements of the Variable Frequency Drive Schedule. In the event of a conflict between the schedule and specification the most stringent requirement will be enforced.
  1. Manual Speed Adjustment
  2. Electronic Thermal Overloads
  3. Control Transformer, Fused, 120 volt. Acceptable Alternative, 120 volt / 24 volt power supply available directly from VFD, 100mA minimum.
  4. Hand-off-Auto Door Switch
  5. Skip Frequency Capability
- B. Line Input Reactor: Provide all VFDs with a minimum input line reactor of (3%). The input line reactor may be integral or individually mounted.
  1. Exception: The manufacturer may substitute an LCL type harmonic filter with an input harmonic filter.; and approximate equivalent (3%) impedance from the harmonic filter is anticipated.
  2. Exception: A dual (positive and negative) 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter. Exception: Not required for Active Front End AFE drives with an IGBT front end instead of a diode-bridge configuration.

- C. Harmonic Distortion Performance Criteria (PCC defined at VFD): The variable frequency drive shall have the following minimum harmonic distortion performance criteria; reference to the latest edition of IEEE 519. The Point of Common Coupling PCC shall be considered the input line terminals of the combination VFD, applicable filters, and accessories for the following requirements.
1. The minimum configuration represents the minimum acceptable solution to achieve THDv and THDi performance requirements. Alternative approved solutions have been listed and shall be substituted within the scope of the original bid pricing when the minimum configuration does not satisfy the harmonic performance requirements listed.
  2. Equivalent HP rating: When a single VFD is configured to serve multiple smaller motors (example: skid packaged equipment, fan wall systems) the equivalent sum of the motor HPs (VFD HP rating) shall be considered the HP rating for the following criteria.
  3. VFD rating 15 HP or less:
    - a. Minimum Configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
      - 1) Voltage Total Harmonic Distortion (THDv) limit: 8 percent
      - 2) Current Total Demand Distortion (THDi) limit: 8 percent
    - b. Approved Solutions for Minimum THDv and THDi Performance: The following approved solutions or a combination of the following is acceptable:
      - 1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or “Ultra low harmonic drives” that do not limit the maximum motor output power at full load.
      - 2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
      - 3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.
  4. VFD rating exceeding 15HP to 99HP:
    - a. Minimum configuration: 6 Pulse with 3% input reactor. A 3% DC line choke is acceptable in lieu of an input line reactor when coupled with an input harmonic filter.
    - b. Minimum Performance Criteria:
      - 1) Voltage Total Harmonic Distortion (THDv) limit: 8 percent
      - 2) Current Total Demand Distortion (THDi) limit: 8 percent
    - c. Approved solutions for minimum THDv and THDi performance: The following approved solutions or a combination of the following is acceptable:

- 1) Driver Configuration: 6 pulse configuration, 12 pulse configuration, 18 pulse configurations, PWM drives with an Active Front End AFE or “Ultra low harmonic drives” that do not limit the maximum motor output power at full load.
- 2) Passive harmonic filter with a minimum equivalent (3%) impedance when the input line reactor or DC choke is not provided.
- 3) Active harmonic filter with minimum three percent (3%) input line reactor on the input line terminals of the VFD; or larger per manufacturer requirements.

D. VFD Output Load Terminals - Minimum Design Requirements:

1. Provide external output line reactors, DV/DT, sine filters, and shielded VFD cable when the manufacturer's recommended maximum distance between the VFD and the motor(s) is exceeded.
2. Provide the following minimum design criteria in addition to manufacturer recommendations:
  - a. Output line reactor (3 percent): When recommended by manufacturer.
  - b. DV/DT output line reactor: VFD to motor distance exceeds 75 feet (480 volt) or 150 feet (240/208 volt).

2.3 VFD DESCRIPTION, RATINGS, DESIGN

A. Pulse Width Modulated (PWM) Variable Frequency Drives:

1. Converter shall be of a diode bridge design with a sine-weighted PWM inverter section. Converts 60 Hertz input power at voltage specified to a variable AC frequency and voltage for controlling the speed of AC motors. The controller shall be suitable for use with standard inverter duty motors without requiring any modifications to the motor or the drive.
2. Drives shall be capable of use with commercially available Internal Permanent Magnet (IPM) motors up to 12 poles.
3. Main semi-conductors in the inverter section of controller shall be IGBT transistors capable of a carrier switching frequency of up to 8 kHz.
  - a. 50HP applications and less: If derating of the inverter is necessary to run at 8kHz, then the unit's derated currents must equal or exceed the motor full load currents listed in NEC Table 430-150.

B. Short Circuit Current Rating SCCR Default: 100 KA. Provide integral circuit breaker or fuse switch with disconnect switch when required to achieve rating.

C. Drive and controller shall be capable of continuous full load operations throughout the following specified environmental operating conditions.

1. Operating Ambient Temperature: 0°C to 40°C.
2. Minimum Relative Humidity Range: 5% to 90% (non-condensing).
3. Minimum Elevation without Derating: 3300 feet.
4. The VFD shall incorporate a protective coating on the main control board to conform to IEC60721-3-3 class 3C2 levels.

- D. Input Voltage Performance: The drive shall provide full rated output from a line voltage range of -15 / +10% nominal voltage.
- E. Controller shall have the functional components listed below:
1. Door interlocked input circuit breaker/fused switch.
  2. Input rectifier section to supply fixed DC bus voltage.
  3. Smoothing reactor or choke for DC bus.
  4. DC bus capacitors.
  5. Control transformer or switch mode powered from all three phases.
  6. Separate terminal blocks for power and control wiring.
  7. Terminal block for operator controls.
  8. Sine weighted PWM generating inverter section.
- F. Enclosure Fabrication:
1. Enclosure: NEMA 250, Type 1, unless otherwise specified.
  2. Finish: Manufacturer's standard enamel.
  3. Devices shall be factory installed in controller enclosure and functionally tested unless otherwise indicated.
- G. Displays: Provide integral digital display to indicate all protection faults and drive status (including overcurrent, overvoltage, undervoltage, ground fault, overtemperature, phase loss, input power ON, output voltage, output frequency, and output current). Include meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).
  2. Motor speed (rpm).
  3. Motor status (running, stop, fault).
  4. Motor current (amperes).
  5. Motor torque (percent).
  6. Fault or alarming status (code).
  7. PID feedback signal (percent).
  8. DC-link voltage (VDC).
  9. Set-point frequency (Hz).
  10. Motor output voltage (V).
- H. Status Indication Door-mounted display shall indicate the following conditions:
1. Power on.
  2. Run.
  3. Overvoltage.
  4. Line fault.
  5. Overcurrent.
  6. External fault.
- I. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
  2. Running log of total power versus time.

3. Total run time.
  4. Fault log, maintaining last four faults with time and date stamp for each.
- J. Panel-Mounted Operator Station or KeyPad, Start-stop, auto-manual selector switches with manual speed control potentiometer, and elapsed time meter: NEMA ICS 2, heavy-duty type.
- K. 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.
- L. Control Relays: Auxiliary and adjustable time-delay relays.
- M. Protection:
1. Input transient protection by means of surge suppressors or equivalent protection.
  2. Snubber networks to protect against malfunctions due to system transients.
  3. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
  4. Power-Interruption Protection: After a power interruption, it prevents the motor from re-energizing until the motor has stopped.
  5. Motor thermal overload relay(s) adjustable and capable of NEMA Class 102030 motor protection and sized per motor nameplate data. When multiple motors are connected to the VFD output, each motor shall have a manual starter with properly sized overload protection.
  6. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination. Skip frequency feature is acceptable.
  7. Instantaneous line-to-line and line-to-ground overcurrent trips on input and output.
  8. Loss-of-phase protection.
  9. Short-circuit protection (fuses or circuit breaker).
  10. Motor overtemperature fault.
  11. Loss of load protection.
- N. For a fault condition other than an internal fault, an auto restart function shall provide up to 10 programmable restart attempts. The programmable time delay before each restart shall range from 0 to 10 seconds.
- O. The deceleration ramp of the controller shall be programmable for normal and fault conditions. Stop modes shall include: DC injection braking, controlled deceleration to stop and coast to stop.
- P. Upon loss of the analog speed reference signal the following shall be selectable:
1. The VFD follows the programmed deceleration ramp to a controlled stop.
  2. The VFD holds the speed based upon the last good value and trigger a warning alarm.
- Q. The VFD operates at a pre-determined frequency (user programmable).
- R. STOP key on the keypad shall be functional at all time, drive mode insensitive.
- S. The VFD shall be insensitive to input power phase sequence. Input phase loss detection shall be available.

