

**SEDGWICK COUNTY
ADULT DETENTION FACILITY
B.A.S. REPLACEMENT**

**BID DOCUMENTS
SPECIFICATIONS**

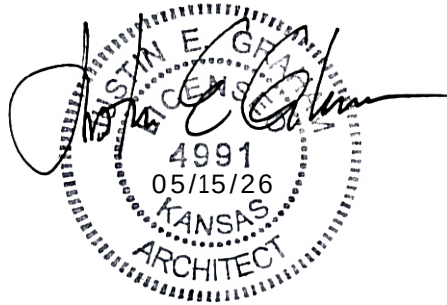
15 May 2026

SCHAEFER PROJECT : 5278.63

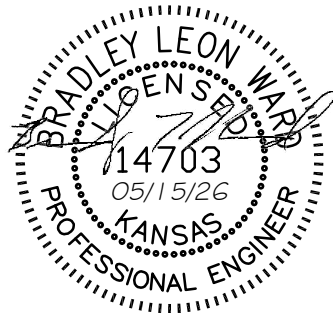


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**SCHAEFER ARCHITECTURE
ARCHITECTS**



**MIDWEST ENGINEERING, INC.
MECHANICAL ENGINEER**



ELECTRICAL ENGINEERS

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Adult Detention Facility Building Automation System Replacement

INVITATION FOR BIDS

PROJECT: Adult Detention Facility Building Automation System Replacement.
141 W Elm Street
Wichita, Ks 67203

COUNTY BID NUMBER: 26-0074

PRE-BID MEETING:

A pre-bid meeting will be held on site. Bidders are to meet at 141 W Elm Street
Wichita, Ks 67203 beginning at 9: 00a.m on Tuesday, 10/6/2026.

Attendance is mandatory for General / Prime Contractors; this will be the only time to meet directly with County staff and the architect to answer questions concerning this project. General / Prime contractors are encouraged to have their subcontractors attend this meeting to view the site conditions.

Bidders are encouraged to examine bidding documents as early as possible. **In order to ensure each bidder has the most current information for bidding there is an established date and time for last questions to be asked. Bidders requiring clarification or interpretation of the Bidding Documents shall make such requests, in writing only, to Lee Barrier, Purchasing Agent, at Lee.Barrier@sedgwick.gov no later than 5:00 p.m. on Friday October,23, 2026**

RESPONSES TO INVITATION FOR BID:

PLEASE NOTE ADDRESS CHANGE FOR PURCHASING DEPARTMENT.

Responses will be received in the Sedgwick County Purchasing Department, located in the Finance Department, **100 N. Broadway Avenue, Suite 610, Wichita, Kansas, 67202**, until **1:45 p.m.** on Tuesday, November 10,2026 Late Bids will not be accepted and will not be considered for award recommendation.

BID RESPONSES WILL BE OPENED AT: 3:00 p.m. on Tuesday, November 10,2026

This meeting will be held in the Finance Department, **100 N. Broadway, Suite 610, Wichita, Kansas, 67202**. All interested parties are invited to attend this meeting, as bids/responses will be received, publicly opened and read aloud.

After review and appropriate approval, a contract will be awarded to the lowest responsive, responsible and best bidder meeting specifications and appropriately licensed to do the specified work outlined in these documents.

Plans and specifications are available in electronic form only and may be downloaded by clicking the following link, [Sedgwick County Construction Projects](#). Company information will be collected to generate a plan holder's list which will be updated weekly and available at the Building Automation System Replacement section of the [current RFP/RFQ page](#). Upon request, plans will be made available for viewing only in the County Clerk's office 100 N. Broadway Avenue, Suite 620, Sixth Floor, Wichita, Kansas, 67202.

There will be **NO** Bid Document Deposit for this set of Documents.

A RECOMMENDATION FOR CONTRACT AWARD:

will be made to the Board of Bids and Contracts at its regular meeting **at 10:00 a.m. on Thursday, November 19,2026**, generally held in the County Commission Meeting Room located at 100 N. Broadway, Sixth Floor, Wichita, Kansas, 67202, although this date or location could change.

CONTRACT AWARD:

Board of County Commissioners will consider award on **Wednesday, December 2,2026, although this date could change.**

Adult Detention Facility Building Automation System Replacement

PROJECT SCOPE:

This project aims to replace the outdated Building Automation System (BAS) to improve heating, ventilation, and air conditioning (HVAC) management, energy efficiency, and overall system reliability. The new BAS will provide enhanced control over essential equipment, including cooling towers, chillers, boilers, circulation pumps, air handlers, and rooftop units, ensuring optimal performance and parts availability.

BIDDING DOCUMENTS:

1. Complete sets of Bidding Documents shall be used in preparing Bids.
2. Neither the Owner nor the Architect/Engineer assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.
3. The Owner or Architect/Engineer, in making copies of the Bidding Documents available, do so only for the purpose of obtaining Bids on the work and do not confer a license or grant for any other use.
4. Bids shall include furnishing all labor, materials, equipment and performing the work for the above-described Project in strict accordance with the Bidding Documents and any Addenda.

DURING BIDDING PERIOD:

Inquiries regarding Bid Documents, Bid/Selection process or any requests for information about this specific project shall be directed in writing only to:

Lee Barrier, Senior. Purchasing Agent
100 N. Broadway, Suite 610
Wichita, KS 67202
Telephone: (316) 660-7258 Fax: (316) 383-7055
E-mail: Lee.Barrier@sedgwick.gov

All contact concerning this solicitation shall be made through the Purchasing Department.

Bidders shall not contact county employees, department heads, using agencies, evaluation committee members or elected officials with questions or any other concerns about the solicitation. Questions, clarifications and concerns shall be submitted to the Purchasing Department **in writing**. Failure to comply with these guidelines may disqualify the Bidder's response.

OWNER'S REPRESENTATION:

Owner's Representative for the duration of the Project:

Andrew Runk
271 W 3rd St N, Wichita, Ks, 67202
Telephone: (316) 660-5249
E-mail: Andrew.Runk@sedgwick.gov

Architect's Representative:

Schaefer Architecture
Justin Graham
Telephone: (316) 684-0171
E-mail: jgraham@schaefer-arch.com

BIDDER'S REPRESENTATION:

In order to induce the Owner to accept their Bid, in addition to and not in lieu of any other representations and warranties contained in the Bidding Documents, the Bidder represents and warrants the following to the Owner:

Adult Detention Facility Building Automation System Replacement

1. The Bidder and their subcontractors are financially solvent and possess sufficient working capital to complete the work, and perform all obligations hereunder.
2. The Bidder is able to provide the plant, tools, materials, supplies, equipment, and labor required to complete the work and perform the Bidder's obligations hereunder.
3. The Bidder will be authorized to do business in the State of Kansas and will be properly licensed to do this work.
4. The Bid and execution of the Bidding Documents and the Bidder's performance thereunder are within the Bidder's duly authorized powers.
5. The Bidder has made an exhaustive study of the Bidding Documents; understands the terms and provisions thereof; and has sought or will timely seek any and all necessary clarifications prior to submitting the Bid; and that the Bid is made in accordance with the foregoing.
6. The Bidder has visited the Project and is completely familiar with the local and special conditions under which the work is to be performed and has correlated such knowledge with the requirements of the Bidding Documents.
7. The Bid is based upon the approved materials, systems and equipment described in the Bidding Documents without exception, including all warranties, coordination and components required to perform the work.
8. The Bidder certifies that their Bid is submitted without collusion, fraud, or misrepresentation as to other Bidders, so that all Bids for the Project result from a free, open and competitive bidding environment.
9. The Bidder possesses a high level of experience and expertise in the business administration, management, and superintendence of projects of the size, complexity and nature of this particular Project, and that the Bidder will work with the care, skill and diligence of such a contractor.
10. The Bidder acknowledges that the Owner is relying upon this Bidder's skill and experience in connection with the work being bid herein.
11. That complete sets of Bidding Documents were used in the preparation of the Bid and that neither the Owner nor the Architect is responsible for errors or misinterpretations resulting from the use of incomplete sets of such Documents.

The foregoing warranties are in addition to, and not in lieu of (A) any and all other liability imposed upon the Contractor by law with respect to the Contractor's duties, obligations and performance of the work and (B) any and all other warranties, representations and certifications made in the Bidding Documents. The Contractor's liability hereunder shall survive the Owner's final acceptance of and payment for the work. All representations and warranties set forth herein and in the Contract Documents shall survive the final completion of the work or the earlier termination of this Agreement.

Bid Guarantee:

1. Bid Security is required in the amount of at least 5% of the bid plus all additional alternates. In case of multiple prices in a bid or alternate, write for the maximum possible contract amount.
2. Bid Security can be in the form of a certified or Cashier's Check or Bid Bond acceptable to Sedgwick County. Checks are to be made payable to the Sedgwick County Clerk and drawn on a solvent Kansas bank or trust company. These checks or bonds will be retained by Sedgwick County until the purchase contract has been awarded.
3. Bid Bonds shall be written by a bonding agency approved by the United States Treasury Department and licensed to do business in the State of Kansas.
4. Bid Bonds shall be submitted on AIA Document A310, latest edition, as issued and approved by the American Institute of Architects.
5. Bid Security will be retained by the Sedgwick County Clerk until the Contract for the Project has been completed and is a guarantee that if awarded the Contract, the Bidder will enter into a contract and give bonds as required. In the event the successful Bidder fails to consummate a signed Contract, through no fault of the Owner, Bid Security shall be retained by the Owner as liquidated damages and not as a penalty.
6. Sedgwick County reserves the right to retain the Bid Security of the three (3) lowest Bidders until the successful Bidder has entered into a Contract or until 60 days after Bid opening, whichever is the shorter. All other Bid Securities will be returned as soon as practicable.

Adult Detention Facility Building Automation System Replacement

Sedgwick County is desirous of allowing as many Kansas vendors as possible the opportunity to participate, including minority owned, woman owned and small businesses, in the roles of general contractors and subcontractors. If your company does not fall into either of these categories, your efforts to contract with vendors who fall in these categories are appreciated.

General Contractor will be required to maintain a subcontractor worksheet throughout the project and will submit the worksheet to County staff at any time requested but shall submit the worksheet at the completion of project.

END OF INVITATION FOR BIDS

Adult Detention Facility Building Automation System Replacement

INSTRUCTIONS TO BIDDERS

PROJECT: Adult Detention Facility Building Automation System Replacement
141 W Elm Street
Wichita, Ks 67203

COUNTY BID NUMBER: 26-0074

ARCHITECT: Schaefer Architecture
Justin Graham
257 N Broadway St, Wichita, KS 67202

Bids shall be made in accordance with these Instructions to Bidders:

- A. Responses to this invitation will be accepted only from General or Mechanical Contractors who are licensed to do business in Sedgwick County.
- B. Applications will also be accepted from General or Mechanical Contractors who have applied to receive a reciprocal license.
- C. A copy of Prime Contractor's Certificate of Insurance will be required to be submitted with the Bid at the time the bids are due. Insurance policy will be due from the successful contractor as part of the required documents prior to issuance of the notice to proceed.
- D. Bidding Documents shall include the Invitation for Bids, Bid Form, construction drawings, proposed Contract Documents, including any Addenda issued prior to receipt of Bids, supplemental information and any additional information requested.
- E. Bids must be on a lump sum basis and shall be the Contract Amount.
- F. Bidder Qualifications: For the duration of the project, all Prime Bidders shall be located within Sedgwick County, Kansas or establish an office in Sedgwick County, Kansas, and may be required by the Owner to furnish information to support the Bidder's capability to fulfill the Contract if awarded the Contract. Such information does not need to be submitted with the Bid, but may be requested at the Owner's option. Such information may include, but not be limited to, the following:
 - 1. Proof of registration with the Kansas Director of Taxation by non-resident Bidders (K.S.A. 79-1009).
 - 2. Proof of registration with the Kansas Secretary of State by foreign corporations.
 - 3. List of projects of similar size and type the Bidder has constructed or in which the Bidder has been engaged in a responsible capacity.
 - 4. Evidence the Bidder maintains a permanent place of business within Sedgwick County.
 - 5. A current financial statement.

Examination:

- 1. BEFORE SUBMITTING A BID, each Bidder shall examine carefully all documents pertaining to the work and visit the site to fully inform himself of the condition of the site and the conditions and limitations under which the work is to be performed.
- 2. SUBMISSION OF A BID will be considered presumptive evidence that the Bidder has fully informed himself of the conditions of the site, requirements of the Contract Documents, and of pertinent national, state and local codes and ordinances, and that the Bid made allowances for all conditions, requirements and contingencies.

Adult Detention Facility Building Automation System Replacement

3. In reviewing these Documents, it is evident that certain information, if disclosed to the public, may jeopardize the security of Sedgwick County, and appropriate measures will be taken to maintain confidentiality.
4. In order to ensure each bidder has the most current information for bidding there is an established date and time for last questions to be asked. Bidders requiring clarification or interpretation of the Bidding Documents shall make such requests, in writing only, to the Purchasing Agent no later than 5:00 p.m. on October 23, 2026.
5. Samples shall be submitted by the above referenced deadline to permit evaluation and notification of Bidders.
6. Any interpretation, correction or change of the Bidding Documents will be made by written Addenda. Interpretations, corrections, or changes of the Bidding Documents made in any other manner will not be binding, and Bidders shall not rely upon such interpretations, corrections, and changes.

Addenda:

1. DISCREPANCIES OR OMISSIONS in the documents will be clarified in the form of an electronic Addendum and will be posted on the County web site. Bidders finding discrepancies, omissions, or who are in doubt as to the meaning of any portion of the Contract Documents, should immediately request an interpretation from the Purchasing Agent. In response, an Addendum will be issued and the contractor shall rely solely on information contained in the written Addenda about said discrepancy or omission. **Neither the Architect nor the Owner will be responsible for any other form of instructions or interpretations given to the contractor, either verbal or written.**
2. ADDENDA received by Bidders shall be acknowledged by same on their Bid Form.

Substitutions:

1. Each Bidder represents that their Bid is based upon materials and equipment described in the Bidding Documents.
2. No substitution will be considered unless written request has been submitted to the Purchasing Agent and the Architect, in duplicate, for approval by 5:00 p.m. on **September 21, 2026**. Each such request shall include a complete description of the proposed substitute, drawings, cuts, performance or test data, or information necessary for a complete evaluation. If the Architect approves any proposed substitution, such approval will be set forth in an Addendum.

Preparation of Bids:

1. BIDS shall be made on unaltered Bid Forms furnished by the County, or detached from this Project Manual.
2. FILL IN all blanks on the Bid Form with ink or type. Blanks left on Bid Form may be cause for disqualification of Bidder.
3. SIGN BID FORM in longhand, with name typed below signature. Where Bidder is a Corporation, Bids must be signed with the legal name of the Corporation, followed by the legal signature of an officer authorized to bind the Corporation to a contract.
4. RECAPITULATION of work to be done shall not be included with any Bid.
5. Where so indicated by the makeup of the Bid Form, amounts shall be expressed in both words and figures, and in case of discrepancy between the two, the written amount shall govern.

Adult Detention Facility Building Automation System Replacement

Identification and Submission of Bid:

1. Contractor shall provide one (1) Original of the Bid Response Form, Bid Security and other supplemental information required to be submitted with the Bid.
2. All of the Bid Documents shall be enclosed in a sealed envelope with the notation "Bid Enclosed" on the face. The firm name and address, Bid number, Bid opening date, and Bid opening time shall be provided in the lower left-hand corner of the Envelope.

Modification and Withdrawal of Bid:

1. A Bid may not be modified, withdrawn or canceled by the Bidder during the stipulated time period that a Bidder's Bid Security is held following the time and date designated for the receipt of Bids. The Bidder so agrees in submitting his Bid.
2. WITHDRAWAL BEFORE BID OPENING: A Bid may be withdrawn at any time before Bid Opening, but may not be resubmitted. If a bidder withdraws a bid, as authorized in K.S.A. 75-6905, the awarding authority may require that such bidder shall not be allowed to perform any work on the project through subcontract agreements or by any other means including re-bids.
3. AFTER BID OPENING: No Bid may be withdrawn or modified, except where the award of contract has been delayed for more than 60 days.

In the event of an Award, the lowest, responsive, responsible and best bid price meeting the specifications will be required to enter into contract required for the Project. Said Bidder shall also provide a Performance Bond for the full amount of the contract. The Performance Bond, in the amount of 100% of the Contract amount, must be submitted within 30 calendar days after award of contract. Failure to return these Documents within the required time period may cause a cancellation of the Award.

Consideration of Bids/Selection Process:

1. Bids received will be opened and read aloud publicly.
2. Owner shall have the right to determine the acceptable Bidder on the basis of the sum of the Base Bid and the Alternates accepted.
3. The Owner will award a contract to the lowest, responsive, responsible and best Bidder provided:
 - a. The Bid conforms to and has been submitted according to the requirements of the Bidding Documents and includes the Certificate of Insurance including Contractor's General Automotive Liability, Workers Compensation Insurance and Owner's Liability Insurance.
 - b. The Bid is judged to be reasonable.
 - c. The Bid does not exceed the funds available.
 - d. The Bid complies with the Instruction to Bidders and Mandatory Requirements.
 - e. The completion time is satisfactory to the Owner.
 - f. Evidence of the experience, qualifications and financial responsibility of the Bidder and his Subcontractors and the time of completion are all satisfactory to the Owner.

Adult Detention Facility Building Automation System Replacement

- g. The County reserves the right to reject Bidders in accordance with the Bidding Documents.
4. Bids will be screened by a Review Committee consisting of the Project Manager, Architect and the Purchasing Agent.
5. No negotiations, decisions, or actions shall be initiated by any firm as a result of any verbal discussion with the Owner or employee of the Owner before the opening of responses to the document.
6. The Owner shall have the right to waive any informality and/or irregularity in any Bid received.
7. The Owner shall have the right to reject any and all Bids.

Time for Completion and Liquidated Damages:

All Bidders are required to state on the Bid Form the time needed for all work under the general contract to be completed, which would yield their best Bid. Unless otherwise required, this time frame shall be stated in calendar days and shall represent the Contractor's commitment to complete the project on schedule.

The contractual period will begin with the issuance of Notice to Proceed and continue through completion of the project.

The Agreement will include a stipulation that liquidated damages will be assessed in the amount of \$500.00 per calendar day after Completion Date that the work is not substantially complete.

Upon satisfactory completion of the Contract, a formal CERTIFICATE OF PROJECT COMPLETION will be forwarded to the Contractor by the Project Architect. The date of substantial completion of the Project will be the starting date of the warranty period.

All work shall be in accordance with all Federal and State Laws, Local Ordinances and Building Codes, and the 2010 Standards for Accessible Design.

Taxes: Materials and equipment incorporated in the work are exempt from payment of sales tax under the laws of the State of Kansas.

Project Time Line:

The following dates are provided in addition to those previously stated to help interested contractors in planning participation in the project herein. The dates listed, however, are in no way guaranteed and are subject to change without notice.

Project out for bid – Monday, September 21, 2026
Pre-bid Meeting – Tuesday, October 6, 2026, at 9:00 a.m.
Last questions received – Friday, October 23, 2026, at 5:00 p.m.
Last Addendum Issued – Friday, October 30, 2026, at 5:00 p.m.
Bids Due in Purchasing – Tuesday, November 10, 2026, at 1:45 p.m.
Bid Opening – Tuesday, November 10, 2026, at 3:00 p.m.
Board of Bids and Contracts – Thursday, November 19, 2026 at 10:00 a.m.
Board of County Commissioners – Wednesday, December 2, 2026 at 9:00 a.m.