- T. The output frequency shall be parameter setting enabled to fold back when the motor is overloaded (stall prevention).
- U. For pump applications, the VFD shall incorporate a forward/reverse pump start sub-routine to assist with clogging.
- V. An optional real time clock feature shall be available, which must facilitate the time stamping of any drive trip messages.
- W. The VFD shall monitor the main circuit capacitors, control circuit capacitor, in-rush suppression circuit, and cooling fan and shall provide a pre-alarm so that maintenance can be scheduled.
- X. The VFD shall include an output timer function so that peripheral equipment maintenance can be scheduled.
- Y. The VFD shall include parameter selectable input and output phase loss protection.
- Z. The VFD basic insulation level shall be tested based upon ANSI/IEEE C62.41-1999.
- AA. The VFD shall be rated as a safety VFD (STO) EN ISO 13849-1 PLd/Cat.3, EN61508, and EN61800-5-2 SIL 1 without additional options.
- BB. Displacement Power Factor: Between 1.0 and 0.95, lagging, over entire range of operating speed and load.
- CC. Minimum Efficiency at Full Load: 96 percent.
- DD. Overload Capability: 1.1 times the base load current for 60 seconds every 10 minutes; 1.3 times the base load current for 2 seconds every minute.
- EE. Starting Torque: 100 percent of rated torque or as indicated.
- FF. Speed Regulation: Plus or minus 1 percent with no motor derating.
- GG. All drives shall have built-in diagnostic capability with status and fault indicators mounted on enclosure door. Complete operating instructions for diagnostics shall be mounted inside of the enclosure door.
- HH. The drive shall provide self-protection when the load is lost or disconnected without damage to the drive.
- II. Acceleration Rate Adjustment: 0.5 - 30 seconds.
- JJ. Deceleration Rate Adjustment: 1 - 30 seconds.
- KK. Minimum Adjustment Range for the Output Frequency shall be: 0 to 90 Hertz.
- LL. Minimum Volts/Hertz Range: 3.7 to 8.6 volts/Hertz.
- MM. Provide MANUAL-OFF-AUTOMATIC selector switch and manual analog speed control mounted on the front of the enclosure.

- NN. Safety Interlocks: Provide terminals for remote contact to inhibit starting under both manual and automatic mode.
- OO. Control Interlocks: Provide terminals for remote contact to allow starting in automatic mode.
- PP. Provide adjustable skip frequencies on the drive output (minimum of three ranges).
- QQ. Automatic Reset/Restart: Attempts up to 10 restarts after controller fault, on return of power after an interruption, or on undervoltage fault, and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load (coasting motor re-start).
- RR. Excitation Control will regulate motor output voltage based on torque requirement. Must be able to provide full motor torque when necessary across the operating speed range.
- SS. Motor Temperature Compensation at Slow Speeds: Adjustable current fallback based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.
- TT. Control Transformer: Provide control power transformer for control, 120 volt secondary, fused.
- UU. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
  2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
    - a. 0 to 10-V dc.
    - b. 0-20 or 4-20 mA.
    - c. Potentiometer using up/down digital inputs.
    - d. Fixed frequencies using digital inputs.
    - e. RS485.
    - f. Keypad display for local hand operation.
  3. Output Signal Interface:
    - a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      - 1) Output frequency (Hz).
      - 2) Output current (load).
      - 3) DC-link voltage (VDC).
      - 4) Motor torque (percent).
      - 5) Motor speed (rpm).
      - 6) Set-point frequency (Hz).
  4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1A) for remote indication of the following:
    - a. Motor running.

- b. Set-point speed reached.
  - c. Fault and warning indication (overtemperature or overcurrent).
  - d. PID high- or low-speed limits reached.
5. The control power for the VFD digital inputs and outputs shall be 24Vdc, selectable to sink or source. Optional 120Vac control power for the digital inputs and outputs shall be available.
  6. The drive control board shall be capable of operating from an independent 24V dc power supply.
  7. All logic connections shall be furnished on a removable terminal strip.
  8. External devices shall be able to be connected to the terminal strip for starting/stopping the VFD, speed control and indicating operation status.
  9. Speed command input shall be by means of:
    - a. Keypad.
    - b. Analog input.
    - c. Serial communications.
- VV. Communications: Provide a communications card to interface VFD with Facility Management Control System (FMCS). Coordinate interface requirements with the FMCS provided under Section 23 09 00. Interface shall allow all parameter settings of VFD to be programmed via FMCS control and displayed on FMCS operator workstation. Provide capability for VFD to retain these settings within the nonvolatile memory.
- WW. Control:
1. With the "Manual-Off-Auto" switch in the "Manual" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the manual speed potentiometer on the drive door or keypad.
  2. With the "Manual-Off-Auto" switch in the "Auto" position and, if applicable, the "Drive-Bypass" in the "Drive" position, the drive shall be controlled by the input signal from an external source.
  3. If applicable, with the "Drive-Bypass" in the "Bypass" position, regardless the position of the "Manual-Off-Auto" switch, the motor shall be connected across the lines and shall be run at full speed.
  4. With the "Manual-Off-Auto" switch in the "Off" position, if applicable, the drive run circuit shall be open and the VFD shall not operate.
  5. If applicable, signal from the fire alarm control panel shall shut down VFD and bypass to direct-on-line operation. In this mode the thermal overload relay for the motor must be disabled.
- XX. All disconnect switches between VFD and motor(s) shall include an auxiliary contact interlock wired to the VFD fault trip input to shut down the drive upon opening of the disconnect main contacts.
- YY. Convertible Auxiliary Contacts (additional): Provide two additional convertible normally open / normally closed contacts.
- ZZ. Electronic Thermal Overloads: Provide adjustable electronic type thermal overloads. Size protection per motor nameplate data.

## 2.4 OPTIONS AND ACCESSORIES - DESCRIPTIONS

- A. Passive Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating.
  - 1. When required:
    - a. As required to satisfy, the Harmonic Distortion Performance Criteria described in Part 2 of this specification.
    - b. Per VFD schedule.
- B. Active Harmonic Filter: LCL (input line reactor, capacitor, tuned inductor) type sized by manufacturer for application. Provide leading power factor management for when the motor/VFD are not operating. Provide all VFDs coupled with an Active Harmonic Filter with a minimum three percent (3%) input line reactor; or larger per manufacturer requirements.
  - 1. When required:
    - a. As required to satisfy, Harmonic Distortion Performance Criteria described in Part 2 of this specification.
    - b. Per VFD schedule.
- C. Active Bridge Rectifier Stage: Capable of limiting current harmonic distortion at the drive input terminals.
  - 1. When required:
    - a. As required to satisfy, Harmonic Distortion Performance Criteria described in Part 2 of this specification.
    - b. Per VFD schedule.

## PART 3 - EXECUTION

### 3.1 FACTORY TESTING

- A. Refer to startup and commissioning requirements.
- B. The VFD and all associated controller components shall be covered by a supplier parts warranty of 2 years from the time of installation. There shall be an option to extend the warranty to 5 years if initial installation is carried out by a supplier-approved contractor.

### 3.2 INSTALLATION

- A. Install variable frequency drive equipment in accordance with the manufacturer's instructions.
- B. Install harmonic filter components in accordance with manufacturer's instructions. Locate filters above or below VFD to minimize use of available horizontal wall space pending field conditions.

- C. Adjust VFD settings per recommendations of the harmonic filter manufacturer's instructions; example: switching frequency.
- D. VFD Output Feeder and Raceway: The contractor shall provide VFD shielded cable for the VFD output feeder when the distance to the motor exceeds manufacturer recommendations or the requirements of this specifications. Contractor to size raceway per code and cable cross sectional area provided by manufacturer.
- E. Floor mount VFD on prefabricated or field fabricated supports with controls no higher than 6'-6" and no lower than 3'-0" AFF. Mount supports on 1/2" thick vibration isolation pads set on concrete housekeeping pads.
- F. Provide engraved phenolic nameplates under the provisions of Section 26 05 53.
- G. Connections: All conduit connections to the VFD shall be by flexible conduit.
- H. Input, output, and control wiring shall each be run in separate conduits.
- I. All interlocking required by the drive manufacturer shall be the responsibility of the Electrical Contractor.

### 3.3 STARTUP AND COMMISSIONING

- A. The Electrical Contractor shall have a factory service engineer present for the start-up, field calibration, and check-out of each VFD installed. Factory service engineer shall be required to return to the site for recalibration or set-up should unit not function as specified during system commissioning. All costs shall be a part of This Contract. Provide tag with date and signature of factory service Engineer on inside cover of each drive.
- B. Verify all settings, parameters, and adjustments with other contractors prior to startup. Make all adjustments and setting to coordinate with controls and equipment.
- C. Accelerate the motor to full speed and verify operation. Decelerate the motor to a stop and verify operation. Slowly operate the motor over the speed range and check for resonance.
- D. Make all adjustments and settings to coordinate with controls and equipment prior to Substantial Completion. Verify that drive is set for auto restart after power loss and undervoltage fault.
- E. Document settings in the Operations and Maintenance manual.