Notice to Proceed:

Adult Detention Facility Building Automation System Replacement

No work shall commence until the Owner issues a Notice To Proceed, and a Notice To Proceed will not be issued until all of the following are mailed or delivered to the Project Services Office, 271 W 3rd St., Suite 325, Wichita, Kansas, 67202, by the selected vendor:

1. The Contract signed by the representative with authority and ability to do so.
2. Performance and Statutory Bonds with the attached powers of attorney. Attach the receipt of the Clerk of the District Court to the Statutory Bond.
3. List of subcontractors and supplier's proof of a valid Contractor's license from the jurisdiction in which the work is being performed for both contractor and applicable sub-contractors is required.
4. Corporate Resolution of authority to sign and deliver the Contract Documents, executed by the Corporation's Secretary or Assistant Secretary and dated before all other dated submittals.
5. Domestic (Kansas) corporations shall furnish evidence of good standing in the form of a Certificate signed by the Kansas Secretary of State. Foreign (non-Kansas) corporations shall furnish evidence of authority to transact business in Kansas, in the form of a Certificate signed by the Kansas Secretary of State.
6. Construction Schedule with major milestones identified.
7. Insurance Certification for Payment.

Such documents must be delivered within ten (10) days of the Owner's written notification to the successful Bidder. If they are not delivered within such time then the Bidder will be deemed to have abandoned its contract with the Owner, and the Owner will award a contract to the next lowest and best Bid.

1. The successful Bidder shall not make claim either for time or money against the Owner for labor or materials performed or delivered prior to issuance of the Notice to Proceed.
2. The County's responsibility to issue a Notice To Proceed is expressly conditioned on the Contractor's timely execution and delivery of such documents.
3. The County intends to issue a Notice To Proceed within 30 days of receipt of Bids.
4. Bidders shall also note that the Work cannot begin until after a State of Kansas Sales Tax Exemption Certificate has been provided by Sedgwick County and affixed to the Purchase Order and the Notice to Proceed.
5. Contractor must submit Insurance Policy.

END OF INSTRUCTIONS TO BIDDERS

Adult Detention Facility Building Automation System Replacement

BID FORM

BID PROVIDED BY:

(Company Name)

I have received the Bid Documents, Specifications, and Construction Documents, collectively known as the Contract Documents for Construction of the

Adult Detention Facility Building Automation System Replacement

COUNTY BID NUMBER: 26-0074

as prepared by the Architect: Justin Graham, AIA, Associate Architect
Schaefer Architecture
257 N. Broadway
Wichita, Kansas 67202-2303
Telephone: (316) 684-0171

In submitting this Bid, I agree:

1. To hold my Bid open for 60 days after the date of this Bid.
2. To enter into and execute a Contract, if awarded on the basis of this Bid, and to proceed in accordance with the requirements of the General Conditions and Contract Form.
3. To provide all labor, materials, equipment, tools of trades and labor, accessories, appliances, warranties and guarantees, and to pay all royalties, fees, permits, licenses and applicable taxes necessary to complete the work in accordance with the proposed Contract Documents.
4. To remove and haul away from the construction site any and all debris arising from this contract and to assume sole liability for all removal, handling, and dumping of debris.
5. To comply with any and all local, state, federal or other governmental laws, rules and regulations with respect to the transportation, disposal, and dumping of debris and other excavated materials and Contractor shall secure any and all necessary permits and approvals incident to said transportation, dumping and disposal.
6. To further agree to indemnify and hold the Owner and Designer harmless from any and all claims and/or damage of any kind whatsoever as a result of the Contractor's performance of this Contract.
7. That attached to this Bid is one copy of the Certificate of Insurance including Contractor's General Automotive Liability, Workers Compensation Insurance and Owner's Liability Insurance.

8. **CALENDAR DAYS:**

The Undersigned agrees to reach substantial completion of the Work in _____ consecutive calendar days from the date of Notice to Proceed.

The Undersigned agrees to reach final completion of the Work in _____ consecutive calendar days from the date of Substantial Completion.

Total Calendar Days _____

Adult Detention Facility Building Automation System Replacement

9. **BID:**
BASE BID
To complete the Base Bid Work, in the time stipulated, in accordance with the Bidding Documents as follows:

The Prime Contractor is to be a licensed General Contractor or licensed Mechanical Contractor.

Base Bid is to include items included in the Plans and Specifications (add additional descriptors and project requirements).

_____ Dollars (\$_____).

ALTERNATES:

Alternate 1: BAS Provider / Temperature Controls Contractor.

1. Building Controls and Services - Siemens Cost: \$ _____
2. C&C Group – Schneider Electric Cost: \$ _____
3. Dynamic Control Systems – Automated Logic Cost: _____
4. Five Star Mechanical – Reliable Controls Cost: \$ _____
5. Johnson Controls Cost: \$ _____
6. Sandifer Engineering & Controls, - Schneider Electric Cost:
\$ _____
7. The Trane Co. – Trane Controls Cost: \$ _____

Alternate 2: Multizone AHU Pre-heat Coils / BAS.

Description: For air handler units 5, 6, 7, 8, 9, 10, 11, 12, 17, 18, 19, 20, 21, 22, 23, 24, & 25 provide a pre-heat coil in the AHU. Include the labor, associated piping, piping specialties, ductwork, electrical, and temperature controls for each unit for a complete installation.

1. Building Controls and Services - Siemens Cost: \$ _____

Adult Detention Facility Building Automation System Replacement

2. C&C Group – Schneider Electric Cost: \$ _____

3. Dynamic Control Systems – Automated Logic Cost:
\$ _____

4. Five Star Mechanical – Reliable Controls Cost: \$ _____

5. Johnson Controls Cost: \$ _____

6. Sandifer Engineering & Controls, - Schneider Electric Cost:
\$ _____

7. The Trane Co. – Trane Controls Cost: \$ _____

Alternate 3: Chilled Water Pump VFD's / BAS.

Description: Provide variable frequency drives for the chilled water pumps as noted on the Plans. Differential pressure sensors, flow meters, control valves and electrical changes are to be included for a complete installation.

1. Building Controls and Services - Siemens Cost: \$ _____

2. C&C Group – Schneider Electric Cost: \$ _____

3. Dynamic Control Systems – Automated Logic Cost:
\$ _____

4. Five Star Mechanical – Reliable Controls Cost: \$ _____

5. Johnson Controls Cost: \$ _____

6. Sandifer Engineering & Controls, - Schneider Electric Cost:
\$ _____

7. The Trane Co. – Trane Controls Cost: \$ _____

Alternate 4: Heating Water Pump VFD's / BAS.

Description: Provide variable frequency drives for the heating water pumps as noted on the Plans. Differential pressure sensors and electrical are to be included for a complete installation.

1. Building Controls and Services - Siemens Cost: \$ _____

Adult Detention Facility Building Automation System Replacement

2. C&C Group – Schneider Electric Cost: \$ _____
3. Dynamic Control Systems – Automated Logic Cost:
\$ _____
4. Five Star Mechanical – Reliable Controls Cost: \$ _____
5. Johnson Controls Cost: \$ _____
6. Sandifer Engineering & Controls, - Schneider Electric Cost:
\$ _____
7. The Trane Co. – Trane Controls Cost: \$ _____

Alternate 5: Airflow Measuring Stations / BAS.

Description: Replace the existing airflow measuring stations as noted on the controls schematics. Include removal of the old airflow measuring stations, patching the associated ductwork, and electrical for a complete installation.

1. Building Controls and Services - Siemens Cost: \$ _____
2. C&C Group – Schneider Electric Cost: \$ _____
3. Dynamic Control Systems – Automated Logic Cost:
\$ _____
4. Five Star Mechanical – Reliable Controls Cost: \$ _____
5. Johnson Controls Cost: \$ _____
6. Sandifer Engineering & Controls, - Schneider Electric Cost:
\$ _____
7. The Trane Co. – Trane Controls Cost: \$ _____

10. **ADDENDA:**

The Bidder acknowledges receipt of the following numbered Addenda:

None () #1() #2() #3 () #4() #5()

Adult Detention Facility Building Automation System Replacement

11. **AGREEMENTS:**

The Undersigned agrees to the following terms and conditions:

- a. An incomplete Bid, or other information not requested which is written on this Bid Form, may be cause for rejection.
- b. Read the Invitation for Bids and the Instructions to Bidders carefully.
- c. The Owner reserves the right to reject any or all Bids and to waive all technicalities should such action be deemed to be in the best interest of the Owner.
- d. This Bid may not be withdrawn for a period of 60 calendar days following the receipt and opening.
- e. Failure to acknowledge receipt of any Addendum issued may be cause for Bid rejection.
- f. In the event that changes to the work are required, the undersigned agrees that ten percent (10% for Self-Perform, 5% for Sub, 3% for Sub of Sub) total between General and Subcontractors of his net costs shall be added thereto for Overhead, Profit and General Requirements (including but not limited to, Insurance and Bonds). Markup shall not be stacked; the Owner shall pay only the single percentage applicable to the tier actually performing the Work.

12. **MAJOR SUBCONTRACTORS:**

The Undersigned acknowledges the following named major subcontractors are to be used for their respective division of work. Contractors shall identify by type, any disadvantaged, minority and women-owned businesses used as a subcontractor for this project.

Subcontractor: _____

Address – City, State, Zip: _____

Additional, if necessary:

13. **DECLARATIONS:**

The Undersigned hereby declares he has carefully examined the Drawings and Specifications, has visited the actual location of the work, has satisfied himself as to all conditions and understands that, in signing this Bid Form, he waives all right to plead any misunderstandings regarding same and agrees to be bound by the provisions of said Drawings and Specifications and all statements made therein.

The Undersigned proposes to enter into Contract and to furnish and pay for the specified Bonds and other required Documents within 10 working days after notification of award of Contract.

14. **FIRM IDENTIFYING INFORMATION:**

FIRM NAME _____

CONTACT _____

SIGNATURE _____ TITLE _____

PRINT NAME _____

ADDRESS _____ CITY/STATE _____ ZIP _____

PHONE _____ FAX _____ HOURS _____

COMPANY WEBSITE ADDRESS _____ E-MAIL _____

Adult Detention Facility Building Automation System Replacement

NUMBER OF LOCATIONS _____ NUMBER OF PERSONS EMPLOYED _____

TYPE OF ORGANIZATION:

Public Corporation ____ Private Corporation ____ Sole Proprietorship ____ Partnership ____ Small Business ____

General Nature of Business _____

Manufacturer ____ Distributor ____ Retail ____ Dealer ____ Service ____

____ Not Minority/Caucasian (00) publicly traded companies and nonprofits are in this category

Minority Owned Business:

____ African American (05), ____ Asian Pacific (10), ____ Subcontinent Asian (15), ____ Hispanic (20),

____ Native American (25), ____ Other (30) - Please specify _____,

____ Not Minority/Caucasian – Woman Owned (50), ____ African American – Woman Owned (55),

____ Asian Pacific – Woman Owned (60), ____ Subcontinent Asian – Woman Owned (65), ____ Hispanic –

Woman Owned (70), ____ Native American – Woman Owned (75), ____ Other – Woman Owned (80)

Insurance registered in the State of Kansas with a minimum best rating of A-VIII: ____ Yes ____ No

15. SIGNATURE AND SEAL:

DATED THIS _____ DAY OF _____, 2024.

LEGAL NAME OF PERSON, FIRM OR CORPORATION

MAILING ADDRESS OF ABOVE

SIGNATURE

TELEPHONE NUMBER

FAX NUMBER

(Affix Corporate Seal here)

E-MAIL

REQUEST FOR BID CONDITIONS

In submitting a response to this Request for Bid, vendors hereby understand the following:

1. Pricing offered in the bid document will be provided to other local governments and governments whom Sedgwick County regularly enters into cooperative agreements.
2. Sedgwick County reserves the right to reject any and/or all bids and responses to these and/or related documents, to accept any item(s) in the bids, to waive any irregularity in the bids, and further if determined to be non-responsive in any form, or if determined to be in the best interest of Sedgwick County.
3. Alternate bids (two or more bids submitted) will be considered for an award. Sedgwick County reserves the right to make the final determination of actual equivalency or suitability of such bids with respect to requirements outlined herein. The bids submitted, and any further information acquired through interviews, will become and is to be considered a part of the final completed contract. If there is any variance or conflict, the bid specifications will control.
4. Bidders MUST return the entire document via email with any supplementary materials to purchasing@sedgwick.gov, on or before the date and time specified.
5. Bids submitted may not be withdrawn for a period of 60 days immediately following the opening of this Request for Bid. Prices MUST be free of federal, state, and local taxes unless otherwise imposed by a governmental body, and applicable to the material on the bid.
6. Sedgwick County interprets the term "Lowest Responsible and Best Bidder" as requiring Sedgwick County to: (a) choose between the kinds of materials, goods, wares, or services subject to the bid, and (b) determine which bid is most suitable for its intended use or purpose. Sedgwick County can consider, among other factors, such things as the availability of service(s), part(s) material(s) and/or supply(s), warranty, maintenance, freight costs, performance of product and labor cost of items upon which bids are received.
7. All requested information must be supplied. If bidders cannot respond to any part of this request, bidders should state the reason they cannot respond and note an exception. Bidders may provide supplemental information to assist Sedgwick County in analyzing its bid.
8. If the bidder refuses or fails to make deliveries of the materials within the times specified on the face of the Request for Bid or purchase order, Sedgwick County may, by written notice, terminate the contract or purchase order.
9. The bidder will certify and warrant that goods, personal property, chattels, and equipment sold and delivered are free and clear of any and all liens, or claims of liens, for materials or services arising under, and by virtue of the provisions of K.S.A. Sections 58-201, et seq., and any other lien, right, or claim of any nature or kind whatsoever.
10. The successful bidder will hold and save Sedgwick County, and its officers, agents, servants/employees harmless from liability of any patented, or unpatented invention, process, article, or appliance manufactured, or used in the performance of the contract, including its use by Sedgwick County. Vendors working on county property or on behalf of County will be required to carry minimum insurance listed in bid document.
11. All items furnished, if applicable, must be the best of their respective kinds, and will be free from defects in material and workmanship. Items will be subject to County inspection and approval at any time within 30 days after delivery. If a substitution is made, it will be the decision of a Sedgwick County representative to determine if it is of equal quality. Items furnished must be manufactured in compliance with all existing legal or governmental directives.
12. Unless specified otherwise, all items bid are to be as a minimum but not necessarily limited to: new, current model year, and untitled prior to shipping and/or installation.
13. Sedgwick County is desirous of allowing as many Kansas vendors as possible the opportunity to participate including minority men and women-owned businesses, and small businesses in the roles of providing goods and services to Sedgwick County. If your company does not fall into any of these categories, your efforts to contract with vendors who do fall into these categories are appreciated. Construction projects utilizing subcontractors requires a subcontracting worksheet. Contact Purchasing for details.
14. Contracts entered into on the basis of submitted bids are revocable if contrary to law.

15. County reserves the right to enter into agreements subject to the provisions of the Cash Basis Law (K.S.A. 10-1112 and 10-1113), the Budget Law (K.S.A. 79-2935). Agreements shall be construed and interpreted so as to ensure that the County shall at all times stay in conformity with such laws, and as a condition of agreements the County reserves the right to unilaterally sever, modify, or terminate agreements at any time if, in the opinion of its legal counsel, the Agreement may be deemed to violate the terms of such law.
16. The Bidder agrees to comply with K.S.A. 44-1030.
 - a. The contractor shall observe the provisions of the Kansas act against discrimination and shall not discriminate against any person in the performance of work under the present contract because of race, religion, color, sex, disability, national origin, or ancestry;
 - b. In all solicitations or advertisements for employees, the contractor shall include the phrase, "equal opportunity employer," or a similar phrase to be approved by the commission;
 - c. If the contractor fails to comply with the manner in which the contractor reports to the commission in accordance with the provisions of K.S.A. 44-1031 and amendments thereto, the contractor shall be deemed to have breached the present contract and it may be canceled, terminated or suspended, in whole or in part, by the contracting agency;
 - d. If the contractor is found guilty of a violation of the Kansas act against discrimination under a decision or order of the commission which has become final, the contractor shall be deemed to have breached the present contract and it may be canceled, terminated or suspended, in whole or in part, by the contracting agency; and
 - e. The contractor shall include the provisions of subsections (a) through (d) in every subcontract or purchase order so that such provisions will be binding upon such subcontractor or vendor.
17. All project participants, consultants, engineers, contractors and subcontractors, must comply with all applicable Federal, State and County laws pertaining to contracts entered into by governmental agencies. All participants must comply with the Americans with Disabilities Act (ADA), including the 2008 ADA Amendments Act, and 2010 ADA Standards for Accessible Design.
18. Contractors/subcontractors performing new construction, maintenance, alterations, or additions to Sedgwick County buildings or facilities must comply with building guidelines/codes, and the 2010 ADA Standards for Accessible Design. Any violation of the provisions of the ADA or 504, or specification deficiencies, should be reported to the county's ADA coordinator. Failure to notify the county's ADA coordinator for remedy may be considered a breach of contract and may be grounds for cancellation, termination for suspension, in whole or in any part of the contract. All construction plans will have the county's ADA coordinator approval prior to beginning any work.
19. Contractors/vendors providing services to the public on behalf of Sedgwick County will agree that all personnel in their employment that have direct contact with the public will attend ADA Awareness and Sensitivity training provided by Sedgwick County or the Independent Living Resource Center. Training should be coordinated through the county's ADA coordinator, (316) 660-7052 and evidence of training shall be provided to the county's ADA coordinator. Any violations of the provisions of ADA or section 504, will be deemed a breach of contract and be subject to termination of contract.
20. The successful bidder may have access to private or confidential data maintained by the County to the extent necessary to carry out its responsibilities of the contract. Contractor shall be responsible for compliance with the privacy provision of the Health Insurance Portability and Accountability Act (HIPAA) and shall comply with all other HIPAA provisions and regulations applicable. If the successful bidder is a business associate as that term is defined under HIPAA, the contract shall include the County's standard business associate addendum. A copy of that standard addendum is available on request.
21. The bidder responding to this bid solicitation proposes to furnish all materials, labor, supplies, equipment and incidentals necessary to provide the equipment/materials/services described herein in accordance with the Notification of Solicitation (if applicable), Request for Information (if applicable), Request for Bid, Addenda, Contract, Bonds, Insurance, Plans, Specifications, any Instructions, Mandatory Requirements and Conditions.
22. Unless specified elsewhere in the document, all prices quoted must be F.O.B. Destination, Freight Prepaid and Allowed, which will include all delivery, handling, and any other charges related to delivery including surcharges.
23. It will be understood that the bidder's sureties and insurers, as applicable, are subject to the approval of the County.
24. Prior to a vendor being awarded a contract, Domestic (Kansas) corporations shall 1) furnish evidence of good standing in the form of a Certificate signed by the Kansas Secretary of State. Foreign (non-Kansas) corporations shall furnish evidence of authority to transact business in Kansas, in the form of a Certificate signed by the Kansas Secretary of State; and 2) a copy of the Corporation Resolution evidencing the authority to sign the Contract Documents, executed by the Corporation's Secretary or Assistant Secretary.

25. Sedgwick County will not award to any vendor that is currently listed in the exclusion records of the SAM (System for Award Management) website maintained by the General Services Administration (GSA) or to any vendor presently debarred, suspended, proposed for debarment, or declared ineligible for the award of contracts by any Federal agency.
26. Sedgwick County reserves the right to conduct background checks at any time on new or existing vendors. Background checks will be used to evaluate eligibility to be engaged in a work capacity by Sedgwick County, and will not be used to discriminate on the basis of race, sex, age, color, religion, national origin, disability, genetic, sexual orientation or veteran status.
27. Upon award, the bidder agrees to execute and deliver to the County a contract in accordance with the contract documents (if applicable) within ten days of notice of the award to the bidder. The bidder agrees that the surety/deposit given concurrently herewith will become the property of the County in the event the bidder fails to execute and deliver such contract within the specified time. In the further event of such failure, the bidder will be liable for the County's actual damages that exceed the amount of the surety.
28. It will be understood that time is of the essence in the bidder's performance. The bidder agrees that the County's damages would be difficult or impossible to predict in the event of a default in the performance hereof; and it is therefore agreed that if the bidder defaults in the performance of the contract documents, the bidder will be liable for payment of the sums stipulated in the contract documents as liquidated damages, and not as a penalty.
29. The bidder hereby certifies that he or she has carefully examined all of the documents for the project, has carefully and thoroughly reviewed this Request for Bid, has inspected the location of the project (if applicable), and understands the nature and scope of the work to be done; and that this bid is based upon the terms, specifications, requirements, and conditions of the Request for Bid documents. The bidder further agrees that the performance time specified is a reasonable time, having carefully considered the nature and scope of the project as aforesaid.
30. It will be understood that any bid and any and/or all referencing information submitted in response to this Request for Bid will become the property of Sedgwick County, and will not be returned. As a governmental entity, Sedgwick County is subject to making records available for disclosure after Board of County Commission approval of the recommendation.
31. Sedgwick County will not be responsible for any expenses incurred by any vendor in the development of a response to this Request for Bid including any onsite (or otherwise) interviews and/or presentations, and/or supplemental information provided, submitted, or given to Sedgwick County and/or its representatives. Further, Sedgwick County will reserve the right to cancel the work described herein prior to issuance and acceptance of any contractual agreement/purchase order by the recommended vendor even if the Board of County Commissioners has formally accepted a recommendation.
32. By submission of a response, the bidder agrees that at the time of submittal, he or she: (1) has no interest (including financial benefit, commission, finder's fee, or any other remuneration) and will not acquire any interest, either direct or indirect, that would conflict in any manner or degree with the performance of bidder's services, or (2) benefit from an award resulting in a "Conflict of Interest". A "Conflict of Interest" will include holding or retaining membership, or employment, on a board, elected office, department, division or bureau, or committee sanctioned by and/or governed by the Sedgwick County Board of County Commissioners. Bidders will identify any interests, and the individuals involved, on separate paper with the response and will understand that the County, at the discretion of the Purchasing Director in consultation with the County Counselor, may reject their bid/quotation. The bidder certifies that this bid is submitted without collusion, fraud or misrepresentation as to other bidders, so that all bids for the project will result from free, open and competitive bidding among all vendors.
33. No gifts or gratuities of any kind shall be offered to any County employee at any time.
34. Sedgwick County will issue a purchase order/contract for the acquisition of products/services specified as a result of an award made in reference to this document. Contract documents will be subject to any regulations governed by the laws of the State of Kansas and any local resolutions specifically applicable to the purchase.
35. Any dispute arising out of the contract documents or their interpretation will be litigated only within the courts of the State of Kansas. No prepayment of any kind will be made prior to shipment. Payment will be made upon verification of delivery, compliance with specifications, assurance that the product/service performs as specified and warranted, and receipt of correct invoicing.

36. Sedgwick County will accept responses transmitted via email to purchasing@sedgwick.gov unless stated to the contrary within this document. Bids must be received prior to the time and dates listed to be considered responsive. Sedgwick County will not accept late responses and will return them to the sender. Further, Sedgwick County will NOT: (1) guarantee security of the document received; (2) be held responsible for Bids which are NOT legible (and may choose to reject such responses); and, (3) guarantee that the receiving facsimile machine will accept transmission or that phone lines are functioning and available for transmission. Submitting a bid response via email does NOT relieve the bidder of: (1) responsibilities stated in the document (such as attendance at a mandatory pre-bid conference); (2) providing non-paper informational items which must be returned with the response (diskettes, large drawings, photographs, models, etc.); and, (3) providing original copies of bid sureties (bonds, certificates of insurance, etc.).

Adult Detention Facility Building Automation System Replacement

BONDS

PERFORMANCE AND LABOR AND MATERIAL BONDS:

PERFORMANCE AND LABOR AND MATERIAL BONDS shall be furnished to the Owner by the Contractor, in an amount equal to 100 percent of the Contract Sum as security for the faithful performance of the contractor and payment of all persons performing labor and furnishing materials in connection with the contract. Said payment bond shall also be executed as a statutory bond and filed in the office of the Clerk of the District Court of the County in which the Project is located. Contractor shall provide the Owner with a certified copy of said statutory bond as so filed.

BONDS FURNISHED shall be written by a SURETY approved by the U.S. Treasury Dept. and licensed to do business in the State of Kansas. No Work shall be commenced until bonds are in force.

FORM OF BOND shall be Statutory Payment Bond – State of Kansas.

POWER OF ATTORNEY for the surety company agent must accompany each bond issued, and must be certified to include the date of the bonds.

PROVIDE TRIPLICATE COPIES of the bond forms and power of attorney.

COST of the bonds shall be included in the bid and paid for by the Contractor.

END OF SECTION

Adult Detention Facility Building Automation System Replacement

BOND TO THE STATE OF KANSAS STATUTORY PAYMENT BOND (K.S.A. 60-1111, as amended)

WITNESSETH: That _____ ("Principal"),
and _____ ("Surety"), are
hereby jointly and severally held and firmly bound unto the STATE OF KANSAS in the sum of
_____ dollars
(\$ _____) lawful money of the United States of America, for the use and
benefit of all persons entitled thereto and for the payment of which we hereby bind ourselves,
our successors, assigns, heirs, executors and administrators.

THE CONDITION OF THE OBLIGATION IS SUCH, THAT,

WHEREAS, the Principal has entered into an Agreement with Sedgwick County, Kansas dated
_____, 2026, for improvements described as the

Adult Detention Facility Building Automation System Replacement 141 W Elm St. Wichita, Ks 67203

(the "Work") according to the Contract Documents, which are incorporated herein by reference.

NOW, THEREFORE, if the Principal and its subcontractors shall pay all indebtedness incurred
for supplies, materials or labor furnished, used or consumed in connection with the Work
including gasoline, lubricating oils, fuel oils, grease, coal and similar items used or consumed
directly in furtherance of the Work, then this obligation is to be null and void; otherwise to remain
in full force and effect.

The Surety covenants and agrees that no change, extension of time, alteration or addition to the
Contract Documents or to the Work shall in any way reduce, nullify, or affect the Surety's
obligations on this bond; and the Surety hereby waives notice on any such change, extension of
time, alteration or additional to said Contract Documents or Work.

IN WITNESS WHEREOF, the parties hereto have caused this instrument to be executed and
delivered this _____ day of _____, 2026

Principal _____
Title _____
Surety _____
Title _____

Adult Detention Facility Building Automation System Replacement

PERFORMANCE BOND

WITNESSETH THAT, _____ (“Principal”) and
_____ (“Surety”) ARE HELD
AND FIRMLY BOUND UNTO THE BOARD OF COUNTY COMMISSIONERS OF SEDGWICK
COUNTY, KANSAS, (the “County”), for the use and benefit of claimants herein below identified
in the amount of:

_____ dollars (\$_____).
and in the amount of any change orders issued for the Work, for which payment Principal and
Surety bind themselves, their heirs, executors, administrators, successors and assigns, jointly
and severally, firmly by these presents.

THE CONDITION OF THIS OBLIGATION IS SUCH, THAT,

WHEREAS, Principal has by agreement dated _____, 2026 entered into a
contract with the County for the construction described as Building Automation System
Replacement 141 W Elm Street Wichita, Ks 67203 in accordance with the Contract Documents, RFB
#26-0074.

NOW, THEREFORE, if the Principal shall well and truly perform all the covenants, conditions,
and obligations of the Contract Documents and any Addenda and Change Orders and shall hold
the County and all interested property owners harmless against all claims, loss, damage,
demands, or causes of actions which they may sustain or suffer by reason of any breach of said
Contract Documents or of negligence of the Principal or of improper execution of the Work or
use of inferior materials by the Principal; and if said Principal shall maintain the improvements
as provided for in said Contract Documents and shall make good all defects in material and
workmanship for a period of one year, or for such other period as provided for in the Contract
Documents; then, this obligation shall be void: Otherwise to remain in full force and effect.

FURTHERMORE, the Surety consents and agrees that no price change, extension of time,
alteration, or addition to the terms of the Contract Documents or to the Work to be performed
thereunder shall in any way affect Surety’s obligation on this bond; and Surety hereby waives
notice of any such change, extension of time, alteration or addition to said Contract Documents.

IN WITNESS WHEREOF, the Principal and Surety have duly executed these presents all as of
the day and year first above written.

Principal _____
Title _____
Surety _____
Title _____

Adult Detention Facility Building Automation System Replacement

CERTIFIED COPY OF A RESOLUTION OF THE BOARD OF DIRECTORS OF _____ A KANSAS CORPORATION

The undersigned, being the duly elected qualified and acting Secretary of _____, a Kansas corporation (the "Corporation"), hereby certifies as follows:

At a special meeting of the board of directors of the Corporation, held _____, 2026, when meeting was duly and properly called according to the by-laws of the Corporation and at which a quorum of said board was present, the following resolution was passed and adopted:

"WHEREAS, the Corporation desires to contract with Sedgwick County, Kansas (the "County") for the construction of certain public improvements, and,

"WHEREAS, the Corporation desires to authorize certain officers of the Corporation to execute and deliver to the County all agreements and documents related thereto.

"NOW, THEREFORE, BE IT RESOLVED BY THE BOARD OF DIRECTORS OF _____, a Kansas corporation, that _____ (name), _____ (title), of the Corporation, be and is hereby authorized to execute and deliver to the County all contracts and documents incidental thereto, including but not limited to statutory bonds, construction bonds, insurance agreements and policies, plans and specifications, and any further documents required thereby, relating or pertaining to the following described project

**Adult Detention Facility Building Automation System Replacement
141 W Elm St. Wichita, Ks 67203
RFB # 26-0074**

"BE IT FURTHER RESOLVED BY THE BOARD OF DIRECTORS OF THE CORPORATION that the authority conferred hereby upon such officer is continuing unless notice in writing be given by the Corporation to the County."

DATED this _____ day of _____, 2026.

(SEAL)

Secretary

Adult Detention Facility Building Automation System Replacement

EXHIBIT A

Liability insurance coverage indicated below must be considered as primary and not as excess insurance. If required, Contractor's professional liability/errors and omissions insurance shall (i) have a policy retroactive date prior to the date any professional services are provided for this project, and (ii) be maintained for a minimum of 3 years past completion of the project. Contractor shall furnish a certificate evidencing such coverage, with County listed as an additional insured including both ongoing and completed operations, except for professional liability, workers' compensation and employer's liability.

Certificate shall be provided prior to award of contract. Certificate shall remain in force during the duration of the project/services and will not be canceled, reduced, modified, limited, or restricted until thirty (30) days after County receives written notice of such change. All insurance must be with an insurance company with a minimum BEST rating of A-VIII and licensed to do business in the State of Kansas **(must be acknowledged on the bid/proposal response form).**

NOTE: If any insurance is subject to a deductible or self-insured retention, written disclosure must be included in your proposal response and also be noted on the certificate of insurance.

It is the responsibility of Contractor to require that any and all approved subcontractors meet the minimum insurance requirements.

Workers' Compensation:	
Applicable coverage per State Statutes	
Employer's Liability Insurance:	\$500,000.00
Commercial General Liability Insurance (on form CG 00 01 04 13 or it's equivalent):	
Each Occurrence	\$1,000,000.00
General Aggregate, per project	\$2,000,000.00
Personal Injury	\$1,000,000.00
Products and Completed Operations Aggregate	\$2,000,000.00
Automobile Liability:	
Combined single limit	\$500,000.00
Umbrella Liability:	
Following form for both the general liability and automobile	
<u> X </u> Required/ <u> </u> Not Required	
Each Claim	\$1,000,000.00
Aggregate	\$1,000,000.00
Professional Liability/ Errors & Omissions Insurance:	
<u> </u> Required/ <u> X </u> Not Required	
Each Claim	\$1,000,000.00
Aggregate	\$1,000,000.00
Pollution Liability Insurance:	
<u> X </u> Required/ <u> </u> Not Required	
Each Claim	\$1,000,000.00
Aggregate	\$1,000,000.00

Special Risks or Circumstances:

Entity reserves the right to modify, by written contract, these requirements, including limits, based on the nature of the risk, prior experience, insurer, coverage, or other special circumstances.

CONTRACTOR IS PROVIDING CONSTRUCTION SERVICES:

In addition to the above coverages, Contractor shall also provide the following:

Builder's Risk Insurance:	In the amount of the initial Contract Sum, plus the value of subsequent modifications and cost of materials supplied and installed by others, comprising the total value for the entire Project on a replacement cost basis without optional deductibles. Entity, Contractor, and all Subcontractors shall be included as named insureds.
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PROJECT SUBCONTRACTING WORK SHEET

Project Name: Adult Detention Facility Building Automation System Replacement

Check here if you are not using subcontractors ☐

Request for Bid #:	26-0074
Prime Contractor:	
Created by:	

Prime Contractors shall provide the name, description, DBE classification (type) Minority Certification #, date of work and dollar value for each subcontractor (including lower-tier subcontractors) used to complete the referenced project. Contractors may be required to provide backup documentation to verify information. Each column requires input.

DBE classification type: African American (1); Asian (2); Hispanic (3); Native American (4); other minority (5); Women Owned Business (6). Additional general classifications: Small Business Owner (7); Does not meet any classification (0).

	Subcontractor Name and Address	Type	Jurisdiction Name & Minority Certification # (if vendor has one)	Description of Services	Date of Work	Dollar Value of work
1.						
2.						
3.						
4.						
5.						
6.						
7.						
8.						
9.						
10.						

Form shall be submitted to Purchasing at the completion of project.

SECTION 01 10 00 - SUMMARY**PART 1 GENERAL****1.01 PROJECT**

- A. Project Name: Sedgwick County ADF BAS Replacement
- B. Owner's Name: Sedgwick County.
- C. The Project consists of the replacement of the Building Automation System at the Sedgwick County Adult Detention Facility.
- D. Contract to be awarded to a licensed General Contractor or licensed Mechanical Contractor. Only one Building Automation System provider will be selected as a Sub-Contractor to the General Contractor or Mechanical Contractor. References to General Contractor hereafter shall refer to the Contractor the prime contract with Owner has been awarded to.

1.02 DESCRIPTION OF ALTERATIONS WORK

- A. Scope of demolition and removal work is indicated on drawings and specified in Section 02 41 00.
- B. HVAC: Alter existing system and add new construction, keeping existing in operation.
- C. Electrical Power: Alter existing system and add new construction, keeping existing in operation.

1.03 OWNER OCCUPANCY

- A. Owner intends to continue to occupy the building during the entire construction period.
 - 1. Cooperate with Owner during construction operations to minimize conflicts and facilitate Owner usage. Perform the Work so as not to interfere with the day-to-day operations of the Owner. Maintain existing exits unless otherwise indicated
 - 2. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
 - 3. Notify the Owner not less than 72 hours in advance of activities that will affect the operations of the Owner.
- B. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.
- C. Schedule the Work to accommodate Owner occupancy.

1.04 CONTRACTOR USE OF SITE AND PREMISES

- A. Construction Operations: _____.
 - 1. Do not disturb portions of Project site beyond areas in which the Work is indicated.
- B. Arrange use of site and premises to allow:
 - 1. Owner occupancy.
 - 2. Work by Others.
- C. Provide access to and from site as required by law and by Owner:
 - 1. Emergency Building Exits During Construction: Keep all exits required by code open during construction period; provide temporary exit signs if exit routes are temporarily altered.
 - 2. Provide temporary exiting pathways where required or as indicated.
 - 3. Do not obstruct roadways, sidewalks, or other public ways without permit.

- D. Existing building spaces may not be used for storage.
- E. Utility Outages and Shutdown:
 - 1. Do not disrupt utility services to the building unless absolutely necessary and fully coordinated with the Owner.
 - 2. Do not disrupt or shut down life safety systems, including but not limited to fire sprinklers and fire alarm system, without 7 days notice to Owner and authorities having jurisdiction.
 - 3. Prevent accidental disruption of utility services to other facilities.
 - 4. Do not disrupt or shut down power to LAN/WAN systems without coordination with the Owner. It is the responsibility of the General Contractor to identify these locations with assistance from the Owner prior to starting any Work.
- F. Controlled Substances: Use of tobacco products and other controlled substances within the new or existing building or the Project site is not permitted.

1.05 WORK SEQUENCE

- A. Coordinate construction schedule and operations with Owner.

1.06 PERMANENT UTILITIES

- A. Owner will pay the direct cost from the utility company for the permanent service for the following:
 - 1. Electric.
 - 2. Gas.
 - 3. Water.
 - 4. Telephone.
 - 5. Cable.
 - 6. Fiber.
- B. All other fees and Work shall be included in the cost of Bid.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION - NOT USED****END OF SECTION**

SECTION 01 23 00 - ALTERNATES**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Description of Alternates.
- B. Procedures for pricing Alternates.

1.02 ALTERNATES - GENERAL

- A. Alternates are units of Work (products, materials, equipment, systems, methods and the like) which may, at the option of the Owner and under terms established in the Instructions to Bidders and Agreement, be selected for the Work in lieu of the corresponding requirements for Base Bid or to complete a unit of work not included in the Base Bid Work.
- B. Selection may be made prior to Contract Date, or may by the Agreement, be deferred for possible selection at a subsequent date.
- C. Refer to the Contract or Owner-Contractor Agreement, and subsequent modifications thereof (if any), for the determination of which Alternates have been accepted and therefore are in effect as though included originally in the Base Bid Work.
- D. Immediately following the award of Contract notify each entity or person involved in the performance of this project work, a notice of the status of each Alternate Bid indicating which Alternates have been: 1) accepted, 2) rejected, 3) deferred for consideration at a later date. Include description of modifications, if any, to the accepted Alternates.
- E. The Alternates herein are abbreviated descriptions but imply that each change must be complete for the scope of the work affected. A reference to this Section is included in specification sections to alert specification users that an alternate will affect that work. The Specifications and Drawings shall be referred to ascertain complete requirements for the Alternate Work. Coordinate related work and modify surrounding work as required to properly integrate or omit the work of the accepted Alternates.