END OF SECTION 26 29 23

## SECTION 26 43 00 - SURGE PROTECTION DEVICES

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. This section describes materials and installation requirements for factory and field wired low voltage surge protection devices (SPD) for the protection of all AC electrical circuits. SPD equipment to be installed at designated service entrance equipment, distribution panels, .

#### 1.2 QUALITY ASSURANCE

- A. The specified unit shall be designed, manufactured, tested and installed in compliance with the above references. The unit shall be "Listed by Underwriters Laboratories" to UL 1449.
- B. Each unit shall be designed and manufactured by a qualified manufacturer of power conditioning equipment. The qualified manufacturer must have been engaged in the design and manufacturer of such products for a minimum of five years.

#### 1.3 REFERENCES

- A. ANSI/IEEE C62.33 - IEEE Guide on Testing of MOV components
- B. ANSI/IEEE C62.35 - IEEE Guide on Testing of SAD components
- C. ANSI/IEEE C62.41 - IEEE Recommended Practice on Surge Voltage in Low Voltage AC Power Circuits
- D. ANSI/IEEE C62.45 - IEEE Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits
- E. ANSI/UL 1449 Latest Edition - UL Standard for Safety for Surge Protective Devices
- F. CBEMA - Computer Business Equipment Manufacturers Association
- G. IEC 664 - International Engineering Consortium, Standard for Clamping Voltage
- H. NFPA 70 - National Electrical Code (NEC)
- I. UL 67 - Listed for Internal Panelboard Transient Voltage Surge Suppressors
- J. UL 96A - Devices listed as approved for secondary surge arrestors (VZCA)
- K. UL 248-1 - Fusing
- L. UL 1283 - Electromagnetic Interference Filters, Fifth Edition

#### 1.4 SUBMITTALS

- A. Shop Drawings: Should include device dimensions, mounting requirements including wire size and over-current protection device rating, nameplate nomenclature, electrical ratings, short circuit current rating, and test results as indicated below under "Testing, Warranty and Life Expectancy" as provided by an independent test lab or a UL certified test lab for the category(ies) of suppression device(s) specified using the appropriate IEEE test wave. Product data sheets with installation instructions for each size and type of device are required. Shop drawings submitted without the testing data as required by section this section will be rejected.
- B. Fuse information: Provide fuse information if required for operation. Include size, manufacturer, time-current chart responses to UL 1449 testing requirements, maximum surge protection capability per mode and phase as limited by the fuse, and verification of repetitive surge protection device operation without system degeneration greater than 10%.

#### 1.5 SPARE PARTS

- A. Surge Protection Modules: Furnish 1 replacement module for each type installed.
- B. Fuses: Furnish to the Owner 3 spare fuses of each type and rating installed.

#### 1.6 TESTING, WARRANTY AND LIFE EXPECTANCY

- A. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.
  - 1. Single pulse surge current capacity: Single pulse surge current tested in a mode at rated surge currents.
  - 2. Single pulse surge current capacity test: An initial UL 1449 defined 1.2 x 50 $\mu$ s, 6000V open circuit voltage waveform and an 8 x 20 $\mu$ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage (VPR).
  - 3. A single 8 x 20 $\mu$ s waveform pulse of maximum rated surge current per mode shall then be applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.
- B. Minimum Repetitive Surge Current Capacity:
  - 1. Service entrance suppressor units should be tested repetitively at an independent lab to verify repetitive capacity.
  - 2. Minimum Repetitive Surge Current Capacity Test:
    - a. An initial UL 1449 surge defined as 1.2 x 50 $\mu$ s, 6000V open circuit voltage waveform and an 8 x 20 $\mu$ s, 500A and 3kA short circuit current waveform shall be applied to benchmark the unit's suppression voltage.
    - b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges, defined as a 1.2 x 50 $\mu$ s 10kV or 20kV open circuit voltage waveform and an 8 x 20 $\mu$ s 10,000A short circuit current waveform, shall then be applied at one-minute intervals.

- c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.
- 3. Survival is achieved if the suppression voltage (VPR) does not vary by more than 10%.
- 4. Proof of such testing shall be the test log generated by the surge generator.
- C. Provide UL 1449 classification white sheet pages indicating the VPR (voltage protection rating) for each SPD unit submitted for this product using the 6kV/3kA combination wave surge.
- D. Warranty: Ten (10) years. Includes workmanship, installation and programming.

## PART 2 - PRODUCTS

### 2.1 DESCRIPTION

- A. General: The unit shall provide transient voltage suppression, surge current diversion and high-frequency noise attenuation, when connected in parallel to the facilities distribution system. The unit MCOV shall not be less than 115% of the nominal system voltage. Operating frequency shall be for a 60 Hz system. The unit shall provide protection in all normal modes for "wye" and "delta" systems.

### 2.2 RATINGS

#### A. **SPD-C1**; Service Entrance Suppressors:

- 1. For 277/480-volt, 3 phase, 4 wire, type 2, category C3 unit.
  - a. Surge current capacity: 100,000/200,000 amps per protection mode/phase
  - b. Nominal Discharge Current: 20 kA.
  - c. Mounting: Refer to the drawings.
  - d. Voltage Protection Rating: Refer to requirements below.
  - e. Components: Minimum component size of 20mm thermally protected metal oxide varistors (MOV).
  - f. Disconnect: Surge-rated disconnect with 200,000 SCCR.
- 2. Manufacturers:
  - a. Square D Surgellogic EMA Series
  - b. Siemens TPS3 Series
  - c. Eaton SPD Series
  - d. Current Technology Current Guard Plus
  - e. ASCO Power Technologies 400 Series
  - f. LEA International LSS Series

#### B. **SPD-B1** Secondary Distribution Suppressors:

- 1. For 120/208-volt, 3 phase, 4 wire, type 2, category B3/C1 unit.
  - a. Surge current capacity: 60,000/120,000 amps per protection mode/phase
  - b. Nominal Discharge Current ( $I_N$ ): 20 kA.

- c. Mounting: Refer to the drawings.
  - d. Voltage Protection Rating: Refer to requirements below.
  - e. Components: Minimum component size of 20mm metal thermally protected oxide varistors (MOV).
2. Manufacturers:
- a. Square D Surgelocic EMA Series
  - b. Siemens TPS3 Series
  - c. Eaton SPD Series
  - d. Current Technology Current Guard Plus
  - e. ASCO Power Technologies 400 Series
  - f. LEA International CFS Series
- C. Voltage Protection Rating:
- 1. Protection modes and UL 1449 voltage protection rating for surge suppression units per each mode (L-N, L-L, L-G, and N-G as appropriate).
    - a. 277/480 Volt, 3 phase, 4 wire. 1200 Volt L-N, L-G, N-G and 1800 Volt L-L
    - b. 120/208 Volt, 3 phase, 4 wire. 700 Volt L-N, N-G, 800 Volt L-G and 1200 Volt L-L
- D. EMI/RFI Noise Rejection or Filtering:
- 1. Each unit shall include a UL1283 first order, high-frequency filter for noise filtering between 10 KHz and 100 MHz.
- E. Indication:
- 1. Each unit shall include solid-state indicators with externally mounted LED visual status indicators that indicate on-line status of each protection mode of the unit.
  - 2. Each unit shall include an audible alarm with silencing switch to indicate when protection has failed.
  - 3. Provide each service entrance secondary distribution type unit(s) with a transient counter.
  - 4. Each unit shall contain form "C" contacts for remote indication of an alarm status.
- F. Fuses:
- 1. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit.
  - 2. Fuses shall be rated 200, 000 AIC minimum interrupting capacity.

## PART 3 - EXECUTION

### 3.1 INSPECTION

- A. Examine equipment for size and type of surge protection device to be used to ensure physical compatibility.

- B. Inspect surge protection device for any signs of physical damage due to shipping or handling before installing surge protection device.

### 3.2 INSTALLATION

#### A. Mounting Location:

1. The unit shall be installed as close as practical to the panel and transformer secondary lugs in accordance with applicable national/Local Electrical Codes and the manufacturer's recommended installation instructions. Connect the unit to the or switchboard or panel using a conduit nipple. Flush mount the unit in the front of the switchboard. Mount unit directly across from the breaker or disconnect serving it.

#### B. Connections:

1. Contractor shall provide wire and circuit breakers sized per the approved manufacturer's requirements. Maximum lead length from protected bus to surge protection device shall be per manufacturer's requirements, but no greater than 5'-0".
2. The surge protection unit shall be isolatable from the electrical distribution system via 3 pole circuit breaker mounted in the switchboard/panelboard or be equipped with a factory supplied integral fused switch or circuit breaker. Single phase 120-volt units shall be hardwired without a disconnecting means.
3. Neutral and ground shall not be bonded together at secondary panelboard locations.