1.03 ACCEPTANCE OF Alternates

- A. Alternates quoted on Bid Forms will be reviewed and accepted or rejected at Owner's option. Accepted Alternates will be identified in the Owner-Contractor Agreement.
- B. Fill in all required prices on the Bid Form.
- C. Alternates will be accepted by the Owner as follows:
 - 1. The Alternates are not listed in order of importance and such listing shall not limit nor dictate the order of acceptance by the Owner.
- D. Coordinate related work and modify surrounding work to integrate the Work of each Alternate.

1.04 SCHEDULE OF Alternates

- A. **Alternate No. One - BAS Provider / Temperature Controls Contractor: Indicate cost for each vendor's Work on the Bid Form.**
- B. **Alternate No. Two - Multizone AHU Pre-heat Coils / BAS: For air handler units 5, 6, 7, 8, 9, 10, 11, 12, 17, 18, 19, 20, 21, 22, 23, 24, & 25 provide a pre-heat coil in the AHU. Include the labor, associated piping, piping specialties, ductwork, electrical, and temperature controls for each unit for a complete installation. Provide cost for each vendor's work on the Bid Form.**

- C. **Alternate No. Three - Chilled Water pump VFD's / BAS: Provide variable frequency drives for the chilled water pumps as noted on the Plans. Differential pressure sensors, flow meters, control valves and electrical changes are to be included for a complete installation. Provide cost for each vendor's work on the Bid Form.**
- D. **Alternate No. Four - Heating Water Pump VFD's / BAS: Provide variable frequency drives for the heating water pumps as noted on the Plans. Differential pressure sensors and electrical are to be included for a complete installation. Provide cost for each vendor's work on the Bid Form.**
- E. **Alternate No. [Five] - [Airflow Measuring Stations / BAS]: Replace the existing airflow measuring stations as noted on the controls schematics. Include removal of the old airflow measuring stations, patching the associated ductwork, and electrical for a complete installation. Provide cost for each vendor's work on the Bid Form.**

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 30 00 - ADMINISTRATIVE REQUIREMENTS**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. General administrative requirements.
- B. Copyright.
- C. AIA Documents.
- D. Electronic document submittal service.
- E. Preconstruction meeting.
- F. Progress meetings.
- G. Construction progress schedule.
- H. Contractor's daily reports.
- I. Progress photographs.
- J. Submittals for review, information, and project closeout.
- K. Number of copies of submittals.
- L. Requests for Interpretation (RFI) procedures.
- M. Additional Architectural or Engineering Work.
- N. Submittal procedures.

1.02 GENERAL ADMINISTRATIVE REQUIREMENTS

- A. Comply with requirements of Section 01 70 00 - Execution and Closeout Requirements for coordination of execution of administrative tasks with timing of construction activities.
- B. Make the following types of submittals to Schaefer Architecture:
 - 1. Requests for Interpretation (RFI).
 - 2. Requests for substitution.
 - 3. Shop drawings, product data, and samples.
 - 4. Test and inspection reports.
 - 5. Design data.
 - 6. Manufacturer's instructions and field reports.
 - 7. Applications for payment and change order requests.
 - 8. Progress schedules.
 - 9. Coordination drawings.
 - 10. Correction Punch List and Final Correction Punch List for Substantial Completion.
 - 11. Closeout submittals.

1.03 COPYRIGHT

- A. The Drawings and Project Manual of the Project are copyrighted by Schaefer Architecture and consultants. Said drawings, details and specifications shall NOT be reproduced in any manner by any contractor, sub-contractor, supplier, or manufacturer for the purpose of preparing required submittals unless specifically directed to do so by these documents.

1.04 AIA DOCUMENTS

- A. Documents of the American Institute of Architects referred to in the specifications can be purchased by the Contractors from:
 - 1. AIA Kansas, Phone (785) 357-5308 or (800) 444-9853.

- B. **Contractors are cautioned that the AIA documents required under this Contract are copyrighted by the AIA.**

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 ELECTRONIC DOCUMENT SUBMITTAL SERVICE

- A. All documents transmitted for purposes of administration of the contract are to be in electronic (PDF) format, as appropriate to the document, and transmitted via an Internet-based submittal service that receives, logs and stores documents, provides electronic stamping and signatures, and notifies addressees via email.
1. Besides submittals for review, information, and closeout, this procedure applies to Requests for Interpretation (RFIs), progress documentation, contract modification documents (e.g. supplementary instructions, change proposals, change orders), applications for payment, field reports and meeting minutes, Contractor's correction punchlist, and any other document any participant wishes to make part of the project record.
 - a. Allows for documents to be uploaded.
 2. Contractor and Schaefer Architecture are required to use this service.
 3. It is Contractor's responsibility to submit documents in allowable format.
 4. Subcontractors, suppliers, and Schaefer Architecture's consultants are to be permitted to use the service at no extra charge.
 5. Users of the service need an email address, internet access, and PDF review software that includes ability to mark up and apply electronic stamps (such as Adobe Acrobat, www.adobe.com, or Bluebeam PDF Revu, www.bluebeam.com), unless such software capability is provided by the service provider.
 6. Paper document transmittals will not be reviewed; emailed electronic documents will not be reviewed.
 7. All other specified submittal and document transmission procedures apply, except that electronic document requirements do not apply to samples or color selection charts.
 8. Automatic CD archive once construction is complete.
- B. Cost: The cost of the service is to be paid by Contractor; include the cost of the service in the Contract Sum.
- C. Submittal Service: Use one of the following:
1. Submittal Exchange (tel: 1-800-714-0024): www.submittalexchange.com/#sle.
 2. Newforma ConstructEx: www.newforma.com/our-solutions/constructex/#sle.
 3. Procore (tel: 1-866-477-6267): www.procore.com
- D. Training: One, one-hour, web-based training session will be arranged for all participants, with representatives of Schaefer Architecture and Contractor participating; further training is the responsibility of the user of the service.
- E. Project Closeout: Schaefer Architecture will determine when to terminate the service for the project and is responsible for obtaining archive copies of files for Owner.

3.02 PRECONSTRUCTION MEETING

- A. Schaefer Architecture will schedule a meeting after Notice of Award.
- B. Attendance Required:

1. Owner.
 2. Schaefer Architecture.
 3. Contractor.
 4. Major Sub-contractors.
- C. Agenda:
1. Submission of list of subcontractors, list of products, schedule of values, and progress schedule.
 2. Designation of personnel representing the parties to Contract, _____ and Schaefer Architecture.
 3. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.
 4. Scheduling.
- D. Record minutes and distribute copies within two days after meeting to participants, with an electronic copy in PDF format to Schaefer Architecture, Owner, participants, and those affected by decisions made.

3.03 PROGRESS MEETINGS

- A. Schedule and administer meetings throughout progress of the work at maximum bi-monthly intervals.
- B. Make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.
- C. Attendance Required:
1. Contractor.
 2. Owner.
 3. Schaefer Architecture.
 4. Contractor's superintendent.
 5. Major subcontractors.
- D. Agenda:
1. Review minutes of previous meetings.
 2. Review of work progress.
 3. Field observations, problems, and decisions.
 4. Identification of problems that impede, or will impede, planned progress.
 5. Review of submittals schedule and status of submittals.
 6. Review of RFIs log and status of responses.
 7. Review of off-site fabrication and delivery schedules.
 8. Maintenance of progress schedule.
 9. Corrective measures to regain projected schedules.
 10. Planned progress during succeeding work period.
 11. Coordination of projected progress.
 12. Maintenance of quality and work standards.
 13. Effect of proposed changes on progress schedule and coordination.
 14. Other business relating to work.
- E. Record minutes and distribute copies within two days after meeting to participants, with an electronic copy in PDF format to Schaefer Architecture, Owner, participants, and those affected by decisions made.

3.04 CONSTRUCTION PROGRESS SCHEDULE

- A. Within 10 days after date of the Agreement, submit preliminary schedule defining planned operations for the first 60 days of work, with a general outline for remainder of work.
- B. If preliminary schedule requires revision after review, submit revised schedule within 10 days.
- C. Within 15 days after review of preliminary schedule, submit draft of proposed complete schedule for review.
 - 1. Include written certification that major contractors have reviewed and accepted proposed schedule.
- D. Within 10 days after joint review, submit complete schedule.
- E. Submit updated schedule every 30 days.

3.05 DAILY CONSTRUCTION REPORTS

- A. Include only factual information. Do not include personal remarks or opinions regarding operations and/or personnel.
- B. Prepare a daily construction report recording the following information concerning events at Project site and project progress:
 - 1. Date.
 - 2. High and low temperatures, and general weather conditions.
 - 3. Safety, environmental, or industrial relations incidents.
 - 4. Meetings and significant decisions.
 - 5. Stoppages, delays, shortages, and losses. Include comparison between scheduled work activities (in Contractor's most recently updated and published schedule) and actual activities. Explain differences, if any. Note days or periods when no work was in progress and explain the reasons why.
 - 6. Testing and/or inspections performed.
 - 7. Signature of Contractor's authorized representative.

3.06 PROGRESS PHOTOGRAPHS

- A. Photography Type: Digital; electronic files.
- B. Provide photographs of site and construction. Take photographs during construction activities where work will be concealed and throughout progress of Work. Photographs may be used to establish location and arrangement of concealed elements such as plumbing systems. These shall be part of the record documents.
- C. Digital Photographs: 24 bit color, minimum resolution of 1024 by 768, in JPG format; provide files unaltered by photo editing software.
 - 1. Delivery Medium: Jump drive.
 - 2. File Naming: Include project identification, date and time of view, and view identification.

3.07 REQUESTS FOR INTERPRETATION (RFI)

- A. Definition: A request seeking one of the following:
 - 1. An interpretation, amplification, or clarification of some requirement of Contract Documents arising from inability to determine from them the exact material, process, or system to be installed; or when the elements of construction are

- required to occupy the same space (interference); or when an item of work is described differently at more than one place in Contract Documents.
2. A resolution to an issue which has arisen due to field conditions and affects design intent.
- B. Whenever possible, request clarifications at the next appropriate project progress meeting, with response entered into meeting minutes, rendering unnecessary the issuance of a formal RFI.
- C. Preparation: Prepare an RFI immediately upon discovery of a need for interpretation of Contract Documents. Failure to submit a RFI in a timely manner is not a legitimate cause for claiming additional costs or delays in execution of the work.
1. Prepare a separate RFI for each specific item.
 - a. Do not forward requests which solely require internal coordination between subcontractors.
 2. Prepare using software provided by the Electronic Document Submittal Service.
 3. Combine RFI and its attachments into a single electronic file. PDF format is preferred.
- D. Reason for the RFI: Prior to initiation of an RFI, carefully study all Contract Documents to confirm that information sufficient for their interpretation is definitely not included.
1. Include in each request General Contractor's signature attesting to good faith effort to determine from Contract Documents information requiring interpretation.
 2. Unacceptable Uses for RFIs: Do not use RFIs to request the following:
 - a. Approval of submittals (use procedures specified elsewhere in this section).
 - b. Approval of substitutions (see Section - 01 60 00 - Product Requirements)
 - c. Changes that entail change in Contract Time and Contract Sum (comply with provisions of the Conditions of the Contract).
 - d. Different methods of performing work than those indicated in the Contract Drawings and Specifications (comply with provisions of the Conditions of the Contract).
 3. Improper RFIs: Requests not prepared in compliance with requirements of this section, and/or missing key information required to render an actionable response. They will be returned without a response.
 4. Frivolous RFIs: Requests regarding information that is clearly indicated on, or reasonably inferable from, the Contract Documents, with no additional input required to clarify the question. They will be returned without a response.
- E. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.
- F. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.
- G. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.
1. Indicate current status of every RFI. Update log promptly and on a regular basis.
 2. Note dates of when each request is made, and when a response is received.
- H. Review Time: Schaefer Architecture will respond and return RFIs to Contractor within seven calendar days of receipt. For the purpose of establishing the start of the mandated response period, RFIs received after 12:00 noon will be considered as having been received on the following regular working day.

1. Response period may be shortened or lengthened for specific items, subject to mutual agreement, and recorded in a timely manner in progress meeting minutes.
- I. Responses: Content of answered RFIs will not constitute in any manner a directive or authorization to perform extra work or delay the project. If in Contractor's belief it is likely to lead to a change to Contract Sum or Contract Time, promptly issue a notice to this effect, and follow up with an appropriate Change Order request to Owner.
 1. Response may include a request for additional information, in which case the original RFI will be deemed as having been answered, and an amended one is to be issued forthwith. Identify the amended RFI with an R suffix to the original number.
 2. Do not extend applicability of a response to specific item to encompass other similar conditions, unless specifically so noted in the response.
 3. Upon receipt of a response, promptly review and distribute it to all affected parties, and update the RFI Log.

3.08 ADDITIONAL ARCHITECTURAL OR ENGINEERING WORK

- A. Design has been based upon product and equipment data available at the time the design work was done.
- B. Any costs for modifying construction and design for substitutes shall be the responsibility of the party making or requesting the substitute for the designed product even when the substitute product is specified. Such costs shall be paid to the Owner who shall reimburse the architect and/or consultants. The rate charged by Schaefer Architecture is \$120 per hour. Consulting Engineers standard rates apply.

3.09 SUBMITTAL SCHEDULE

- A. Items requiring color selections, including mechanical and electrical devices, will not be made until Contractor submits all data and samples for selecting colors and finishes.

3.10 SUBMITTALS FOR REVIEW

- A. When the following are specified in individual sections, submit them for review:
 1. Product data.
 2. Shop drawings.
 3. Samples for selection.
 4. Samples for verification.
- B. Submit to Schaefer Architecture for review for the limited purpose of checking for compliance with information given and the design concept expressed in Contract Documents.
- C. Samples will be reviewed for aesthetic, color, or finish selection.
 1. Physical sample(s) showing the color and other physical properties is required for selection. Electronic images or PDF's will not be reviewed for sample selection. Printed cards or brochures not containing actual physical color and finish sample(s) will not be accepted.
- D. After review, provide copies and distribute in accordance with SUBMITTAL PROCEDURES article below and for record documents purposes described in Section 01 78 00 - Closeout Submittals.

3.11 SUBMITTALS FOR INFORMATION

- A. When the following are specified in individual sections, submit them for information:
 1. Design data.

2. Certificates.
3. Test reports.
4. Inspection reports.
5. Manufacturer's instructions.
6. Manufacturer's field reports.
7. Other types indicated.

B. Submit for Schaefer Architecture's knowledge as contract administrator or for Owner.

3.12 SUBMITTALS FOR PROJECT CLOSEOUT

- A. Submit Final Correction Punch List for Substantial Completion.
- B. When the following are specified in individual sections, submit them at project closeout in compliance with requirements of Section 01 78 00 - Closeout Submittals:
 1. Project record documents.
 2. Operation and maintenance data.
 3. Warranties.
 4. Other types as indicated.
- C. Submit for benefit of the Owner during and after project completion.

3.13 NUMBER OF COPIES OF SUBMITTALS

- A. Electronic Documents: Submit one electronic copy in PDF format; an electronically-marked up file will be returned. Create PDFs at native size and right-side up; illegible files will be rejected.
- B. Samples: Submit the number specified in individual specification sections; one of which will be retained by Schaefer Architecture.
 1. Retained samples will not be returned to Contractor unless specifically so stated.

3.14 SUBMITTAL PROCEDURES

- A. General Requirements:
 1. Use a separate transmittal for each item.
 2. Transmit using approved form.
 - a. Use form generated by Electronic Document Submittal Service software.
 3. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
 4. Apply Contractor's stamp, signed or initialed certifying that review, approval, verification of products required, field dimensions, adjacent construction work, and coordination of information is in accordance with the requirements of the work and Contract Documents.
 - a. Submittals from sources other than the Contractor, or without Contractor's stamp will not be acknowledged, reviewed, or returned.
 5. Schedule submittals to expedite the Project, and coordinate submission of related items.
 - a. For each submittal for review, allow 15 days time to and from the Contractor.
 - b. For sequential reviews involving Schaefer Architecture's consultants, Owner, or another affected party, allow an additional 7 days.
 6. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
 7. Provide space for Contractor and Schaefer Architecture review stamps.

8. When revised for resubmission, identify all changes made since previous submission.
 9. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
 10. Incomplete submittals will not be reviewed, unless they are partial submittals for distinct portion(s) of the work, and have received prior approval for their use.
- B. Product Data Procedures:
1. Submit only information required by individual specification sections.
 2. Collect required information into a single submittal.
 3. Do not submit (Material) Safety Data Sheets for materials or products.
- C. Shop Drawing Procedures:
1. Digital Data Files: Electronic copies of CAD drawings or Building Information Model of the Contract Drawings will be provided by Schaefer Architecture, Engineers or Consultants for Contractor's use in preparing submittals as follows.
 - a. Cost for each CAD sheet is \$150.00.
 - b. Cost for Navisworks model is \$300.00.
 - c. Contractor to sign Electronic Release Form and pay Schaefer Architecture prior to receiving CAD sheet(s) or Navisworks model.
 - d. Schaefer Architecture makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings.
 2. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting Contract Documents and coordinating related work.
 3. Do not reproduce Contract Documents to create shop drawings.
 4. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

3.15 SUBMITTAL REVIEW

- A. Submittals for Review: Schaefer Architecture will review each submittal, and approve, or take other appropriate action.
- B. Submittals for Information: Schaefer Architecture will acknowledge receipt and review. See below for actions to be taken.
- C. Schaefer Architecture's actions will be reflected by marking each returned submittal using virtual stamp on electronic submittals.
1. Notations may be made directly on submitted items and/or listed on appended Submittal Review cover sheet.
- D. Schaefer Architecture's and consultants' actions on items submitted for review:
1. Authorizing purchasing, fabrication, delivery, and installation:
 - a. "No exception taken", or language with same legal meaning.
 - b. "Make corrections noted", or language with same legal meaning.
 - 1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
 - c. "Submit specified item", or language with same legal meaning.
 - 1) Submit correct item, with review notations acknowledged and incorporated. Submit separately, or as part of project record documents.
 2. Not Authorizing fabrication, delivery, and installation:

- a. "Revise and Resubmit".
 - 1) Resubmit revised item, with review notations acknowledged and incorporated.
- b. "Rejected".
 - 1) Submit item complying with requirements of Contract Documents.
- E. Schaefer Architecture's and consultants' actions on items submitted for information:
 - 1. Items for which no action was taken:
 - a. "Received" - to notify the Contractor that the submittal has been received for record only.
 - 2. Items for which action was taken:
 - 3. "Reviewed" - no further action is required from Contractor.
- F. Maintain one complete set of submittals at the Project.

END OF SECTION

SECTION 01 40 00 - QUALITY REQUIREMENTS**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Submittals.
- B. Quality assurance.
- C. References and standards.
- D. Control of installation.
- E. Tolerances.
- F. Defect Assessment.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Certificates: When specified in individual specification sections, submit certification by the manufacturer and General Contractor or installation/application subcontractor to Schaefer Architecture, in quantities specified for Product Data.
 - 1. Indicate material or product complies with or exceeds specified requirements. Submit supporting reference data, affidavits, and certifications as appropriate.
 - 2. Certificates may be recent or previous test results on material or product, but must be acceptable to Schaefer Architecture.
- C. Manufacturer's Instructions: When specified in individual specification sections, submit printed instructions for delivery, storage, assembly, installation, start-up, adjusting, and finishing, for the Owner's information. Indicate special procedures, perimeter conditions requiring special attention, and special environmental criteria required for application or installation.