#### C. General:

1. Check unit for proper operation of protection and indication under start-up.
2. Check unit to ensure all MOVs for each mode of protection are operational. Verify integral fuse links are operational and have not melted.
3. Surge suppression devices shall not be installed ahead of the main service disconnect(s).
4. Install fuses in all fuse holders and fused disconnects internal to the surge protection unit. Use fuses recommended by the manufacturer to satisfy repetitive UL 1449 operation of the surge suppression unit. External fusing of the surge protection device is not allowed.
5. Coordinate location of surge protection device to allow adequate clearances for maintenance.
6. Manufacturer service phone number shall be posted on the front of the surge protection device.

END OF SECTION 26 43 00

## SECTION 26 51 19 - LED LIGHTING

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Interior luminaires and accessories
- B. Exterior luminaires and accessories
- C. Light-emitting diode (LED) luminaire systems
- D. LED emergency lighting units
- E. Emergency exit signs
- F. Emergency inverter for LED light engines (individual luminaires - integral)
- G. Automatic load control relay (ALCR) (individual luminaire - integral) ALCR3

#### 1.2 RELATED SECTIONS

- A. The lighting system design includes a combination of luminaire sources, lighting control components, programming sequences, and supplementary components for building and energy code compliance. The design uses performance-based specifications for portions of the lighting system to account for the limitation of comparable product solutions available by competitive manufacturers. The Contractor shall reference related specification sections, plans, schedules, and details prior to submitting pricing, submittals, and installation. The Contractor shall coordinate system component compatibility among various manufacturers and suppliers for a turnkey lighting system. Referenced sections include, but are not limited to, the following:
  - 1. 26 09 33 Lighting Control Systems
  - 2. Electrical drawings: Plans, luminaire schedules, lighting control sequence of operations, diagrams, and details

#### 1.3 REFERENCES

- A. ANSI C78.377 - Specifications for the Chromaticity of Solid State Lighting Products
- B. ANSI C82.16 - Light-Emitting Diode Drivers - Method of Measurement
- C. ANSI C82.77 - Standard for Harmonic Emission Limits and Related Power Quality Requirements for Lighting Equipment
- D. NFPA 70E - National Electrical Safety Code
- E. NEMA SSL1 - Electronic Drivers for LED Devices, Arrays or System
- F. UL 8750 - Light Emitting Diode (LED) Equipment for use in Lighting Products

- G. LM-79 - Approved Method: Electrical and Photometric Measurements of Solid-State Lighting Products
- H. LM-80 - Measuring Luminous Flux and Color Maintenance of LED
- I. FS W-L-305 - Light Set, General Illumination (Emergency or Auxiliary)
- J. UL 924 - Standard for Emergency Lighting and Power Equipment
- K. UL676 Standard for Underwater Luminaires and Submersible Junction Box
- L. Project site classification as defined in IESNA RP-33.

#### 1.4 SUBMITTALS

- A. Submit product data under provisions of Section 26 05 00.
- B. Basic Requirements of Submittal:
  - 1. Submit product data sheets for luminaires, LED light engines, drivers and poles. Include complete product model number with all options as specified. Submittal shall be arranged with luminaires listed in ascending order, and with each luminaire's, LED light engine, driver, or pole information following luminaire's product data. Failure to organize submittal in this manner will result in the submittal being rejected.
  - 2. Submit lens product data, dimensions and weights if not included in product data sheet submittal.
  - 3. Include outline drawings, support points, weights, and accessory information for each luminaire.
  - 4. Submit manufacturer origin of LED chipset and driver.
- C. LED Lighting - Performance Testing Submittal (when requested by Architect/Engineer):
  - 1. IESNA LM-79: Include photometric report for the latest generation system being furnished. Provide name of independent testing laboratory, report number, date of test, luminaire series/model number, input wattage, and light source specifications.
  - 2. IESNA LM-80: Measuring Lumen Maintenance of LED Light Sources.
- D. LED Lighting - Control Compatibility Submittal:
  - 1. Submit lighting control capability data for each LED luminaire. The submittal shall clearly identify device data proposed by the Contractor and approved by the luminaire manufacturer for dimming, switching, addressable, wireless, and similar control characteristics.
- E. Submit Design Lights Consortium (DLC) information for each luminaire type.
- F. Submit utility rebate forms where offered at project location. Submit completed rebate forms within 30 days of Substantial Completion.

1.5 EXTRA STOCK

- A. Provide extra stock under provisions of Section 26 05 00.
- B. LED Light Engines or Modules: Three (3) percent of quantity installed, minimum one (1) of each size and type of field replaceable light engine or module. Provide field replacement installation instructions.
- C. Lenses: Three (3) percent of quantity installed, minimum one (1) of each size and type.
- D. LED Drivers: Three (3) percent of quantity installed, minimum one (1) of each size and type.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver products to site. Store and protect under provisions of Section 26 05 00.
- B. Protect luminaire finishes, lenses, and trims from damage during storage and installation. Do not remove protective films until construction cleanup within each area is complete.
- C. Handle site lighting poles carefully to prevent breakage and damage to finish.

1.7 WARRANTY

- A. The warranty period begins at the date of Substantial Completion.
- B. LED Light Engines and Drivers:
  - 1. LED Drivers and Dimming Drivers: Five (5) years
  - 2. Light Emitting Diode (LED) Light Engines: Five (5) years
- C. Emergency Lighting Units and Exit Signs:
  - 1. Emergency Lighting Units: Three (3) year, non-prorated
  - 2. Exit Signs: Three (3) year, non-prorated
  - 3. Emergency Unit and Exit Sign Battery: Sealed lead acid or lead calcium cell, requiring no maintenance or replacement for ten (10) years under normal conditions.
- D. Emergency Drivers:
  - 1. Emergency LED Driver: Five (5) years
- E. Emergency Inverter for LED Light Engines:
  - 1. Emergency Inverter and Battery: Sealed nickel cadmium five (5) year, non-prorated.
- F. Automatic Load Control Relay (ALCR): Five (5) year

1.8 REGULATORY REQUIREMENTS

- A. Conform to NFPA 101 for installation requirements

## PART 2 - PRODUCTS

### 2.1 INTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Lensed Troffers: Provide hinged frames with latches and 0.125-inch thick virgin acrylic lenses. Prismatic lenses shall have depth of no less than 0.080", KSH12 or equal. Other lenses as scheduled.
- B. Recessed Luminaires: Confirm ceiling and wall type and furnish trim and accessories necessary to permit proper installation in each system. Where fire-rated ceiling or wall assemblies are specified, furnish and install listed enclosures around luminaires that maintain the system rating.
- C. Luminaires: Louvers shall be anodized low iridescent specular aluminum with mitered corners and interlocking construction.
- D. Suspended Luminaires: Coordinate power feed and suspension canopies with ceiling type and architectural RCP for proper fit and location. Ensure finished installations are plumb and level at elevations specified. Verify suspension length prior to submittal.
- E. Painted reflector surfaces shall have a minimum reflectance of 90%.
- F. All painted components shall be painted after fabrication.

### 2.2 EXTERIOR LUMINAIRES AND ACCESSORIES - GENERAL

- A. Listed for wet or damp location as scheduled. Provide ingress protection (IP) rating when scheduled.
- B. Provide low temperature LED drivers, with reliable starting to -20°F.
- C. Exterior LED luminaires shall contain separate, easily accessible and replaceable Category C surge protection device.

### 2.3 LIGHT EMITTING DIODE (LED) LUMINAIRE SYSTEMS

- A. Refer to the luminaire schedule for color temperature and minimum color rendering index CRI requirements. Provide light source color consistency by utilizing a binning tolerance within a maximum 3-step McAdam ellipse unless noted otherwise.
- B. LED chip arrays specified as color changing shall have chip colors as noted on the luminaire schedule.
- C. Rated life shall be minimum of 50,000 hours at L70.
- D. LED chips shall be wired so that failure of one chip does not prohibit operation of the remainder of the chip array.
- E. Luminaire delivered lumens is defined as the absolute lumens per the manufacturers LM-79-08 test report.

- F. LED luminaires shall be designed for ease of component replacement including modular replaceable boards or Zhaga sockets. Luminaires that are factory sealed and do not have field replaceable parts shall provide a 10-year warranty.
- G. LED light engine shall have a maximum LLD of 0.85 at 100,000 hours at 25°C ambient.
- H. LED Driver:
  1. Solid state driver with integral heat sink. Driver shall have over-heat, short-circuit and overload protection, power factor 0.90 or above and maximum total harmonic distortion of 10%. Driver shall have a voltage fluctuation tolerance of +/- 10%.
  2. Drivers shall have dimming capabilities as outlined in the luminaire schedule for each luminaire type. Dimming shall control light output in a continuous curve from 100% to 10% unless noted otherwise.
  3. Driver shall have a minimum of 50,000 hours rated life.
  4. Driver shall be tested to ANSI C82-16 for input current inrush, total harmonic distortion (THD), and power factor. Driver start time shall be less than 0.5 seconds to 98% of initial light output. Flicker should be less than 30% throughout the operating range.
  5. Driver shall be field replaceable without removal of the luminaire.
  6. Class A sound rating; inaudible in a 27 dBA ambient.
  7. Demonstrate no visible change in light output with a variation of plus or minus 10 percent change in line-voltage input.