1.03 QUALITY ASSURANCE

- A. Designer Qualifications: Where professional engineering design services and design data submittals are specifically required of General Contractor by Contract Documents, provide services of a Professional Engineer experienced in design of this type of work and licensed in Kansas.

1.04 REFERENCES AND STANDARDS

- A. For products and workmanship specified by reference to a document or documents not included in the Project Manual, also referred to as reference standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by applicable codes.
 - 1. If compliance with two or more standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer conflicting requirements that are different, but apparently equal, to Schaefer Architecture for a decision before proceeding. Refer instances of uncertainty as to which two levels of quantity or quality is more stringent to Schaefer Architecture for decision.
- B. Comply with reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.
- C. Should specified reference standards conflict with Contract Documents, request clarification from Schaefer Architecture before proceeding.

1. Schaefer Architecture may select the more stringent of the two for the application intended.
- D. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Schaefer Architecture shall be altered from Contract Documents by mention or inference otherwise in any reference document.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.01 CONTROL OF INSTALLATION**

- A. Monitor quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.
- B. Comply with manufacturers' instructions, including each step in sequence.
- C. Should manufacturers' instructions conflict with Contract Documents, request clarification from Schaefer Architecture before proceeding.
- D. Comply with specified standards as minimum quality for the work except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
- E. Where drawings and/or specifications designate a standard of performance (e.g., fire rating, sound transmission class, insulation value, heating output, air velocity, etc.) the completed installation shall perform at least to the designated standard.
- F. Have work performed by persons qualified to produce required and specified quality.
- G. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.
- H. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, and disfigurement.

3.02 TOLERANCES

- A. Monitor fabrication and installation tolerance control of products to produce acceptable Work. Do not permit tolerances to accumulate.
- B. Comply with manufacturers' tolerances. Should manufacturers' tolerances conflict with Contract Documents, request clarification from Schaefer Architecture before proceeding.
- C. Adjust products to appropriate dimensions; position before securing products in place.

3.03 DEFECT ASSESSMENT

- A. Replace Work or portions of the Work not complying with specified requirements at Contractors expense.
- B. If, in the opinion of Schaefer Architecture, it is not practical to remove and replace the work, Schaefer Architecture will direct an appropriate remedy or adjust payment.

END OF SECTION

SECTION 01 41 00 - REGULATORY REQUIREMENTS**PART 1 GENERAL****1.01 SUMMARY of Reference Standards**

- A. Regulatory requirements applicable to this project are the following:
- B. 29 CFR 1910 - Occupational Safety and Health Standards; Current Edition.
- C. 36 CFR 1191 - Americans with Disabilities Act (ADA) Accessibility Guidelines for Buildings and Facilities; Architectural Barriers Act (ABA) Accessibility Guidelines; current edition.
- D. ADA Standards - 2010 ADA Standards for Accessible Design; 2010.
- E. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.
- F. ICC (IFC) - International Fire Code; 2018.
- G. ICC (IBC) - International Building Code; 2024.
- H. ICC (IBC) - ICC International Existing Building Code, 2024.
- I. IAPMO (UPC) - Uniform Plumbing Code; 2021.
- J. ICC (IMC) - International Mechanical Code; 2024.
- K. ICC (IFGC) - International Fuel Gas Code; 2021.
- L. NFPA 70 - National Electrical Code; 2023.
- M. ICC (IECC) - International Energy Conservation Code; 2006.
- N. Kansas Department of Health and Environment.
- O. Applicable State Statutes Annotated (K.S.A.).
- P. ASHRAE 90.1 - 2004.
- Q. National Fire Protection Association, National Fire Codes.
- R. American Welding Society, AWS D1.1-04.
- S. Kansas Boiler Safety Act, KSA 44-913, 2006.
- T. All other federal, state, county, and local requirements applicable and/or referenced.

1.02 QUALITY ASSURANCE

- A. General Contractor's Designer Qualifications: Refer to Section - 01 40 00 - Quality Requirements.

1.03 BUILDING PLAN REVIEW & PERMIT:

- A. The Owner has submitted the Bidding Documents for Code Plan Review and paid the review fee.
- B. No code plan review by MABCD is expected for this project. Mechanical and electrical trade permits, however, will be necessary.
- C. Mechanical and Electrical Permit(s) and all other construction fees shall be included in the cost of the Work being bid.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION - NOT USED****END OF SECTION**

SECTION 01 42 16 - DEFINITIONS**PART 1 GENERAL****1.01 SUMMARY**

- A. This section supplements the definitions contained in the General Conditions.
- B. Other definitions are included in individual specification sections.
- C. Specifications.
- D. Drawings.

1.02 DEFINITIONS

- A. A great amount of the specification language can be recognized as specific definitions for nominal terms found on the drawings and in other contract documents. Certain terms used more generally throughout the Contract Documents are hereby defined as follows:
- B. Directed, Requested, Etc.: Where not otherwise explained, terms such as "directed," "requested," "authorized," "selected," "approved," "required," "accepted" and "permitted" mean "directed by the Architect," "requested by the Architect," etc. However, no such implied meaning will be interpreted to extend the Architect's responsibility into the Contractor's area of construction supervision.
- C. Furnish: To supply, deliver, unload, inspect for damage and ready for unpacking, assembly and installation.
- D. General Requirements: The terms "General Requirement(s)" and "Division 1 Section(s)" are alike in meaning and significance.
- E. Guarantee and Warranty: Defined to be identical in meaning and used interchangeably.
- F. Indicated: The term "indicated" is a cross reference to details, notes, or schedules on the drawings, other paragraphs or schedules in the specifications, and similar means of recording requirements in the contract documents. Where terms such as "shown," "noted," "scheduled" and "specified" are used in lieu of "indicated," it is for the purpose of helping the reader accomplish the cross reference, and no limitation of location is intended except as specifically noted.
- G. Install, Erect, Construct, and Similar Terms: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use as part of the Work.
- H. Installer: The person or entity engaged by the Contractor or his Subcontractor or Sub-subcontractor for the performance of a particular unit of Work at the project site, including installation, erection, application, and similar required operations. It is a general requirement that Installers be recognized experts in the work they are engaged to perform.
- I. Product: Material, machinery, components, equipment, fixtures, and systems forming the work result. Not materials or equipment used for preparation, fabrication, conveying, or erection and not incorporated into the work result. Products may be new, never before used, or re-used materials or equipment.
- J. Project Site: The space available to the Contractor for the performance of the Work, either exclusively or in conjunction with others performing other work as part of the Project.
- K. Provide: To furnish and install, complete and ready for the intended use.
- L. Reviewed: Where used in conjunction with the Architect's or Engineer's response to submittals, requests, applications, inquiries, reports, and claims by the Contractor, the

meaning of the term "reviewed" will be held to the limitations of the Architect's responsibilities and duties as specified in the General and Supplementary Conditions and General Requirements. In no case will "reviewed" by the Architect be interpreted as an assurance to the Contractor that the requirements of the Contract Documents have been fulfilled.

- M. Supply: Same as Furnish.
- N. Testing Laboratory: An independent entity engaged to perform specific inspections or tests of the work, either at the project site or elsewhere; and to report and (if required) interpret the results of those inspections or tests.

1.03 PROJECT MANUAL

- A. The Project Manual is the volume(s) which binds together the Bidding Documents, General Conditions as Modified, and Specifications; identified for this Contract. The several parts of the volume(s) are listed in the Table of Contents of the volume(s).

1.04 SPECIFICATIONS

- A. General: This series of explanations is provided to assist the user of these specifications and associated contract documents to more readily understand the format, language, implied requirements and similar conventions of the content. None of these explanations will be interpreted to modify the substance of the requirements.
- B. Format Explanation: The format of the principal portions of specifications can be described as follows - although other portions may not fully comply and no particular significance will be attached to such compliance or noncompliance.
- C. Sections: Sections have been subdivided into 3 (or less) "parts" for uniformity and convenience (Part 1 -General, Part 2 - Products, and Part 3 - Execution). These do not imply a particular meaning and are not an integral part of the text which specified requirements.
- D. Imperative language is frequently used and, except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor. For clarity of reading, contrasting subjective language is frequently used to describe the responsibilities which must be fulfilled either indirectly by the Contractor or by others.
- E. Streamlined style of the specifications results in abbreviated and incomplete sentences. Omission of words or phrases such as "the Contractor shall," "according to the plans," "a," "the," and "all" are intentional. Omitted words or phrases shall be supplied by inference in the same manner as they are when a note occurs on the drawings.
- F. Section number is for the purposes of abbreviated identification in connection with cross references. The Sections are placed in the binder(s) in sequence; however, this sequence is not complete and the Table of Contents of the Project Manual must be consulted to determine the total listing of Sections.
- G. Pages of each Section are numbered independently for each Section. The Section number is shown with the page number at the bottom of each page. "End of Section" appears on the last page of each Section. Contractor(s) shall verify that all pages of the Specifications are included.
- H. Project identification and date of publication, and revision where applicable, of the Contract Documents are recorded on each page to minimize misuse of the specifications and confusion with other project specifications.

- I. Mechanical and Electrical Provisions: Certain portions of Mechanical Work and Electrical Work of the General Requirements have been specified in their Divisions. This is for the traditional convenience and clarity of using the Contract Documents, and no other meaning will be interpreted from this arrangement of content, except as otherwise specifically indicated. They in turn reference certain other Divisions and Sections to minimize duplication in specifications and to correlate similar work performed by different parties.
- J. Contractors are responsible for their work regardless which Section it is included in.
- K. Contractor's Options: Where more than one set of requirements are specified for a particular unit of work. The option is intended to be the Contractor's.
- L. Specifications and Drawings Complementary: What is included in one is the same as though included in the other or included in both.
- M. Overlapping Requirements and Conflicts: In the event of conflicts between the Contract Documents or between the Contract Documents and applicable standards, codes, resolutions and ordinances, the Contractor shall (1) provide the better quality or greater quantity of Work or (2) comply with the more stringent requirement; or both in accordance with the interpretation of Schaefer Architecture.
- N. Abbreviations: The language of the Specifications and elsewhere in the Contract Documents is of the abbreviated type in certain instances, and implies words and meanings which will be appropriately interpreted. Actual word abbreviations of a self-explanatory nature have been included in the text. Trade associations and general standards are frequently abbreviated. Singular words will be interpreted as plural and plural words will be interpreted as singular wherever applicable and the full context of the requirement so indicated.

1.05 DRAWINGS

- A. Not all conditions have been detailed although such work is a part of the Contract.
- B. In lieu of details, some work may require conformance with written instructions, notes, and/or standards. Such work is a part of the Contract.
- C. Do not scale drawings for dimensions. Accurately layout such work from dimensions indicated unless such be found in error.
- D. Where drawings indicate a portion of the work and the remainder is shown in outline. The parts drawn out apply to other like portions of the work. Where detail is indicated by starting, only, such detail shall continue to apply throughout the courses or parts in which it occurs and apply to similar parts of work unless otherwise indicated.
- E. Details indicate the general application of work at all locations where it logically applies. Provide other related work incident thereto to fully complete the work consistent with the detail, other related details, and actual conditions.
- F. Consult Architect for interpretations concerning locations of equipment.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 50 00 - TEMPORARY FACILITIES AND CONTROLS**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Temporary telecommunications services.
- B. Temporary sanitary facilities.
- C. Temporary Controls: Barriers, enclosures, and fencing.
- D. Hoisting Facilities.
- E. Fire Protection.
- F. Security requirements.
- G. Vehicular access and parking.
- H. Waste removal facilities and services.
- I. Moisture and Mold Control.

1.02 REFERENCE STANDARDS

- A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2023d.

1.03 TEMPORARY UTILITIES - See Section 01 51 00**1.04 TELECOMMUNICATIONS SERVICES**

- A. Contractor shall provide, maintain, and pay for telecommunications services to field office at time of project mobilization.
- B. Superintendent for Contractor shall be available by cell phone throughout the day.
- C. Long distance calls shall be paid for by party making call.

1.05 TEMPORARY SANITARY FACILITIES

- A. Contractor to provide and maintain required temporary facilities and enclosures. Provide at time of project mobilization.
 - 1. Temporary toilet facilities shall meet the requirements of the state and local departments of public health.
- B. Use of existing facilities is not permitted.
- C. Maintain daily in clean and sanitary condition.

1.06 BARRIERS

- A. Contractor to provide barriers to prevent unauthorized entry to construction areas, to prevent access to areas that could be hazardous to workers or the public, to allow for owner's use of site and to protect existing facilities and adjacent properties from damage from construction operations and demolition.
- B. Provide barricades and covered walkways required by governing authorities for public rights-of-way and for public access to existing building.
- C. Provide protection for plants designated to remain. Replace damaged plants.
 - 1. Care, pruning and maintenance of trees which are to remain shall be done under the direction of and in accordance with recommendations of a qualified and approved arborist or tree trimming specialist.
- D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.07 FENCING

- A. Construction: Commercial grade chain link fence. A panelized system may be utilized.

- B. Provide 6 foot (1.8 m) high fence around construction site; equip with vehicular and pedestrian gates with locks.
 - 1. Extent of Fence: As required to enclose portion determined sufficient to accommodate construction operations.

1.08 EXTERIOR ENCLOSURES

- A. Provide temporary weather tight closure of exterior openings to accommodate acceptable working conditions and protection for Products, to allow for temporary heating and maintenance of required ambient temperatures identified in individual specification sections, and to prevent entry of unauthorized persons. Provide access doors with self-closing hardware and locks.

1.09 INTERIOR ENCLOSURES

- A. Provide temporary partitions and ceilings as indicated to separate work areas from Owner-occupied areas, to prevent penetration of dust and moisture into Owner-occupied areas, and to prevent damage to existing materials and equipment.
- B. Construction: Framing and reinforced polyethylene sheet materials with closed joints and sealed edges at intersections with existing surfaces unless indicated or required otherwise:
 - 1. Maximum flame spread rating of 75 in accordance with ASTM E84.

1.10 HOISTING FACILITIES

- A. For two stories (including roof) or less above grade; each contractor and subcontractor shall be responsible for providing their own hoisting of their own materials and debris.
- B. Elevator Use: Use of elevator(s) is not permitted.
- C. Existing Stair Usage: Use of Owner's existing stairs will be permitted, provided stairs are cleaned and maintained in a condition acceptable to Owner. At Substantial Completion, restore stairs to condition existing before initial use.
 - 1. Provide protective coverings, barriers, devices, signs, or other procedures to protect stairs and to maintain means of egress. If stairs become damaged, restore damaged areas so no evidence remains of correction work.

1.11 FIRE PROTECTION

- A. Contractor shall provide temporary fire protection. Portable fire extinguishers shall be provided with class and extinguishing agent as required by locations and classes of fire exposures. Subcontractors will be responsible for their own specialty requirements. Permanent fire protection equipment used for fire protection during construction shall be the responsibility of the installing contractor.

1.12 SECURITY

- A. Provide security and facilities to protect Work, and Owner's operations from unauthorized entry, vandalism, or theft.
- B. Contractor may provide a "watchman" at their own cost.

1.13 VEHICULAR ACCESS AND PARKING

- A. Contractor shall provide adequate access including roads into the site of the structure, if required, for the prosecution of the work. Also provide and maintain at least one temporary or permanent access to each working elevation which is to be permanently occupied

- B. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.
- C. Coordinate access and haul routes with governing authorities and Owner.
- D. Provide and maintain access to fire hydrants, free of obstructions.
- E. Existing on-site roads may be used for construction traffic.
- F. Parking space is available in the adjacent garage on first come first served basis.

1.14 WASTE REMOVAL

- A. Provide waste removal facilities and services as required to maintain the site in clean and orderly condition.
- B. Provide containers with lids. Remove trash from site periodically.
- C. Each Contractor or Subcontractor shall be responsible to collect and deposit their debris in such collection facilities. The Contractor shall be responsible for the removal of all debris from the job site.
- D. If materials to be recycled or re-used on the project must be stored on-site, provide suitable non-combustible containers; locate containers holding flammable material outside the structure unless otherwise approved by the authorities having jurisdiction.
- E. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.
- F. Trash that blows onto adjacent property shall be removed by the responsible party or parties under the direct supervision of the Contractor.
- G. Subcontractors shall collect and remove their own liquid waste and properly dispose of off-site.

1.15 MOISTURE AND MOLD CONTROL

- A. Avoid trapping water in finished work. Document visible signs of mold that may appear during construction.
- B. Partially Enclosed Construction Phase: After installation of weather barriers but before full enclosure and conditioning of building, when installed materials are still subject to infiltration of moisture and ambient mold spores, protect as follows:
 - 1. Do not load or install drywall or other porous materials or components, or items with high organic content, into partially enclosed building.
 - 2. Keep interior spaces reasonably clean and protected from water damage.
 - 3. Periodically collect and remove waste containing cellulose or other organic matter.
 - 4. Discard or replace water-damaged material.
 - 5. Do not install material that is wet.
 - 6. Discard, replace or clean stored or installed material that begins to grow mold.
 - 7. Perform work in a sequence that allows any wet materials adequate time to dry before enclosing the material in drywall or other interior finishes.
- C. Controlled Construction Phase of Construction: After completing and sealing of the building enclosure but prior to the full operation of permanent HVAC systems, maintain as follows:
 - 1. Control moisture and humidity inside building by maintaining effective dry-in conditions.
 - 2. Use permanent HVAC system when they come available to control humidity.
 - 3. Comply with manufacturer's written instructions on products for temperature, relative humidity, and exposure to water limits.

1.16 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

- A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.
- B. Remove underground installations to a minimum depth of 2 feet (600 mm). Grade site as indicated.
- C. Clean and repair damage caused by installation or use of temporary work.
- D. Restore existing facilities used during construction to original condition.
- E. Restore new permanent facilities used during construction to specified condition.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION - NOT USED****END OF SECTION**

SECTION 01 51 00 - TEMPORARY UTILITIES**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Temporary Utilities: Provision of electricity, lighting, heat, ventilation, and water.

1.02 TEMPORARY ELECTRICITY

- A. Cost: By Owner.
- B. Connect to Owner's existing power service.
 - 1. Do not disrupt Owner's need for continuous service.
 - 2. Exercise measures to conserve energy.
- C. Power Service Characteristics: 120/208 or 120/240 volt, required ampere, three phase, four wire.
 - 1. Each Contractor shall be responsible for power they require exceeding systems specified.
- D. Complement existing power service capacity and characteristics as required.
- E. Electrical Contractor shall provide power outlets for construction operations, with branch wiring and distribution boxes located as required so that an extension no longer than 100 feet (30 m) will reach any work station. Each Contractor shall provide their own flexible power cords as required.
 - 1. Provide sufficient capacity for construction tools, equipment, temporary ventilation and lighting.
 - 2. Modify, maintain and upon completion of project remove temporary power system.
- F. Employ permanent systems as they are completed and available.
- G. Permanent convenience receptacles may be utilized during construction.

1.03 TEMPORARY LIGHTING FOR CONSTRUCTION PURPOSES

- A. Provide and maintain LED, compact fluorescent, or high-intensity discharge lighting as suitable for the application for construction operations in accordance with requirements of 29 CFR 1926 and authorities having jurisdiction.
 - 1. Each Contractor shall be responsible for lighting they require exceeding systems specified.
- B. Provide branch wiring from power source to distribution boxes with lighting conductors, pigtails, and lamps as required.
- C. Maintain lighting and provide routine repairs.
 - 1. Upon completion of project or when permanent system are deployed remove temporary lighting system.
- D. Permanent building lighting may be utilized during construction.

1.04 TEMPORARY HEATING

- A. Cost of Energy: By Owner.
- B. Provide heating devices and heat as needed to maintain specified conditions for construction operations.
 - 1. Subcontractors having additional specific or unusual requirements shall be responsible for their own requirements.
- C. Maintain minimum ambient temperature of 50 degrees F (10 degrees C) in areas where construction is in progress, unless indicated otherwise in specifications.
- D. Owner's existing heat plant may be used.

1. Exercise measures to conserve energy.
- E. Mechanical and Electrical Contractors shall cooperate with General Contractor in making permanent system(s) available as soon as possible.
- F. Prior to operation of permanent equipment for temporary heating purposes, verify that installation is approved for operation, equipment is lubricated and filters are in place. Provide and pay for operation, maintenance, and regular replacement of filters and worn or consumed parts.
 1. Warranties shall not begin on equipment until the date of substantial completion. Contractor shall purchase extended warranties as required.

1.05 TEMPORARY COOLING

- A. Cost of Energy: By Owner.
- B. Provide cooling devices and cooling as needed to maintain specified conditions for construction operations.
 1. Subcontractors having additional specific or unusual requirements shall be responsible for their own requirements.
- C. Owner's existing cooling plant may be used.
 1. Exercise measures to conserve energy.

1.06 TEMPORARY VENTILATION

- A. Existing ventilation equipment may not be used.

1.07 TEMPORARY WATER SERVICE

- A. Cost of Water Used: By Owner.
- B. Plumbing Contractor shall provide and maintain suitable quality water service for construction operations at time of project mobilization.
- C. Extend branch piping with outlets located so water is available by hoses with threaded connections.
 1. Provide at least one hose bibb in each floor level.
 2. Each contractor shall provide their own water hose.
 3. Each Contractor shall be responsible for water they require exceeding systems specified.
- D. Contractor shall provide potable drinking water in convenient and accessible locations, for all persons engaged upon the work, so long as they have personnel on the job.
- E. Employ permanent systems when available and remove temporary service when no longer needed.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION - NOT USED****END OF SECTION**

SECTION 01 60 00 - PRODUCT REQUIREMENTS**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. General product requirements.
- B. Re-use of existing products.
- C. Transportation, handling, storage and protection.
- D. Product option requirements.
- E. Substitution limitations.
- F. Maintenance materials, including extra materials, spare parts, tools, and software.

PART 2 PRODUCTS**2.01 EXISTING PRODUCTS**

- A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by Contract Documents.
- B. Unforeseen historic items encountered remain the property of the Owner; notify Owner promptly upon discovery; protect, remove, handle, and store as directed by Owner.
- C. Existing materials and equipment indicated to be removed, but not to be re-used, relocated, reinstalled, delivered to the Owner, or otherwise indicated as to remain the property of the Owner, become the property of the Contractor; remove from site.
 - 1. The Owner has first salvage rights on materials and equipment whether identified to remain as property of the Owner or not.

2.02 NEW PRODUCTS

- A. Provide products that comply with the Contract Documents, are undamaged and, unless otherwise indicated, are new at time of installation.
- B. Use of products having any of the following characteristics is not permitted:
 - 1. Containing lead, cadmium, or asbestos.

2.03 PRODUCT OPTIONS

- A. General: The specifying of particular products, materials and systems is done to establish a minimum standard of performance, quality, type and physical characteristics.
- B. Prebid approval is required for proposed materials, equipment or systems for manufacturers not specified or listed in the Contract Documents when other manufacturers and/or products are specified and there is listed a Provision for Substitutions.
- C. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.
- D. Products where it is specified by name, model number or series to establish quality with a Provision for Substitutions: Use product indicated. Submit a request for substitution for any product not named.
- E. Products Specified by Naming One or More Manufacturers: Use a product of one of the manufacturers named and meeting specifications, no options or substitutions allowed.
- F. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.
- G. Products Specified as Basis-of-Design: Submit substitution requests for unnamed products to Schaefer Architecture for evaluation.

2.04 PRODUCT OPTIONS AFTER BID

- A. After execution of contract, substitutions of materials, equipment or systems other than those specified and approved by addendum will be approved by the Schaefer Architecture only if the following are met:
 - 1. Materials specified and ordered in a timely manner cannot be delivered to the job in time to complete the work in proper sequence.
 - 2. An equal or superior material is proposed.
 - 3. The Project cost will lower or remain unchanged.

2.05 MAINTENANCE MATERIALS

- A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.
- B. Deliver and place in location as directed; obtain receipt prior to final payment.

PART 3 EXECUTION**3.01 TRANSPORTATION AND HANDLING**

- A. Package products for shipment in manner to prevent damage; for equipment, package to avoid loss of factory calibration.
- B. If special precautions are required, attach instructions prominently and legibly on outside of packaging.
- C. Coordinate schedule of product delivery to designated prepared areas in order to minimize site storage time and potential damage to stored materials.
- D. Transport and handle products in accordance with manufacturer's instructions.
- E. Transport materials in covered trucks to prevent contamination of product and littering of surrounding areas.
- F. Promptly inspect shipments to ensure that products comply with requirements, quantities are correct, and products are undamaged.
- G. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage, and to minimize handling.
- H. Arrange for the return of packing materials, such as wood pallets, where economically feasible.

3.02 STORAGE AND PROTECTION

- A. Provide protection of stored materials and products against theft, casualty, or deterioration.
- B. Designate receiving/storage areas for incoming products so that they are delivered according to installation schedule and placed convenient to work area in order to minimize waste due to excessive materials handling and misapplication.
 - 1. Structural Loading Limitations: Handle and store products and materials so as not to exceed static and dynamic load-bearing capacities of project floor and roof areas.
- C. Store and protect products in accordance with manufacturers' instructions.
- D. Store with seals and labels intact and legible.
- E. Store sensitive products in weathertight, climate-controlled enclosures in an environment favorable to product.
- F. For exterior storage of fabricated products, place on sloped supports above ground.

- G. Protect products from damage or deterioration due to construction operations, weather, precipitation, humidity, temperature, sunlight and ultraviolet light, dirt, dust, and other contaminants.
- H. Comply with manufacturer's warranty conditions, if any.
- I. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.
- J. Prevent contact with material that may cause corrosion, discoloration, or staining.
- K. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
- L. Arrange storage of products to permit access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.

END OF SECTION

SECTION 01 70 00 - EXECUTION AND CLOSEOUT REQUIREMENTS**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Examination, preparation, and general installation procedures.
- B. Requirements for alterations work, including selective demolition, except removal, disposal, and/or remediation of hazardous materials and toxic substances.
- C. Pre-installation meetings.
- D. Cutting and patching.
- E. Cleaning and protection.
- F. Starting of systems and equipment.
- G. Demonstration and instruction of Owner personnel.
- H. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.
- I. General requirements for maintenance service.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
 - 1. Structural integrity of any element of Project.
 - 2. Efficiency, maintenance, or safety of any operational element.
 - 3. Visual qualities of sight exposed elements.
 - 4. Work of Owner or separate Contractor.
 - 5. Include in request:
 - a. Location and description of affected work.
 - b. Necessity for cutting or alteration.
 - c. Description of proposed work and products to be used.
 - d. Date and time work will be executed.
- C. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.03 QUALIFICATIONS

- A. For demolition work, employ a firm specializing in the type of work required.

1.04 PROJECT CONDITIONS

- A. Use of explosives is not permitted.
- B. Grade site to drain. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
- C. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.
- D. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.
- E. Dust Control: Execute work by methods to minimize raising dust from construction operations. Provide positive means to prevent air-borne dust from dispersing into atmosphere and over adjacent property.
 - 1. Provide dust-proof enclosures to prevent entry of dust generated outdoors.

2. Provide dust-proof barriers between construction areas and areas continuing to be occupied by Owner.
- F. Erosion and Sediment Control: Plan and execute work by methods to control surface drainage from cuts and fills, from borrow and waste disposal areas. Prevent erosion and sedimentation.
 1. Minimize amount of bare soil exposed at one time.
 2. Provide temporary measures such as berms, dikes, and drains, to prevent water flow.
 3. Construct fill and waste areas by selective placement to avoid erosive surface silts or clays.
 4. Periodically inspect earthwork to detect evidence of erosion and sedimentation; promptly apply corrective measures.
- G. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.
- H. Pollution Control: Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious, toxic substances, and pollutants produced by construction operations. Comply with federal, state, and local regulations.

1.05 COORDINATION

- A. See Section 01 10 00 for occupancy-related requirements.
- B. Coordinate scheduling, submittals, and work of the various sections of the Project Manual to ensure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- C. Notify affected utility companies and comply with their requirements.
- D. Verify that utility requirements and characteristics of new operating equipment are compatible with building utilities. Coordinate work of various sections having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- E. Coordinate space requirements, supports, and installation of mechanical and electrical work that are indicated diagrammatically on drawings. Follow routing indicated for pipes, ducts, and conduit, as closely as practicable; place runs parallel with lines of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- F. In finished areas except as otherwise indicated, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.
- G. Coordinate completion and clean-up of work of separate sections.
- H. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.

PART 2 PRODUCTS

2.01 PATCHING MATERIALS

- A. New Materials: As specified in product sections; match existing products and work for patching and extending work.
- B. Type and Quality of Existing Products: Determine by inspecting and testing products where necessary, referring to existing work as a standard.

- C. Product Substitution: For any proposed change in materials, submit request for substitution described in Section 01 60 00 - Product Requirements.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that existing site conditions and substrate surfaces are acceptable for subsequent work. Start of work means acceptance of existing conditions.
- B. Verify that existing substrate is capable of structural support or attachment of new work being applied or attached.
- C. Examine and verify specific conditions described in individual specification sections.
- D. Take field measurements before confirming product orders or beginning fabrication, to minimize waste due to over-ordering or misfabrication.
- E. Verify that utility services are available, of the correct characteristics, and in the correct locations.
- F. Prior to Cutting: Examine existing conditions prior to commencing work, including elements subject to damage or movement during cutting and patching. After uncovering existing work, assess conditions affecting performance of work. Beginning of cutting or patching means acceptance of existing conditions.

3.02 PREPARATION

- A. Clean substrate surfaces prior to applying next material or substance.
- B. Seal cracks or openings of substrate prior to applying next material or substance.
- C. Apply manufacturer required or recommended substrate primer, sealer, or conditioner prior to applying any new material or substance in contact or bond.

3.03 PREINSTALLATION MEETINGS

- A. When required in individual specification sections, convene a preinstallation meeting at the site prior to commencing work of the section.
- B. Require attendance of parties directly affecting, or affected by, work of the specific section.
- C. Notify Schaefer Architecture four days in advance of meeting date.
- D. Prepare agenda and preside at meeting:
 - 1. Review conditions of examination, preparation and installation procedures.
 - 2. Review coordination with related work.
- E. Record minutes and distribute copies within two days after meeting to participants, with two copies to Schaefer Architecture, Owner, participants, and those affected by decisions made.

3.04 ORDERING, RECEIVING, AND STORING MATERIALS

- A. Order materials in timely manner to assure delivery in ample time for orderly incorporation into the Work.
- B. On receipt of materials, check for in-transit damage in ample time to replace any damaged materials prior to installation time.
- C. Wherever possible deliver materials and equipment to project site in manufacturer's original packages, keeping labels intact until final cleaning. Where items are to be job-assembled, label, tag, mark or otherwise properly identify each component part until incorporated in the Work.

- D. Store materials in a manner to prevent deterioration, staining, soiling and intrusion of foreign materials. Provide waterproof well-ventilated enclosures for materials subject to deterioration by dampness. Adequately protect those materials subject to damage by freezing and frost.
- E. Remove from premises and replace with new, any materials showing deterioration or damage.

3.05 MANUFACTURER'S REQUIREMENT:

- A. All materials and equipment supplied for this building shall be installed, applied or erected in strict accordance with the manufacturer's recommendations or with manufacturer's trade association requirements unless the specifications bound herewith exceed those requirements.
 - 1. Exception: Methods or procedures, set forth in the manufacturer's recommendations which the Contractor finds unacceptable shall be submitted to Schaefer Architecture in writing for clarification.

3.06 GENERAL INSTALLATION REQUIREMENTS

- A. Install products as specified in individual sections, in accordance with manufacturer's instructions and recommendations, and so as to avoid waste due to necessity for replacement.
- B. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.
- C. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.
- D. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.
- E. Make neat transitions between different surfaces, maintaining texture and appearance.
- F. Prepare all work to receive subsequent work or finish as needed and described in specifications for both substrate and subsequent products.
- G. Furnish, apply, install, connect, erect, clean and condition manufactured articles, materials, and equipment per manufacturer's printed directions. If otherwise indicated or specified, notify Schaefer Architecture well in advance of installation and prerequisite construction.
- H. Manufacturer's printed directions must be on job prior to and during installation of materials and equipment.
- I. Provide all attachment devices and materials necessary to secure materials together or to other materials and to secure work of other trades.
- J. Make allowance for ample expansion and contraction for all building components subject to same.
- K. Each trade shall build in openings required for their own work and sleeves furnished by another trade for their work and prepare openings when another trade requires and furnishes the information in a timely manner. Each trade shall be responsible for cutting into construction when they have not acted in timely manner; all in accordance with CUTTING AND PATCHING in this section. Each trade shall be responsible for filling around their work, within blockouts, sleeves, and holes for their work, to maintain the integrity (acoustic, fire, smoke, appearance, etc.) of the construction.
- L. Where proper fit of work depends upon close tolerances of manufactured products, furnish manufacturer with necessary templates to insure proper fit of all components.

- M. Install materials only when conditions of adjacent building components are conducive to achieving best installation results.
- N. Construct job assemblies accurately and as necessary for other trades having adjunct work. Correct errors in cutting, shop fabrication and installation. Where necessary to cut into other building components, do so only in a manner not to damage building structurally nor aesthetically, then repair adjoining parts and materials thoroughly and neatly.
- O. Erect, install and secure building components in a structurally sound and appropriate manner. Where necessary, temporarily brace, shore, or otherwise support members until final connection or installation. Brace walls and other structural elements to prevent damage by wind and construction operations. Leave temporary bracing, shoring, or other structural supports in place as long as necessary for safety and until structure is strong enough to withstand all loads involved.
- P. Where construction consists of a series of courses or units, assemble units in best acceptable manner to provide structurally sound installation, waterproof where exposed to exterior. Accurately plumb and level all courses and verify levels of frequent courses with instrument.
- Q. Handle materials in manner to prevent scratching, abrading, distortion, chipping, breaking or other disfigurement to those materials as well as to materials and construction already existing.
- R. Unless indicated, fabricate and install materials true to line, plumb and level. Leave finished surfaces smooth and flat or of smooth contour where indicated, free from wrinkles, warps, scratches, dents, and other imperfections
- S. Provide quality of workmanship not less than the commercially accepted standards of that trade.
- T. Where obviously of best practice, furnish materials in longest practical lengths and largest practical sizes to avoid unnecessary jointing. Make all joints secure.
- U. Consult Schaefer Architecture for mounting height or position of any unit not specifically located.
- V. Mix no more materials than can be used before materials begin to "set". Mix no partially "set" batch with another. Clean tools and appliances prior to mixing materials that can be contaminated.
- W. Conduct work in a manner to avoid injury to previously placed work.
- X. Do not disturb materials requiring curing time until appropriate curing time has transpired.
- Y. Install, connect, service, and operate permanent systems at earliest practical dates, except as may be modified by specification section 01 51 00.

3.07 ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Schaefer Architecture before disturbing existing installation.
 - 3. Beginning of alterations work constitutes acceptance of existing conditions.
- B. Keep areas in which alterations are being conducted separated from other areas that are still occupied.

1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 in locations indicated on drawings.
- C. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
 1. Where openings in exterior enclosure exist, provide construction to make exterior enclosure weatherproof.
 2. Insulate existing ducts or pipes that are exposed to outdoor ambient temperatures by alterations work.
- D. Remove existing work as indicated and as required to accomplish new work.
 1. Remove items indicated on drawings.
 2. Relocate items indicated on drawings.
 3. Where new surface finishes are to be applied to existing work, perform removals, patch, and prepare existing surfaces as required to receive new finish; remove existing finish if necessary for successful application of new finish.
 4. Where new surface finishes are not specified or indicated, patch holes and damaged surfaces to match adjacent finished surfaces as closely as possible.
- E. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, Telecommunications, and LAN/WAN/Data Systems): Remove, relocate, and extend existing systems to accommodate new construction.
 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components; if necessary, modify installation to allow access or provide access panel.
 2. Where existing systems or equipment are not active and Contract Documents require reactivation, put back into operational condition; repair supply, distribution, and equipment as required.
 3. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 - a. Disable existing systems only to make switchovers and connections; minimize duration of outages.
 - b. Provide temporary connections as required to maintain existing systems in service.
 4. Verify that abandoned services serve only abandoned facilities.
 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings as indicated; remove back to source of supply where possible, otherwise cap stub and tag with identification; patch holes left by removal using materials specified for new construction.
- F. Protect existing work to remain.
 1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 3. Repair adjacent construction and finishes damaged during removal work.
- G. Adapt existing work to fit new work: Make as neat and smooth transition as possible.
 1. When existing finished surfaces are cut so that a smooth transition with new work is not possible, terminate existing surface along a straight line at a natural line of division and make recommendation to Schaefer Architecture.

2. Where removal of partitions or walls results in adjacent spaces becoming one, rework floors, walls, and ceilings to a smooth plane without breaks, steps, or bulkheads.
 3. Where a change of plane of 1/4 inch (6 mm) or more occurs in existing work, submit recommendation for providing a smooth transition for Schaefer Architecture review and request instructions.
 4. Trim existing wood doors as necessary to clear new floor finish. Refinish trim as required.
- H. Patching: Where the existing surface is not indicated to be refinished, patch to match the surface finish that existed prior to cutting. Where the surface is indicated to be refinished, patch so that the substrate is ready for the new finish.
- I. Refinish existing surfaces as indicated:
1. Where rooms or spaces are indicated to be refinished, refinish all visible existing surfaces to remain to the specified condition for each material, with a neat transition to adjacent finishes.
 2. If mechanical or electrical work is exposed accidentally during the work, re-cover and refinish to match.
- J. Clean existing systems and equipment.
- K. Remove demolition debris and abandoned items from alterations areas and dispose of off-site; do not burn or bury.
- L. Do not begin new construction in alterations areas before demolition is complete.
- M. Comply with all other applicable requirements of this section.

3.08 CUTTING AND PATCHING

- A. **Prior approval for cutting and patching is required unless waived by the Schaefer Architecture.**
- B. **Approval of Schaefer Architecture to proceed with proposed cutting-and-patching does not waive right to later require complete removal and replacement of work found to be cut-and-patched in an unsatisfactory manner.**
- C. General:
1. "Cutting-and-patching" is hereby defined to include, but is not necessarily limited to; the cutting and patching of nominally completed and existing work, in order to accommodate the coordination of work, or the installation of other work, or to uncover other work for access or inspection, or to obtain samples for testing, or for repair or correction, or for similar purposes.
 2. Patching also is defined as repair to new or existing landscaping or other features.
 3. Existing work shall be prepared, cleaned, and patched as required for new work by appropriate trades, ready for the subsequent finishes.
 4. Excavating and the associated operations of boulder removal, dewatering, bracing, removal of underground debris, penetration of rock and other barriers, backfilling, and similar work as specified in Division 31 and in other contract documents, may be required as a special form of cutting-and-patching, but is recognized primarily as an example of a related-but-separate category of work.
 5. Restoring or removing and replacing non-complying work may require cutting-and-patching operations as specified herein.