#### 2.4 LED EMERGENCY LIGHTING UNITS

- A. Self-Powered Emergency Lighting Units: One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, automatic charger and electronic circuitry. Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- B. Battery: Maintenance free lead calcium type, with 90 minute capacity to supply the connected lamp load.
- C. Charger: Dual-rate solid state current charger, capable of maintaining the battery in a full-charge state during normal conditions, and capable of recharging discharged battery to full charged within 168 hours. Low voltage disconnect to prevent deep discharge of battery.
- D. LED Lamp Wattage: As scheduled on luminaire schedule.
- E. Remote Lamps: Match LED lamps on unit.
- F. Indicators: Provide lamps to indicate AC ON and RECHARGING.
- G. Provide test switch to transfer unit from normal supply to battery supply.
- H. Electrical Connection: Knockout for conduit connection.
- I. Unit Voltage: Refer to luminaire schedule volts, AC.

J. Self-Diagnostics and Testing:

1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.
2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five-minute discharge/diagnostic test at any time.

2.5 EMERGENCY EXIT SIGNS

- A. Self-Powered Exit Signs: Stencil face, 6-inch high letters, directional arrows as indicated, universal mounting type as indicated on the drawings. One-piece, self-contained unit with sealed, maintenance-free nickel cadmium battery, test switch, AC ON pilot light, automatic charger, and electronic circuitry. Power failure relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
- B. Directional Indicators: The directional indicator for exit signage shall be of a chevron type meeting all requirements of NFPA 101.
- C. Self-Diagnostics and Testing:
1. Unit shall be self-diagnostic with continuous monitoring of charger performance and battery voltage. Any malfunction of battery, charger, transfer circuit, or emergency lamps shall be detected and visually indicated.
  2. Unit shall be programmed to exercise the battery and test emergency operation by performing a five-minute discharge/diagnostic cycle every six months. A manual test switch shall allow a five minute discharge/diagnostic test at any time.

2.6 EMERGENCY INVERTER FOR LED LIGHT ENGINES (INDIVIDUAL LUMINAIRES - INTEGRAL)

- A. Unit: Self-contained, with automatic transfer to battery supply on loss of normal power, UL 924 listed for factory or field installation, indoor and damp locations, 32°F to 122°F operating temperature. Compatible with switched, dimmed, and unswitched lighting controls. Compatible with LED light engines. The inverter output shall be sinusoidal with solid-state low voltage disconnect circuit.
- B. Battery: Sealed, high temperature, maintenance free, nickel cadmium battery with capacity to provide 90 minutes of emergency operation at full lumen and wattage output, with 24-hour recharge time. Refer to Luminaire Schedule for lumen and wattage requirements.
- C. Features: Integral battery charger with LED charging indicator light, test switch, electronic circuitry for use with ballasts and LED drivers. Test and monitor switch shall be integral to luminaire or mounted flush in finished ceiling per Luminaire Schedule.

- D. Factory and Field Installation: Listed for installation inside and adjacent to luminaire. Refer to Luminaire Schedule for individual luminaire requirements. Remote-mounted units shall be located above finished ceiling, adjacent to luminaire, and accessible from below through luminaire opening.
- E. Self-Test Diagnostics and Testing: Provide with listed automatic monthly self-test diagnostics.
- F. Manufacturers:
  - 1. Myers LVU Series

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Securely fasten luminaires to the listed and labeled ceiling framing member by mechanical means such as bolts, screws, rivets or listed clips identified for use with the type of ceiling framing members. The architectural ceiling framing system may be used in lieu of independent support with prior written approval by the ceiling system manufacturer and Authority Having Jurisdiction (AHJ). Luminaires and wiring installed in fire-rated ceiling assemblies shall be independently supported for all applications.
  - 1. Install recessed flanged luminaires to permit removal from below. Use manufacturer-supplied plaster frames and swing gate supports. Provide independent support as follows:
    - a. Luminaires less than 56 lbs: Provide a minimum of two (2) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires.
    - b. Luminaires 56 lbs or greater: Provide a minimum of four (4) #12 gauge suspended ceiling support wires located on diagonal corners of the luminaires. Support luminaire independent of the ceiling system.
    - c. Luminaires larger than eight square feet (8 ft<sup>2</sup>): Support luminaire independent of the ceiling system.
- B. Do not fasten luminaire supports to piping, ductwork, mechanical equipment, or conduit, unless otherwise noted. Support wires shall be tightly wrapped (minimum of three turns within 3 inches of the connection) and sharply bend to prevent vertical movement.
- C. Support suspended or pendant mounted luminaires independent of ceiling grid with adjustable stainless steel aircraft cables or per luminaire schedule mounting requirements. Suspension assembly and anchors shall be capable of supporting 300 pounds dead load at each suspension point.
- D. Support wire used to independently support luminaires, raceways, and wiring systems shall be distinguishable from ceiling support systems by color (field paint), tagging or equivalent means.
- E. Install lamps in lamp holders of luminaires.

- F. Recessed luminaires and other optical accessories shall remain in protective wraps or films until construction in area is complete and area has been cleaned.
- G. Industrial Pendant Luminaires: Use power hook hangers rated 500 pounds minimum or provide safety chain between ballast and structure. Provide safety chain between reflector and ballast.
- H. Use belt slings or non-chafing ropes to raise and set pre-finished luminaire poles.

### 3.2 CONSTRUCTION USE OF PROJECT LUMINAIRES

- A. The Contractor shall provide temporary construction lighting per the requirements of Division 1.
- B. The project luminaires shown on the construction documents shall not be used for temporary construction purposes without providing a plan for Owner approval that addresses energy and luminaire operating hours.

### 3.3 AUTOMATIC LOAD CONTROL RELAYS

- A. Factory or field installation per manufacturer requirements.
- B. Remote Test Switch: Provide connection to remote test switch.
- C. Fire Alarm Override: Provide connection to addressable fire alarm relay.

### 3.4 EMERGENCY LIGHTING UNITS AND EXIT SIGNS

- A. Install units plumb and level.
- B. Aim directional lamp heads as directed.
- C. Test emergency lighting equipment for 60 minutes to determine proper operation, prior to Substantial Completion. Provide electronic copy of periodic test log form to Owner's Representative. Explain and instruct Owner's Representative of requirements for testing and maintenance. Refer to latest adopted NFPA 101 for testing and logging requirements.

### 3.5 RELAMPING

- A. Replace failed LED light engine modules or arrays at completion of work.

### 3.6 ADJUSTING AND CLEANING

- A. Align luminaires and clean lenses and diffusers at completion of work. Clean paint splatters, dirt, and debris from installed luminaires.
- B. Touch up luminaire and pole finish at completion of work.

### 3.7 LUMINAIRE SCHEDULE

- A. As shown on the drawings.

END OF SECTION 26 51 19

## SECTION 28 31 00 - FIRE ALARM AND DETECTION SYSTEMS

### PART 1 - GENERAL

#### 1.1 SECTION INCLUDES

- A. Fire alarm and detection systems.

#### 1.2 RELATED WORK

- A. Section 26 05 53 - Electrical Identification: Refer to electrical identification for color and identification labeling requirements.

#### 1.3 QUALITY ASSURANCE

- A. Manufacturer: Company specializing in smoke detection and fire alarm systems with ten years' experience.
- B. Installer: A factory-authorized Electrical or Security Contractor licensed with the State and local jurisdiction with five years' experience in the design, installation, and maintenance of fire alarm systems by that manufacturer.
- C. Qualifications: The person managing/overseeing the preparation of shop drawings and the system installation/programming/testing shall be trained and certified by the system manufacturer and shall be Fire Alarm Certified by NICET, minimum Level 2. This person's name and certification number shall appear on the start-up and testing reports.

#### 1.4 REFERENCES

- A. NFPA 70 - National Electrical Code (NEC)
- B. NFPA 72 - National Fire Alarm and Signaling Code
- C. NFPA 101 - Life Safety Code
- D. UL 2017 - General Purpose Signaling Devices and Systems
- E. 2015 Fire Code

#### 1.5 SUBMITTALS

- A. Submit shop drawings and product data under provisions of Section 26 05 00 and as noted below.
  - 1. Failure to comply with all the following and all the provisions in 26 05 00 will result in the shop drawing submittal being rejected without review.
  - 2. Failure to submit the fire alarm without all requirements fulfilled in a single comprehensive submittal will be grounds to require a complete resubmittal.
- B. Provide product catalog data sheets as shop drawings.