6. Refer to other sections of these specifications and all drawings for ramifications regarding work necessary to accomplish installation of items shown.
 7. Each trade shall be responsible for the sizing, location, timing, coordinating and cost for cutting and patching necessary to accommodate their work. Cutting and patching shall be done by individuals skilled in working the tools and materials involved.
- D. Quality Assurance:
1. Requirements for Structural Work: Do not cut-and-patch structural work in a manner resulting in a reduction of load-carrying capacity or load/deflection ratio.
 2. Operational and Safety Limitations: Do not cut-and-patch operational elements and safety-related components in a manner resulting in a reduction of capacities to perform in the manner intended or resulting in decreased operational life, increased maintenance, or decreased safety. Operational elements include but are not limited to the following:
 - a. Primary operational systems and equipment.
 - b. Fire separation assemblies.
 - c. Air or smoke barriers.
 - d. Fire-suppression systems.
 - e. Mechanical systems piping and ducts.
 - f. Control systems.
 - g. Fire alarm and Communication systems.
 - h. Conveying systems.
 - i. Electrical wiring systems.
 - j. Operating systems of special construction.
 3. Other Construction Elements: Do not cut and patch other construction elements or components in a manner that could change their load-carrying capacity, that results in reducing their capacity to perform as intended, or that results in increased maintenance or decreased operational life or safety. Other construction elements include but are not limited to the following:
 - a. Water, moisture, or vapor barriers.
 - b. Membranes and flashings.
 - c. Exterior curtain-wall construction.
 - d. Equipment supports.
 - e. Piping, ductwork, vessels, and equipment.
 - f. Noise- and vibration-control elements and systems.
 4. Visual Requirements: Do not cut-and-patch work which is exposed on the exterior or exposed in occupied spaces of the building, in a manner resulting in a reduction of visual qualities or resulting in substantial evidence of the cut-and-patch work, both as judged solely by the Architect. Remove and replace work judged by the Architect to be cut-and-patched in a visually unsatisfactory manner. Trade requiring cutting may use small escutcheons or similar trim at piping, ducts and the like, if permitted for new work, and not as a device to cover work which should be patched.
 5. Engage the original Installer/Fabricator to perform cutting-and-patching in new construction. Engage capable personnel to perform cut-and-patch work.
- E. Submittals:

1. Unless waived by Schaefer Architecture, submit proposal well in advance of time work will be performed and request approval to proceed. Include description of why cutting-and-patching cannot (reasonably) be avoided, how it will be performed, products to be used, firms and tradesmen to perform the work, approximate dates of the work, and anticipated results in terms of variations from the work as originally completed.
 2. Schaefer Architecture may require that the Contractor provide structural engineering services through the project structural engineer at the Contractor's expense.
 3. Where applicable, include cost proposal, suggested alternatives to the cutting-and-patching procedure proposed
- F. Materials: Provide materials for cutting-and-patching which will result in equal-or-better work than the work being cut-and-patched, in terms of performance characteristics and including visual effect where applicable. Comply with the requirements, and use materials identical with the original materials where feasible and where recognized that satisfactory results can be produced thereby.
- G. Whenever possible, execute the work by methods that avoid cutting or patching.
- H. See Alterations article above for additional requirements.
- I. Perform whatever cutting and patching is necessary to:
1. Complete the work.
 2. Fit products together to integrate with other work.
 3. Provide openings for penetration of mechanical, electrical, and other services.
 4. Match work that has been cut to adjacent work.
 5. Repair areas adjacent to cuts to required condition.
 6. Repair new work damaged by subsequent work.
 7. Remove samples of installed work for testing when requested.
 8. Remove and replace defective and non-complying work.
- J. Protection: Construct barriers to separate work areas from occupied areas and to protect building occupants from danger of uncontrolled temperature and pollution. Seal openings as needed to provide such protection.
1. Ventilate areas where dust and odors are produced to the outside.
 2. Provide and maintain filters over building ventilating and return air outlets enveloped by dust enclosures when system ties into occupied areas.
- K. Execute work by methods that avoid damage to other work and that will provide appropriate surfaces to receive patching and finishing. In existing work, minimize damage and restore to original condition.
- L. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.
1. Minimize the use of hammering and chopping tools.
- M. Restore work with new products in accordance with requirements of Contract Documents.
- N. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.
- O. At penetrations of fire rated walls, partitions, ceiling, or floor construction, completely seal voids with fire rated material in accordance with Section 07 84 00, to full thickness of the penetrated element.
- P. Patching:

1. Finish patched surfaces to match finish that existed prior to patching. On continuous surfaces, refinish to nearest intersection or natural break. For an assembly, refinish entire unit.
2. Floors and Walls: Where walls or partitions that are removed extend one finished area into another, patch and repair floor and wall surfaces in the new space. Provide an even surface of uniform finish, color, texture, and appearance. Remove in-place floor and wall coverings and replace with new materials, if necessary, to achieve uniform color and appearance unless otherwise indicated.
3. Ceilings: Patch, repair, or rehang in-place ceilings as necessary or as indicated to provide an even-plane surface of uniform appearance.
4. Match color, texture, and appearance.
5. Repair patched surfaces that are damaged, lifted, discolored, or showing other imperfections due to patching work. If defects are due to condition of substrate, repair substrate prior to repairing finish.
6. Restore exposed finishes of patched areas, and where necessary, extend finish restoration and new finish onto adjoining retained work, in a manner which will eliminate evidence of patching. As an example; where patch occurs in or adjacent to a painted surface, extend final paint coat over the entire unbroken surface containing the patch after patched area has received prime and base coats and whole surface prepared for painting.

3.09 PROGRESS CLEANING

- A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
 1. Clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
- B. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces, and other closed or remote spaces, prior to enclosing the space.
- C. Broom and vacuum clean interior areas prior to start of surface finishing, and continue cleaning to eliminate dust.
- D. Collect and remove waste materials, debris, and trash/rubbish from site periodically and dispose off-site; do not burn or bury.

3.10 PROTECTION OF INSTALLED WORK

- A. Protect existing construction, property and installed work from damage by construction operations, weather and its elements.
- B. Provide special protection where specified in individual specification sections.
- C. Provide temporary and removable protection for installed products. Control activity in immediate work area to prevent damage.
- D. Provide protective coverings at walls, projections, jambs, sills, and soffits of openings.
- E. Protect finished floors, stairs, and other surfaces from traffic, dirt, wear, damage, or movement of heavy objects, by protecting with durable sheet materials.
- F. Prohibit traffic or storage upon waterproofed or roofed surfaces. If traffic or activity is necessary, obtain recommendations for protection from waterproofing or roofing material manufacturer.
- G. Prohibit traffic from landscaped areas.

- H. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.
- I. Remove ice and snow as necessary for safety and proper execution of Work.
- J. Brace all construction to prevent damage from wind and construction loading.
- K. Transport, handle, store and erect materials in a manner to keep them free from injury.
- L. Repair damaged materials, systems, equipment and the like. If satisfactory repair cannot be attained, replace damaged products with equally aesthetic and serviceable products, systems and equipment.
- M. Clean off any foreign materials accidentally deposited on finish surfaces and, where such would stain, corrode or otherwise disfigure, clean same immediately with material that will not damage finished work.

3.11 SYSTEM STARTUP

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Schaefer Architecture and Owner seven days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, and for conditions that may cause damage.
- D. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.
- G. When specified in individual specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, 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.

3.12 DEMONSTRATION AND INSTRUCTION

- A. See Section 01 79 00 - Demonstration and Training.

3.13 ADJUSTING

- A. Adjust operating products and equipment to ensure smooth and unhindered operation.
- B. Adjust windows, doors, drawers, hardware, appliances, motors, valves, controls, and other equipment for proper operation.
- C. Seal exterior joints between materials to form a weathertight enclosure.
- D. Touch up imperfections in surfaces, paint, and other finishes after all Contractors and tradesmen have completed their work.
- E. Completed work shall be thoroughly clean and free from foreign materials and stains.
- F. Clean surfaces using appropriate materials and methods that will thoroughly clean but not damage materials and their finishes, not damage or adversely affect other materials in the project.

3.14 FINAL CLEANING

- A. Execute final cleaning prior to Substantial Completion.

1. Clean areas to be occupied by Owner prior to final completion before Owner occupancy.
2. 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.
- B. Use cleaning materials that are nonhazardous.
- C. Clean interior and exterior glass, surfaces exposed to view; remove temporary labels, stains and foreign substances, polish transparent and glossy surfaces, vacuum carpeted and soft surfaces.
- D. Remove all labels that are not permanent. Do not paint or otherwise cover fire test labels or nameplates on mechanical and electrical equipment.
- E. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and material being cleaned.
- F. Wipe surfaces of mechanical and electrical equipment and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances
- G. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
- H. Replace filters of operating equipment.
- I. Clean debris from roofs, gutters, downspouts, scuppers, overflow drains, area drains, and drainage systems.
- J. Clean site; sweep paved areas, rake clean landscaped surfaces.
- K. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.15 CLOSEOUT PROCEDURES

- A. Preliminary Procedures: Before requesting inspection for determining date of Substantial Completion, complete the following:
 1. Prepare a list of items to be completed and corrected (punch list), the value of items on the list, and reasons why the Work is not complete.
 2. Advise Owner of pending insurance changeover requirements.
 3. Advise Owner of pending utility changeover requirements if applicable.
 4. Make final changeover of permanent locks and deliver keys to Owner. Advise Owner's personnel of changeover in security provisions.
 5. Deliver tools, spare parts, extra materials, and similar items to location designated by Owner. Label with manufacturer's name and model number where applicable.
 6. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
 7. Submit changeover information related to Owner's occupancy, use, operation, and maintenance.
 8. Complete final cleaning requirements, including touchup painting.
 9. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- B. Make submittals that are required by governing or other authorities.
 1. Provide copies to Schaefer Architecture.
- C. Notify Schaefer Architecture when work is considered ready for Schaefer Architecture's Substantial Completion inspection.

- D. Submit written certification containing Contractor's Correction Punch List, that Contract Documents have been reviewed, work has been inspected, and that work is complete (by Contractor and Subcontractors) in accordance with Contract Documents and ready for Schaefer Architecture's Substantial Completion inspection.
 - 1. Separate inspections for mechanical, electrical and general construction work and equipment shall be arranged in the same basic time period by Schaefer Architecture, engineers and consultants.
 - 2. Schaefer Architecture may decline to perform the inspection if the building (or designated portion) can not be used for the intended purpose.
 - 3. Schaefer Architecture may also terminate the inspection at any time if the amount and/or type of incomplete work demonstrates that the building can not be used for the intended purpose without generating an inspection report.
- E. Conduct Substantial Completion inspection and create Final Correction Punch List containing Schaefer Architecture's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Schaefer Architecture.
- F. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.
- G. Notify Schaefer Architecture when work is considered finally complete and ready for Schaefer Architecture's Substantial Completion final inspection.
- H. Complete items of work determined by Schaefer Architecture listed in executed Certificate of Substantial Completion.
- I. All additional inspections incurred by Schaefer Architecture and/or consultants because of incomplete or unsatisfactory work will be charged to the Contractor. Time will be billed through the Owner at \$120 per worker hour for time chargeable to the Project whether on site, traveling, or in office. Payments to be deducted from amounts owed to the Contractor by the Owner without any additional action required by the Owner, Schaefer Architecture, or Contractor.

3.16 MAINTENANCE

- A. Provide service and maintenance of components indicated in specification sections.

END OF SECTION

SECTION 01 78 00 - CLOSEOUT SUBMITTALS**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Project record documents.
- B. Operation and maintenance data.
- C. Warranties.

1.02 SUBMITTALS

- A. Project Record Documents: Submit documents to Schaefer Architecture with claim for final Application for Payment.
- B. Operation and Maintenance Data:
 - 1. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance. Submit two copies.
- C. Warranties:
 - 1. For equipment or component parts of equipment put into service during construction with Owner's permission, submit documents within 10 days after acceptance.
 - 2. Make other submittals within 10 days after Date of Substantial Completion, prior to final Application for Payment.
 - 3. For items of Work for which acceptance is delayed beyond Date of Substantial Completion, submit within 10 days after acceptance, listing the date of acceptance as the beginning of the warranty period.
- D. Consent of Surety to Final Payment, on AIA Form G707. Submit one electronic copy.
- E. Contractor's Affidavit of Payment of Debts and Claims, AIA Document G706. Submit one electronic copy.
- F. Contractor's Affidavit of Release of Liens, AIA Document G706A. Submit one electronic copy.
- G. Contractor's Release or Waiver of Liens, conditional upon receipt of payment, on the Contractor's letterhead. Submit one electronic copy.
 - 1. The Owner reserves the right to require any other data necessary to establish satisfactory payment of all contractual obligations.
- H. Sales Tax Exemption Certificate. Submit one electronic copy.
- I. If required by Owner or Schaefer Architecture, one copy each of all invoices properly identified with the Sales Tax Exemption number as required by the State of Kansas. The Contractor shall retain such invoices for a period of not less than five years.
- J. For the Owner's records, submit copies of permits, licenses, certifications, inspection reports, releases, jurisdictional settlements, notices, receipts for fee payments, judgments, and similar documents, correspondence and records established in conjunction with compliance with standards and regulations bearing upon performance of the work.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.01 PROJECT RECORD DOCUMENTS**

- A. Maintain on site one set of the following record documents; record actual revisions to the Work:
 - 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 Drawings and Shop Drawings: Legibly mark each item to record actual construction including:
 - 1. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
 - 2. Field changes of dimension and detail.
 - 3. Details not on original Contract drawings.

3.02 OPERATION AND MAINTENANCE DATA

- A. Source Data: For each product or system, list names, addresses and telephone numbers of Subcontractors and suppliers, including local source of supplies and replacement parts.
- B. Product Data: Mark each sheet to clearly identify specific products and component parts, and data applicable to installation. Delete inapplicable information.
- C. Drawings: Supplement product data to illustrate relations of component parts of equipment and systems, to show control and flow diagrams. Do not use Project Record Documents as maintenance drawings.
- D. Typed Text: As required to supplement product data. Provide logical sequence of instructions for each procedure, incorporating manufacturer's instructions.

3.03 OPERATION AND MAINTENANCE DATA FOR MATERIALS AND FINISHES

- A. Instructions for Care and Maintenance: Manufacturer's recommendations for cleaning agents and methods, precautions against detrimental cleaning agents and methods, and recommended schedule for cleaning and maintenance.
- B. Moisture protection and weather-exposed products: Include product data listing applicable reference standards, chemical composition, and details of installation. Provide recommendations for inspections, maintenance, and repair.
- C. Additional information as specified in individual product specification sections.

- D. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.

3.04 OPERATION AND MAINTENANCE DATA FOR EQUIPMENT AND SYSTEMS

- A. For Each Item of Equipment and Each System:
 - 1. Description of unit or system, and component parts.
 - 2. Identify function, normal operating characteristics, and limiting conditions.
 - 3. Include performance curves, with engineering data and tests.
 - 4. Complete nomenclature and model number of replaceable parts.
- B. Where additional instructions are required, beyond the manufacturer's standard printed instructions, have instructions prepared by personnel experienced in the operation and maintenance of the specific products.
- C. Operating Procedures: Include start-up, break-in, and routine normal operating instructions and sequences. Include regulation, control, stopping, shut-down, and emergency instructions. Include summer, winter, and any special operating instructions.
- D. Maintenance Requirements: Include routine procedures and guide for preventative maintenance and trouble shooting; disassembly, repair, and reassembly instructions; and alignment, adjusting, balancing, and checking instructions.
- E. Provide servicing and lubrication schedule, and list of lubricants required.
- F. Include manufacturer's printed operation and maintenance instructions.
- G. Include sequence of operation by controls manufacturer.
- H. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.
- I. Include test and balancing reports.
- J. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

- A. Assemble operation and maintenance data for Owner's personnel use, with data arranged in the same sequence as, and identified by, the specification sections.
- B. Where systems involve more than one specification section, provide separate tabs dividing each system.
- C. Submit operations and maintenance manuals in a PDF electronic file.
- D. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Schaefer Architecture, Consultants, Contractor and subcontractors, with names of responsible parties.
- E. Tables of Contents: List every item by a bookmark that allows for easy access of content.
- F. Arrangement of Contents: Organize as follows:
 - 1. Project Directory.
 - 2. Table of Contents.
 - 3. Operation and Maintenance Data: Arranged by system, then by product category.
 - a. Source data.
 - b. Product data, shop drawings, and other submittals.
 - c. Operation and maintenance data.
 - d. Field quality control data.
 - e. Photocopies of warranties and bonds.

4. Design Data: To allow for addition of design data furnished by Schaefer Architecture or others, provide a bookmark "Design Data".

3.06 WARRANTIES

- A. For all pieces of operating equipment and system provided by any trade for this Project and when warranties or guarantees are otherwise specified, submit written guarantee or warranty documents which shall include the following information:
 1. Name and address of Project and Owner.
 2. Article, material or system covered.
 3. Name and address of Installing contractor.
 4. Name and address of Prime Contractor.
 5. Signature of individual authorized to sign contracts for the company issuing the guarantee.
- B. Verify that documents are in proper form, contain full information, and are notarized.
- C. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
 1. Scan warranties and assemble complete warranty submittal package into a single indexed electronic PDF file with links enabling navigation to each item. Provide table of contents at beginning of document.
- D. The following terms (minimum) shall be incorporated:
 1. Duration, one year or as specified, dated from "Date of Substantial Completion." This shall be in addition to and not a limitation of other rights the Owner may have under the Contract Documents.
 2. The article, material or system is free from defective materials and workmanship.
 3. Costs of repair or replacement shall not accrue to the Owner including repair or replacement of other work disturbed by repair or replacement.
- E. Guarantees which are standard guarantees provided by a manufacturer for his product shall be received by the Contractor, filled out and filed with the company for the Owner. Certificates or registration stubs shall be included with the shop drawings submitted for the Owner upon completion of the work. The Contractor's responsibility stipulated in the paragraph before this one, terminates as stipulated therein. The Owner shall administrate manufacturer's warranties/guarantees thereafter.
- F. Co-execute submittals when required.

END OF SECTION

SECTION 01 79 00 - DEMONSTRATION AND TRAINING**PART 1 GENERAL****1.01 SUMMARY**

- A. Demonstration of products and systems where indicated in specific specification sections.
- B. Training of Owner personnel in operation and maintenance is required for:
 - 1. All software-operated systems.
 - 2. HVAC systems and equipment.
 - 3. Plumbing equipment.
 - 4. Electrical systems and equipment.
 - 5. Items specified in individual product Sections.

1.02 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Training Reports:
 - 1. Identification of each training session, date, time, and duration.
 - 2. Sign-in sheet showing names and job titles of attendees.