1. Provide a product catalog data sheet for each item shown on the Electrical Symbols List and for each piece of equipment that is not shown on the drawings, but required for the operation of the system.
2. Where a particular Electrical Symbols List item has one or more variations (such as those denoted by subscripts, etc.) a separate additional product catalog data sheet shall be provided for each variation that requires a different part number to be ordered. The corresponding Electrical Symbols List symbol shall be shown on the top of each sheet.
3. Where multiple items and options are shown on one data sheet, the part number and options of the item to be used shall be clearly denoted.

C. Submit CAD Floor Plans as Shop Drawings:

1. The complete layout of the entire system, device addresses, auxiliary equipment, and manufacturer's wiring requirements shall be shown.
2. A legend or key shall be provided to show which symbols shown on the submittal floor plans correspond with symbols shown on the Contract Documents.

D. With regard to all fire alarm circuits, provide the following: manufacturer's wiring requirements (manufacturer, type, size, etc.) and voltage drop calculations.

E. Provide installation and maintenance manuals under provisions of Section 26 05 00.

F. Submit manufacturer's certificate that system meets or exceeds specified requirements.

G. Provide information on the system batteries as follows: total battery capacity, total capacity used by all devices on this project, total available future capacity.

H. Submit photocopy proof of NICET certification of the person overseeing the preparation of drawings and installation/testing.

I. When required to comply with local or state regulatory reviews, the fire alarm submittal shall have a Professional Engineer's stamp and signature of the state in which the project is completed. NOTE: The Architect/Engineer cannot stamp and seal submittal drawings not prepared under their supervision.

## 1.6 EXTRA MATERIALS

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

1. Provide quantity equal to 2 percent (2%) of amount of each type installed, but no less than two (2) units of each type.
  - a. Smoke and heat detectors, manual pull stations, duct smoke detectors, monitor modules, control modules and relays.
  - b. Notification Appliances: Speakers, speaker strobes, and strobes.

## 1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to site under provisions of Section 26 05 00.

- B. Store and protect products under provisions of Section 26 05 00.

## 1.8 REGULATORY REQUIREMENTS

- A. System: UL or FM Global listed.
- B. Conform to requirements of NFPA 101.
- C. Conform to requirements of Americans with Disabilities Act (ADA).
- D. Conform to UL 864 Fire Alarm, UL 1076 Security, UL2017 General Signaling, and UL 2572 Mass Notification Communications.

## 1.9 SYSTEM DESCRIPTION

- A. Performance Statement: This specification section and the accompanying fire alarm specific design documents describe the minimum material quality, required features, and operational requirements of the system. These documents do not convey every wire that must be installed and every equipment connection that must be made. Based on the equipment described and the performance required of the system, as presented in these documents, the Vendor and the Contractor are solely responsible for determining all wiring, programming and miscellaneous equipment required for a complete and operational system.
- B. This section of the specifications includes the furnishing, installation and connection of the microprocessor controlled, intelligent reporting, fire alarm equipment required to form a complete coordinated system that is ready for operation. It shall include, but is not limited to, alarm initiating devices, control panels, auxiliary control devices, annunciators, power supplies, and wiring as indicated on the drawings and specified herein.
- C. Extending the Existing Fire Alarm System: Provide all items, components, devices, hardware, software, programming, expansion components, conduit, wiring etc. needed to extend fire alarm system with the new fire alarm devices. This includes, but is not limited to, additional power supplies, initiating devices and circuits, signaling devices and circuits, monitoring devices and circuits, auxiliary control and related devices such as, door holders and their control, smoke damper control, fan shutdown, etc. The existing fire alarm system shall be extended with the new fire alarm devices such that the existing fire alarm system's functionality, integrity and annunciation shall be equivalent to pre-construction conditions, unless noted otherwise. The functionality and integrity shall be maintained during construction. The entire system shall be able to be completely reset from any single reset location point. The entire system shall be annunciated at any annunciation location.
- D. Extending the Existing Simplex 4100 ES Fire Alarm System (East HS and Lincoln) and Existing Notifier NFS-320 Fire Alarm System (Washington and Flinn): The existing control panel shall remain and shall be operational throughout construction. The system shall only be disabled to make new connections and to modify the programming. A fire watch shall be provided for all areas affected during outages. All system outages must be scheduled with the Owner at least one week prior. Individual devices may be disabled as needed based on construction activities to reduce the potential for false alarms, but all devices must be operational when the Contractor is not physically on site. New initiating devices may be connected to the existing signaling line circuits where capacity is available. Provide additional signaling line circuits as needed based on existing and new device quantity, including

replacement of existing panel components. Provide new notification circuits to serve the new devices, including all necessary power supplies, amplifiers, batteries, and 120-volt input circuits. All new devices shall be programmed to provide the same sequence of operation as the existing devices of the same type, unless noted otherwise.

- E. Fire Alarm System: NFPA 72; Automatic and manual fire alarm system, non-coded, analog-addressable with automatic sensitivity control of certain detectors, multiplexed signal transmission.
- F. System Supervision: Provide electrically supervised system, with supervised Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC). Occurrence of single ground or open condition in initiating or signaling circuit places circuit in TROUBLE mode. Component or power supply failure places system in TROUBLE mode.
- G. Alarm Reset: Key-accessible RESET function resets alarm system out of ALARM if alarm initiating circuits have cleared.
- H. Lamp Test: Manual LAMP TEST function causes alarm indication at each zone at fire alarm control panel and at annunciator panels.
- I. Drawings: Only device layouts and some equipment have been shown on the contract drawings. Wiring and additional equipment to make a complete and functioning system has not been shown, but shall be submitted on the shop drawings.

#### 1.10 PROJECT RECORD DOCUMENTS

- A. Submit documents under the provisions of Section 26 05 00.
- B. Include location of end-of-line devices.
- C. Provide a CAD drawing of each area of the building (minimum scale of 1/16" = 1'-0") showing each device on the project and its address. The devices shall be shown in their installed location and shall be labeled with the same nomenclature as is used in the fire alarm panel programming.
- D. Submit test results of sound pressure level (dBA) and intelligibility (STI) with the rooms tested designated on the floor plan. Notification devices shall have the tap wattage designated.

#### 1.11 OPERATION AND MAINTENANCE DATA

- A. Submit data under provisions of Section 26 05 00.
- B. Include operating instructions, and maintenance and repair procedures.
- C. Include results of testing of all devices and functions.
- D. Include manufacturer's representative's letter stating that system is operational.
- E. Include the CAD floor plan drawings.

- F. Include shop drawings as reviewed by the Architect/Engineer and the local Authority Having Jurisdiction.

#### 1.12 WARRANTY

- A. Provide one (1) year warranty on all materials and labor from Date of Substantial Completion.
- B. Warranty requirements shall include furnishing and installing all software upgrades issued by the manufacturer during the one (1) year warranty period.

### PART 2 - PRODUCTS

#### 2.1 MANUFACTURERS

- A. Johnson Controls - Simplex 4100 ES
- B. Notifier by Honeywell

#### 2.2 EXISTING FIRE ALARM CONTROL PANEL (FAP) - SIMPLEX 4100 ES (EAST HS & LINCOLN), NOTIFIER NFS-320 (WASHINGTON & FLINN)

- A. Control Panel: Upgrade as required to support new devices.
- B. Each Signaling Line Circuit (SLC loop) shall not be loaded over 80% of the maximum device capacity. For example, in the minimum system capacity column listed below, if the fire alarm manufacturer's system capacity of analog sensors per loop is 99 devices, then no more than 79 devices shall be wired on that loop.
- C. Signal Line Circuit (SLC) and Notification Appliance Circuit (NAC) Boards:
  - 1. Each board shall communicate directly with each addressable analog sensor and binary input to determine normal, alarm, or trouble conditions. Analog signals would be used for automatic test and determination of maintenance requirements.
  - 2. Each board shall contain its own microprocessor and shall be provided to monitor addressable inputs and to control addressable outputs (addressable relays). The board shall communicate and provide power to all devices on its loop over a single pair of wires, except where 4-wire devices require a separate power circuit.
  - 3. Pathway Class B: Circuits NOT capable of transmitting an alarm beyond the location of the fault condition. Wiring of outgoing and return conductors is permitted to be run in the same conduit or cable.
- D. Central Processing Unit:
  - 1. Upgrade as required to support new devices.
- E. Memory: Upgrade as required to support new devices.

F. Surge Protection:

1. All fire alarm control panels, NAC panels, etc. shall be provided with a surge protection device (SPD). The SPD shall be UL listed to Standard 1449 Rev 3. The unit should be clearly labeled in accordance with Identification Section 26 05 53. The SPD shall have thermal fuses to protect against fire in short circuit conditions. The unit shall provide visual indication that the unit is protecting and functioning.
2. Any communications or signaling circuits associated with the fire alarm system, which leave or enter a facility, shall be provided with a surge protection device. The devices shall be as recommended by the fire alarm system manufacturer.

2.3 SIGNALING LINE CIRCUIT DEVICES

A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.

B. Signal Line Device(s):

1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device type as follows:
    - 1) W = Weather Proof
    - 2) WG = Wire guard is required
    - 3) Candela Ratings:
      - a) ## = 15 Candela, 30 Candela; 75 Candela; 110 Candela; 177 Candela
      - b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.
  - b. Sequence of operation as follows:
    - 1) D = HVAC Control

C. FA-120; Smoke Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) Blank = Photoelectric
2. (BLANK) Analog Photoelectric Type Sensor: Shall use the photoelectric principle to measure smoke density and send data to the control panel representing the analog level of smoke density measured.
3. Each smoke detector shall connect directly to an SLC loop, unless listed as stand alone.

4. Each detector shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided. Provide a two-piece head/base design.
5. Each detector shall have a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
6. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. Remote indicator terminals shall be provided. Provide a remote LED indicator device if detector is not visible from a floor standing position.
7. A test means shall be provided to simulate an alarm condition.
8. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

D. FA-121; Gas Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) CO = Carbon Monoxide
2. (CO) Analog Carbon Monoxide Type Sensor.

E. FA-122; Duct Smoke Detectors, Sampling Tube Type:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) # = Equipment or system
  - b. Duct-type smoke detectors shall use the same analog photoelectric sensor technology, with the same features specified for standard smoke detectors, except with additional features as specified below.
  - c. Provide sampling tubes and mounting hardware to match the duct to which it is attached. Where the detector housing is larger than the duct height, Contractor shall fabricate a mounting bracket for the detector and attach according to the fire alarm manufacturer's recommendations.
  - d. Provide a remote alarm LED indicator device (FA-241) or (FA-242) if detector is not visible from a floor-standing position. If detector is located above a suspended ceiling, mount remote indicator in ceiling directly below detector with a white single-gang faceplate labeled: Duct Smoke Detector.

F. FA-130; Manual Pull Stations:

1. Manual pull station, addressable, double action with plastic breakrod, reset key lock, semi-flush mount, red high abuse plastic or cast metal construction with white lettering. Provided with all necessary mounting hardware.

2. Manual stations shall connect directly to an SLC loop. Stations shall provide address setting means using rotary decimal or DIP switches.
3. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location, with maintained temperatures between 32°F and 120°F.

G. FA-140; Heat Detectors:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) Blank = Combination Rate of Rise / Fixed Temp
2. (BLANK) Combination rate of rise and 135°F fixed temperature analog thermal type sensor. Factory programmed to alarm at 135°F and at 15°F per minute rate-of-rise. Sensor shall measure heat level and send data to the control panel representing the analog level of thermal measurement and rate-of-rise.
3. Provide a two-piece head/base design, with a manual switching means to set the internal identifying code (address) of that detector, which the control panel shall use to identify its address with the type of sensor connected.
4. Heat detectors shall connect directly to SLC loops. Where fixed temperature or explosion proof detectors are used, one monitor module may be used to monitor all detectors in one room/area as shown on the drawings.
5. Detectors shall be mounted, where shown on the drawings, on a twist-lock base with all mounting hardware provided.
6. Provide a remote LED indicator device if detector is not visible from a floor-standing position.
7. Dual alarm and power indicators shall be provided that flash under normal conditions and remain continuous under alarm or trouble conditions. A connection for attachment of a remote indicator shall be provided.
8. A test means shall be provided to simulate an alarm condition.
9. Where operation is noted as required below 32°F and/or above 120°F, a conventional device shall be installed with a unique monitor module located in the nearest available location with maintained temperatures between 32°F and 120°F.

H. FA-160; Monitor Modules:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
  - a. Device types as follows:
    - 1) Blank = Refer to Plans
2. Monitor Module shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit. It shall interface initiating devices with the control panel using Style D or Style B circuits. Contractor Option: Use an interface module (2-wire operation) for Style B circuits connected to normally-open dry contacts, such as a flow switch.

3. The module shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being monitored, or where shown on the drawings. All mounting hardware shall be provided.
4. The module shall supply the required power to operate the monitored device(s).
5. The module shall provide address setting means using rotary decimal or DIP switches.

I. FA-161; Addressable Control Module:

1. Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation
  - a. Device types as follows:
    - 1) Blank = Refer to Plans
2. Relay that represents an addressable control point used primarily for the control of auxiliary devices as indicated on the drawings. Contractor to provide additional child relay(s), as required, rated for the electrical load being controlled (Contractor to match voltage, amps, etc.).
3. Relay shall connect directly to an SLC loop and receive power from a separate 24 VDC circuit.
4. The relay shall be mounted in an enclosure located in an accessible service location as near as possible to the device(s) being controlled, unless otherwise shown on the drawings. All mounting hardware shall be provided.
5. The relay shall supply 24 VDC power to the device(s) being controlled, unless otherwise indicated on the drawings.

2.4 NOTIFICATION APPLIANCE DEVICES

- A. Combination Devices: Subscripts identify combination type devices when applicable. Contractor shall provide the combination device or provide multiple device(s) to meet the functionality when the manufacturer does not offer the required functionality with a single device.
- B. Notification Appliance Device(s):
  1. Subscripts: Subscripts are used to define the device type, installation, and identify the device with a specific sequence of operation.
    - a. Device types as follows:
      - 1) W = Weather Proof
      - 2) WG = Wire guard is required
      - 3) Candela Ratings:
        - a) ## = 15 Candela; 30 Candela; 75 Candela; 110 Candela; 177 Candela
        - b) CD = NICET designer shall select Candela rating as required to provide full coverage of the space.

- C. Notification Device(s):
  - 1. Wall Mounted: White housing with red lettering or pictogram.
  - 2. Ceiling Mounted: White housing with red lettering or pictogram.
  
- D. FA-211; Combination Audio Horn and Visual Alarm Device:
  - 1. Wall or ceiling mounted, refer to plans.
  - 2. Combine audio and visual components into a single device. Refer to the corresponding paragraphs above for requirements of each component.
  - 3. (W) Weatherproof Audio/Visual Notification Device: Electronic horn with high intensity strobe, square housing, 75 Candela, suitable for wet locations. Provide with weatherproof back box.
    - a. Mounting: Semi-flush wall.
    - b. Conduit shall not be exposed.

## 2.5 NOTIFICATION APPLIANCE CIRCUIT PANEL (NAC)

- A. As shown on the plans or as a Contractor's option if not shown, furnish and install NAC extender panels as necessary to provide remote power supply for notification appliance circuits (NAC). Contractor shall indicate quantity and locations of each NAC on the shop drawing submittals.
  
- B. Each NAC shall be self-contained remote power supply with batteries, and battery charger mounted in a surface lockable cabinet. Battery capacity shall be sufficient for operation for 24 hours in a non-alarm state followed by alarm for 15 minutes, plus 25% spare capacity for future devices. Each NAC provides a minimum of up to 4 outputs, 2A continuous, or 6A full load total capacity.
  
- C. Power for each NAC shall be from a local 120 VAC emergency circuit. Provide two #12 conductors and one #12 ground in 1/2" conduit to each NAC from a dedicated 20A/1P circuit breaker with a red handle and a manufacturer's standard handle lock-on device. Coordinate panel and circuit number with the Architect/Engineer prior to installation.
  
- D. NAC extender panels may be installed only in locations coordinated with the Architect/Engineer.
  
- E. Mounting: Surface.

## 2.6 ANNUNCIATION

- A. FA-241; Fire Alarm Remote Indicator:
  - 1. Red LED type.
  - 2. Mounts flush to a single gang box.

## 2.7 WIRING

- A. Fire alarm wiring/cabling shall be furnished and installed by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes. Cabling shall be UL listed and labeled as complying with the Electrical Code for power-limited fire alarm signal service.
- B. Fire Alarm Cable:
  - 1. Manufacturers:
    - a. Comtran Corp.
    - b. Helix/HiTemp Cables, Inc.
    - c. Rockbestos-Suprenant Cable Corp.
    - d. West Penn Wire/CDT.
    - e. Radix.

## PART 3 - EXECUTION

### 3.1 SEQUENCES OF FIRE ALARM OPERATION

- A. General:
  - 1. All system output programs assigned via control-by-event equations to be activated by the particular point in alarm shall be executed, and the associated system outputs (alarm notification appliances and/or relays) shall be activated.
- B. Panel/Annunciator Alarm, Trouble, Supervisory Indication:
  - 1. Appropriate system Alarm, Trouble, or Supervisory LED shall flash at the control panel, transponder, and annunciator locations.
  - 2. A local signal in the control panel shall sound.
  - 3. The LCD display shall indicate all information associated with the condition, including the name of the item, type of device and its location within the protected premises.
  - 4. history storage equipment shall log the information associated with the fire alarm control panel (FAP) condition, along with the time and date.
  - 5. Transmit the appropriate signal (supervisory, trouble, alarm) to the central station via the digital communicator.
  - 6. Transmit the appropriate signal (supervisory, trouble, alarm) to the building automation system via addressable relays tied to contact monitors on the system.
- C. Audible Alarms Sequence:
  - 1. Matched with existing Audible Alarms Sequence as required.
- D. Visual Alarms Sequence:
  - 1. Matched with existing Visual Alarms Sequence as required.

E. HVAC System Sequence:

F. Smoke Damper Control Sequence:

1. The fire alarm system shall utilize an addressable relay to open the power connection to smoke or fire/smoke dampers and allow them to close. Coordinate other requirements with damper installer.
2. Where a damper is in a main air duct, where closure of that single damper will entirely block airflow in the duct system, the smoke damper sequence shall also initiate the AHU and mechanical fan shutdown sequence for the affected unit.
3. The AHU and mechanical fan shutdown sequence shall be initiated only when ALL the dampers associated with that unit or mechanical fan are closed. Otherwise, the AHU or mechanical fan shall continue to serve other areas.
4. Smoke and fire/smoke dampers located in branch ductwork shall be closed individually or in groups, as identified on the plans.

G. AHU and Mechanical Fan Shutdown Sequence:

1. The fire alarm system shall utilize addressable relays to de-energize all AHU motor controllers and mechanical fans. Coordinate other requirements with HVAC installer.
2. The fire alarm system shall directly shut down the AHU or mechanical fan through the local HVAC control device (i.e., variable frequency drive or motor starter).
3. Where a facility has more than one AHU or mechanical fan, each shall be shutdown individually based on input from initiation devices in the area served by the unit or designated for each air distribution system.

### 3.2 INSTALLATION

A. Install system in accordance with manufacturer's instructions and referenced codes.

B. Devices:

1. General:

- a. All ceiling-mounted devices shall be located where shown on the reflected ceiling and floor plans. If not shown on the reflected ceiling or reflected floor drawings, the devices shall be installed in the relative locations shown on the floor drawings in a neat and uniform pattern.
- b. All devices shall be coordinated with luminaires, diffusers, sprinkler heads, piping and other obstructions to maintain a neat and operable installation. Mounting locations and spacing shall not exceed the requirements of NFPA 72.
- c. Where the devices are to be installed in a grid type ceiling system, the detectors shall be centered in the ceiling tile.
- d. The location of all fire alarm devices shall be coordinated with other devices mounted in the proximity. Where a conflict arises with other items or with architectural elements that will not allow the device to be mounted at the location or height shown, the Contractor shall adjust location of device so that new location meets all requirements in NFPA 72 and all applicable building codes.

2. Per the requirements of NFPA, detector heads shall not be installed until after the final construction cleaning unless required by the local Authority Having Jurisdiction (AHJ). If detector heads must be installed prior to final cleaning (for partial occupancy, to monitor finished areas or as otherwise required by the AHJ), they shall not be installed until after the fire alarm panel is installed, with wires terminated, ready for operation. Any detector head installed prior to the final construction cleaning shall be removed and cleaned prior to closeout.
3. Duct-type Analog Smoke Detectors:
  - a. Duct-type analog smoke detectors shall be installed on the duct where shown on the drawings and details. The sampling tubes shall be installed in the respective duct at the approximate location where shown on the electrical drawings to meet the operation requirements of the system.
  - b. All detectors shall be accessible.
  - c. Duct-type detectors shall be installed according to the manufacturer's instructions.
4. Heat Detector, Linear Wire Type:
  - a. Install detection wire within 20 inches of the underside of building roof, floor, or as recommended by the manufacturer.
  - b. The protected area shall not exceed 4,000 square feet per zone. Provide a separate zone for areas divided by fire/smoke rated walls.
5. Manual Pull Stations:
  - a. Stations shall be located where shown and at the height noted on the drawings.
6. Addressable Relays and Monitor Modules:
  - a. Modules shall be located as near to the respective monitor or control devices as possible, unless otherwise indicated on the drawings.
  - b. All modules shall be mounted in or on a junction box in an accessible location.
  - c. Where not visible from a floor standing position, a remote indicator shall be installed to allow inspection of the device status from a local floor standing location.
7. SLC Loop Isolation Modules:
  - a. Isolation modules shall be installed to limit the number of addressable devices that are incapacitated by a circuit fault.
  - b. Install all Isolation Modules within the fire alarm control panel, unless otherwise indicated on the drawings. Refer to the fire alarm riser diagram for requirements. Refer to the floor plans for areas served by separate isolation modules.
8. Notification Appliance Devices:
  - a. Devices shall be located where shown on the drawings.
  - b. Wall-mounted audio, visual and audio/visual alarm devices shall be mounted as denoted on the drawings.

- c. Where ceiling mounted visual alarm devices or combination audio/visual alarm devices are shown where the ceiling is greater than 30'-0" high, they shall be stem mounted so that the entire unit is below 30'-0". This does not apply to audio-only alarm devices.

C. Wiring:

1. Fire alarm wiring/cabling shall be provided by the Contractor in accordance with the manufacturer's recommendations and pursuant to National Fire Codes.
2. Wiring shall be installed in conduit. Refer to Identification Section 26 05 13 for color and identification requirements.
3. All junction boxes with SLC and NAC circuits shall be identified on cover. Refer to Identification Section 26 05 13 for color and identification requirements.
4. Fire Alarm Power Branch Circuits: Building wiring as specified in Section 26 05 13.
5. Notification Appliance Circuits shall provide the features listed below. These requirements may require separate circuits for visual and audible devices.
  - a. Fire alarm temporal audible notification for all audio appliances.
  - b. Synchronization of all visual devices where two or more devices are visible from the same location.
  - c. Ability to silence audible alarm while maintaining visual device operation.
6. Signal line circuits connecting devices shall be provided with an isolation module at each floor separation or as otherwise shown on the drawings.
7. No wiring other than that directly associated with fire alarm detection, alarm or auxiliary fire protection functions shall be in fire alarm conduits. Wiring splices shall be avoided to the extent possible, and if needed, they shall be made only in junction boxes, and enclosed by plastic wire nut type connectors. Transposing or changing color coding of wires shall not be permitted. All conductors in conduit containing more than one wire shall be labeled on each end, in all junction boxes, and at each device with "E-Z Markers" or equivalent. Conductors in cabinets shall be carefully formed and harnessed so that each drops off directly opposite to its terminal. Cabinet terminals shall be numbered and coded, and no unterminated conductors are permitted in cabinets or control panels. All controls, function switches, etc. shall be clearly labeled on all equipment panels.

D. Fire Alarm Cabling Color Code: Provide circuit conductors with insulation color coding as follows, or using colored tape at each conductor termination and in each junction box.

1. Power Branch Circuit Conductors: In accordance with Section 26 05 53.
2. Signaling Line Circuit: Overall red jacket with black and red conductors.
3. DC Power Supply Circuit: Overall red jacket with violet and brown conductors.
4. Notification Appliance Circuit: Overall red jacket with blue and white conductors.
5. Door Release Circuit: Gray conductors.
6. Central Station Trip Circuit: Orange conductors.
7. Central Station Fire Alarm Loop: Black and white conductors.

E. Devices surface mounted in finished areas shall be mounted on surface backboxes furnished by fire alarm equipment supplier. Backboxes shall be painted to match device, shall be the same shape and size as the device shall not have visible knockouts.

- F. Make conduit and wiring connections to door release devices, sprinkler flow and pressure switches, sprinkler valve monitor switches, fire suppression system control panels, duct analog smoke detectors and all other system devices shown or noted on the Contract Documents or required in the manufacturer's product data and shop drawings.

### 3.3 FIELD QUALITY CONTROL

- A. Field inspection and testing will be performed under provisions of Section 26 05 00.
- B. Test in accordance with NFPA 72, Chapter 14 and local fire department requirements. Submit documentation with O & M manuals in accordance with Section 14.6 of the Code.

### 3.4 MANUFACTURER'S FIELD SERVICES

- A. Provide manufacturer's field services under provisions of Section 26 05 00.
- B. Include services of certified technician to supervise installation, adjustments, final connections, and system testing.
- C. Note that room numbers depicted on the architectural/engineering drawings will not necessarily reflect the actual room (signage) numbers that the Owner selects. Contractor and fire alarm manufacturer shall coordinate the actual room numbers as the Owner directs to identify each device. This list shall be a part of the floor plan record drawing to be turned in at the project closeout.

### 3.5 SYSTEM TRAINING

- A. System training shall be performed under provisions of Section 26 05 00.
- B. Minimum on-site training times shall be:
  - 1. System Operators: One (1) day.

END OF SECTION 28 31 00