1.03 QUALITY ASSURANCE

- A. Instructor Qualifications: Familiar with design, operation, maintenance and troubleshooting of the relevant products and systems.
 - 1. Provide as instructors the most qualified trainer of those contractors and/or installers who actually supplied and installed the systems and equipment.
 - 2. Where a single person is not familiar with all aspects, provide specialists with necessary qualifications.

PART 2 PRODUCTS - NOT USED**PART 3 EXECUTION****3.01 DEMONSTRATION - GENERAL**

- A. Demonstrations conducted during system start-up do not qualify as demonstrations for the purposes of this section, unless approved in advance by Owner.
- B. Demonstration may be combined with Owner personnel training if applicable.
- C. Operating Equipment and Systems: Demonstrate operation in all modes, including start-up, shut-down, seasonal changeover, emergency conditions, and troubleshooting, and maintenance procedures, including scheduled and preventive maintenance.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.
 - 2. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.
- D. Non-Operating Products: Demonstrate cleaning, scheduled and preventive maintenance, and repair procedures.
 - 1. Perform demonstrations not less than two weeks prior to Substantial Completion.

3.02 TRAINING - GENERAL

- A. Conduct training on-site unless otherwise indicated.
- B. Training schedule will be subject to availability of Owner's personnel to be trained; re-schedule training sessions as required by Owner; once schedule has been approved by

Owner failure to conduct sessions according to schedule will be cause for Owner to charge Contractor for personnel "show-up" time.

1. Installing subcontractor/supplier, Schaefer Architecture, Engineer/Consultant shall be invited.
- C. Review of Facility Policy on Operation and Maintenance Data: During training discuss:
1. The location of the O&M manuals and procedures for use and preservation; backup copies.
 2. Typical contents and organization of all manuals, including explanatory information, system narratives, and product specific information.
 3. Typical uses of the O&M manuals.
- D. Product- and System-Specific Training:
1. Review the applicable O&M manuals.
 2. For systems, provide an overview of system operation, design parameters and constraints, and operational strategies.
 3. Review instructions for proper operation in all modes, including start-up, shut-down, seasonal changeover and emergency procedures, and for maintenance, including preventative maintenance.
 4. Provide hands-on training on all operational modes possible and preventive maintenance.
 5. Emphasize safe and proper operating requirements; discuss relevant health and safety issues and emergency procedures.
 6. Discuss common troubleshooting problems and solutions.
 7. Discuss any peculiarities of equipment installation or operation.
 8. Discuss warranties and guarantees, including procedures necessary to avoid voiding coverage.
 9. Review recommended tools and spare parts inventory suggestions of manufacturers.
 10. Review spare parts and tools required to be furnished by Contractor.
 11. Review spare parts suppliers and sources and procurement procedures.
- E. Be prepared to answer questions raised by training attendees; if unable to answer during training session, provide written response within three days.

END OF SECTION

SECTION 02 41 00 - DEMOLITION**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Selective demolition of building elements for alteration purposes.
- B. Abandonment and removal of existing utilities and utility structures.

1.02 RELATED REQUIREMENTS

- A. Section 01 10 00 - Summary: Limitations on General Contractor's use of site and premises.
- B. Section 01 10 00 - Summary: Sequencing and staging requirements.
- C. Section 01 10 00 - Summary: Description of items to be removed by Owner.
- D. Section 01 10 00 - Summary: Description of items to be salvaged or removed for re-use by General Contractor.
- E. Section 01 50 00 - Temporary Facilities and Controls: Site fences, security, protective barriers, and waste removal.
- F. Section 01 60 00 - Product Requirements: Handling and storage of items removed for salvage and relocation.
- G. Section 01 70 00 - Execution and Closeout Requirements: Project conditions; protection of bench marks, survey control points, and existing construction to remain; reinstallation of removed products; temporary bracing and shoring.

1.03 REFERENCE STANDARDS

- A. 29 CFR 1926 - Safety and Health Regulations for Construction; Current Edition.
- B. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2022, with Errata (2021).

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Site Plan: Showing:
 - 1. Areas for temporary construction and field offices.
 - 2. Areas for temporary and permanent placement of removed materials.
- C. Project Record Documents: Accurately record actual locations of capped and active utilities and subsurface construction.

1.05 QUALITY ASSURANCE

- A. Demolition Firm Qualifications: Company specializing in the type of work required.
 - 1. Minimum of three years of documented experience.

PART 2 PRODUCTS -- NOT USED**PART 3 EXECUTION****3.01 SCOPE**

- A. Remove portions of existing buildings
- B. Remove other items indicated, for salvage and relocation.

3.02 GENERAL PROCEDURES AND PROJECT CONDITIONS

- A. Comply with other requirements specified in Section 01 70 00.
- B. Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.

1. Obtain required permits.
2. Use of explosives is not permitted.
3. Take precautions to prevent catastrophic or uncontrolled collapse of structures to be removed; do not allow worker or public access within range of potential collapse of unstable structures.
 - a. Proceed with demolition of structural framing members systematically, from higher to lower level. Complete building demolition operations above each floor or tier before disturbing supporting members on the next lower level.
 - b. Remove debris from elevated portions of the building by chute, hoist, or other device that will convey debris to grade level in a controlled descent.
 - c. Remove structural framing members and lower to ground by method suitable to minimize ground impact and dust generation.
4. Provide, erect, and maintain temporary barriers and security devices.
5. Use physical barriers to prevent access to areas that could be hazardous to workers or the public.
6. Conduct operations to minimize effects on and interference with adjacent structures and occupants.
7. Do not close or obstruct roadways or sidewalks without permit.
8. Conduct operations to minimize obstruction of public and private entrances and exits; do not obstruct required exits at any time; protect persons using entrances and exits from removal operations.
9. Obtain written permission from owners of adjacent properties when demolition equipment will traverse, infringe upon or limit access to their property.
- C. Do not begin removal until receipt of notification to proceed from Owner.
- D. Do not begin removal until built elements to be salvaged or relocated have been removed.
- E. Do not begin removal until vegetation to be relocated has been removed and specified measures have been taken to protect vegetation to remain.
- F. Protect existing structures and other elements that are not to be removed.
 1. Provide bracing and shoring.
 2. Prevent movement or settlement of adjacent structures.
 3. Stop work immediately if adjacent structures appear to be in danger.
- G. Promptly repair damages caused to adjacent facilities by demolition work.
- H. Minimize production of dust due to demolition operations; do not use water if that will result in ice, flooding, sedimentation of public waterways or storm sewers, or other pollution.
- I. If hazardous materials are discovered during removal operations, stop work and notify Schaefer Architecture and Owner; hazardous materials include regulated asbestos containing materials, lead, PCB's, and mercury.
- J. Perform demolition in a manner that maximizes salvage and recycling of materials.
 1. Dismantle existing construction and separate materials.
 2. Set aside reusable, recyclable, and salvageable materials; store and deliver to collection point or point of reuse.
- K. Refrigerant: Remove refrigerant from mechanical equipment according to 40 CFR 82 and regulations of authorities having jurisdiction before starting demolition.

3.03 EXISTING UTILITIES

- A. Coordinate work with utility companies; notify before starting work and comply with their requirements; obtain required permits.
- B. Protect existing utilities to remain from damage.
- C. Do not disrupt public utilities without permit from authority having jurisdiction.
- D. Do not close, shut off, or disrupt existing life safety systems that are in use without at least 7 days prior written notification to Owner.
- E. Do not close, shut off, or disrupt existing utility branches or take-offs that are in use without at least 3 days prior written notification to Owner.
- F. Locate and mark utilities to remain; mark using highly visible tags or flags, with identification of utility type; protect from damage due to subsequent construction, using substantial barricades if necessary.
- G. Unused underground piping may be abandoned in place provided it is completely drained and capped; remove exposed piping, valves, meters, equipment, supports, and foundations of disconnected and abandoned utilities.
- H. Prepare building demolition areas by disconnecting and capping utilities outside the demolition zone; identify and mark utilities to be subsequently reconnected, in same manner as other utilities to remain.

3.04 SELECTIVE DEMOLITION FOR ALTERATIONS

- A. Drawings showing existing construction and utilities are based on casual field observation and existing record documents only.
 - 1. Verify that construction and utility arrangements are as indicated.
 - 2. Report discrepancies to Schaefer Architecture before disturbing existing installation.
 - 3. Beginning of demolition work constitutes acceptance of existing conditions that would be apparent upon examination prior to starting demolition.
- B. Demolition work for remodeling and replacement of work within existing remaining building shall be done by subcontractors and trades who shall be responsible for removing equipment and materials from the building. Except for Owner's salvage, items removed shall become the property of General Contractor. Refer Section 01 10 00, who shall also be responsible for disposing of it as waste or salvage. Owner has first salvage rights.
- C. Demolition work is not specified in detail. Much of the work will be implied by indications on the drawings. For example, removing of a wall may involve removal and patching of the surface preparatory for new finish; piping being removed to at least behind the wall surface; removal of systems extending into areas not being demolished but systems will become inoperative. Complete removal of such systems may not be required except to avoid conflict with other work and finished appearance; removal of doors will involve removing of anchorage, furring, grounds, etc.
- D. Work is shown and called out to be "removed." When the word "removed" is used without any modifiers, it shall mean that it and any associate items built with or into it shall be disconnected, removed, services terminated, or treated as otherwise noted.
- E. Where "removed" is modified those instructions shall be followed. Remaining construction shall be patched and finished equivalent to other similar and remaining work.
- F. Separate areas in which demolition is being conducted from other areas that are still occupied.

1. Provide, erect, and maintain temporary dustproof partitions of construction specified in Section 01 50 00 .
- G. Maintain weatherproof exterior building enclosure except for interruptions required for replacement or modifications; take care to prevent water and humidity damage.
 1. Provide adequate dams and protection to prevent rain water from entering into the existing building.
- H. Remove existing work as indicated and as required to accomplish new work.
 1. Remove items indicated on drawings.
 2. Stock pile removed items such as existing ceiling tile, glazed tile block and trim which is removed as part of the demolition work to be used as patch materials to match surrounding surfaces where areas are indicated to be patched or filled.
- I. Services (Including but not limited to HVAC, Plumbing, Fire Protection, Electrical, and Telecommunications): Remove existing systems and equipment as indicated.
 1. Maintain existing active systems that are to remain in operation; maintain access to equipment and operational components.
 2. Where existing active systems serve occupied facilities but are to be replaced with new services, maintain existing systems in service until new systems are complete and ready for service.
 3. See Section 01 10 00 for other limitations on outages and required notifications.
 4. Verify that abandoned services serve only abandoned facilities before removal.
 5. Remove abandoned pipe, ducts, conduits, and equipment, including those above accessible ceilings or in tunnels where indicated; remove back to source of supply where possible, otherwise cap stub and tag with identification.
- J. Protect existing work to remain.
 1. Prevent movement of structure; provide shoring and bracing if necessary.
 2. Perform cutting to accomplish removals neatly and as specified for cutting new work.
 - a. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping, to minimize disturbance of adjacent surfaces.
 - b. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
 3. Repair adjacent construction and finishes damaged during removal work.
 4. Patch as specified for patching new work.
- K. Moveable Equipment: The Owner shall cooperate with the General Contractor and will move their property and the residents as specified in 01 10 00 Sequencing and staging requirements. The General Contractor shall schedule and coordinate the work with the Owner to allow time to accomplish the work. There may be times and situations when minimal amount of work is required that the General Contractor will find it expeditious to move furniture out of workers way. Perform such work.

3.05 DEBRIS AND WASTE REMOVAL

- A. Remove debris, junk, and trash from site.
 1. Legally dispose of materials in a landfill. Do not burn demolished materials.
- B. Leave site in clean condition, ready for subsequent work.
- C. Clean up spillage and wind-blown debris from public and private lands.

END OF SECTION

SECTION 03 10 00 - CONCRETE FORMING AND ACCESSORIES**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Formwork for cast-in place concrete, with bracing and anchorage.
- B. Openings for other work.
- C. Form accessories.
- D. Form stripping.

1.02 RELATED REQUIREMENTS

- A. Section 03 20 00 - Concrete Reinforcing.
- B. Section 03 30 00 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ACI 117 - Standard Specifications for Tolerances for Concrete Construction and Materials; 2010.
- B. ACI 301 - Specifications for Structural Concrete; 2016.
- C. ACI 318 - Building Code Requirements for Structural Concrete; 2019 (Reapproved 2022).
- D. ACI 347R - Guide to Formwork for Concrete; 2014.
- E. ASME A17.1 - Safety Code for Elevators and Escalators; 2019.
- F. ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation; 2015a.
- G. PS 1 - Structural Plywood; 2009.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pertinent dimensions, materials, bracing, special form joints and reveals, and arrangement, location and pattern of joints and ties. Review is for general architectural applications and features only. Designing formwork for structural stability and efficiency is Contractor's responsibility.
- C. Product Data: Material and type of form liners.

PART 2 PRODUCTS**2.01 FORMWORK - GENERAL**

- A. Provide concrete forms, accessories, and bracing as required to accomplish cast-in-place concrete work .
- B. Design and construct to provide resultant concrete that conforms to design with respect to shape, lines, and dimensions.
- C. Comply with applicable state and local codes with respect to design, fabrication, erection, and removal of formwork.
- D. Comply with relevant portions of ACI 301, ACI 318, ACI 347R, ACI 301, ACI 318, ACI 347R, ACI 301, ACI 318, and ACI 347R.

2.02 WOOD FORM MATERIALS

- A. Softwood Plywood: PS 1, B-B High Density Concrete Form Overlay, Class I.
- B. Plywood: PS 1, B-B Concrete Form Panels, Class 1, Exterior Grade, mill-applied release agent and edge sealed.

2.03 FORMWORK ACCESSORIES

- A. Form Release Agent: Capable of releasing forms from hardened concrete without staining or discoloring concrete or forming bugholes and other surface defects, compatible with concrete and form materials, and not requiring removal for satisfactory bonding of coatings to be applied.
 - 1. Composition: Colorless reactive, mineral oil-based, soy-based, or vegetable-oil based compound.
 - 2. Do not use materials containing diesel oil or petroleum-based compounds.
 - 3. Products:
 - a. SpecChem, LLC; Bio Strip WB (water-based): www.specchemllc.com/#sle.
 - b. W. R. Meadows, Inc; Duogard: www.wrmeadows.com/sle.
 - c. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Filler Strips for Chamfered Corners: Rigid plastic type; 3/4 x 3/4 inch (19 x 19 mm) size; maximum possible lengths.
- C. Nails, Spikes, Lag Bolts, Through Bolts, Anchorages: Sized as required, of sufficient strength and character to maintain formwork in place while placing concrete.
- D. Embedded Anchor Shapes, Plates, Angles and Bars: As specified in Section 05 12 00.

PART 3 EXECUTION**3.01 EXAMINATION**

- A. Verify lines, levels and centers before proceeding with formwork. Ensure that dimensions agree with drawings.

3.02 EARTH FORMS

- A. Hand trim sides and bottom of earth forms. Remove loose soil prior to placing concrete.

3.03 ERECTION - FORMWORK

- A. Erect formwork, shoring and bracing to achieve design requirements, in accordance with requirements of ACI 301.
- B. Provide bracing to ensure stability of formwork. Shore or strengthen formwork subject to overstressing by construction loads.
- C. Arrange and assemble formwork to permit dismantling and stripping. Do not damage concrete during stripping. Permit removal of remaining principal shores.
- D. Arrange form-facing material in an orderly and symmetrical manner with a minimum of seams.
- E. Align joints and make watertight. Keep form joints to a minimum.
- F. Obtain approval before framing openings in structural members that are not indicated on drawings.
- G. Coordinate this section with other sections of work that require attachment of components to formwork.
- H. If formwork is placed after reinforcement, resulting in insufficient concrete cover over reinforcement, request instructions from Schaefer Architecture before proceeding.

3.04 APPLICATION - FORM RELEASE AGENT

- A. Apply form release agent on formwork in accordance with manufacturer's recommendations. Use low-VOC compound.
- B. Apply prior to placement of reinforcing steel, anchoring devices, and embedded items.

- C. Coat steel forms with a nonstaining, rust preventative material. Rust-stained steel formwork is not acceptable.
- D. Do not apply form release agent where concrete surfaces will receive special finishes or applied coverings that are affected by agent. Soak inside surfaces of untreated forms with clean water. Keep surfaces coated prior to placement of concrete.

3.05 INSERTS, EMBEDDED PARTS, AND OPENINGS

- A. Provide formed openings where required for items to be embedded in passing through concrete work.
- B. Locate and set in place items that will be cast directly into concrete.
- C. Coordinate with work of other sections in forming and placing openings, slots, reglets, recesses, sleeves, bolts, anchors, other inserts, and components of other work.
- D. Install accessories in accordance with manufacturer's instructions, so they are straight, level, and plumb. Ensure items are not disturbed during concrete placement.
- E. Provide temporary ports or openings in formwork where required to facilitate cleaning and inspection. Locate openings at bottom of forms to allow flushing water to drain.
- F. Close temporary openings with tight fitting panels, flush with inside face of forms, and neatly fitted so joints will not be apparent in exposed concrete surfaces.

3.06 FORM CLEANING

- A. Clean forms as erection proceeds, to remove foreign matter within forms.
- B. Clean formed cavities of debris prior to placing concrete.
 - 1. Flush with water or use compressed air to remove remaining foreign matter. Ensure that water and debris drain to exterior through clean-out ports.
 - 2. During cold weather, remove ice and snow from within forms. Do not use de-icing salts. Do not use water to clean out forms, unless formwork and concrete construction proceed within heated enclosure. Use compressed air or other means to remove foreign matter.

3.07 FORMWORK TOLERANCES

- A. Construct formwork to maintain tolerances required by ACI 117, unless otherwise indicated.
- B. Construct and align formwork for elevator hoistway in accordance with ASME A17.1.
- C. Camber slabs and beams in accordance with ACI 301.

3.08 FIELD QUALITY CONTROL

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. Inspect erected formwork, shoring, and bracing to ensure that work is in accordance with formwork design, and to verify that supports, fastenings, wedges, ties, and items are secure.
- C. Do not reuse wood formwork more than two times for concrete surfaces to be exposed to view. Do not patch formwork.
- D. Split, frayed, delaminated or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-coating compound as specified for new formwork.

3.09 FORM REMOVAL

- A. Do not remove forms or bracing until concrete has gained sufficient strength to carry its own weight and imposed loads.
- B. Formwork not supporting weight of concrete, such as sides of beams, walls, columns and similar parts of the work, may be removed after cumulatively curing at not less than 50 deg F (10 deg C) for 24 hours after placing concrete, provided concrete is sufficiently hard to not be damaged by form-removal operations and providing curing and protection operations are maintained.
- C. Formwork supporting weight of concrete, such as beam soffits, joists, slabs and other structural elements, may not be removed in less than 14 days or until concrete has attained at least 75 percent of design minimum compressive strength at 28 days.
Determine potential compressive strength of in-place concrete by testing field-cured specimens representative of concrete location or members.
- D. Form-facing material may be removed 4 days after placement only if shores and other vertical supports have been arranged to permit removal of form-facing material without loosening or disturbing shores and supports.
- E. Loosen forms carefully. Do not wedge pry bars, hammers, or tools against finish concrete surfaces scheduled for exposure to view.
- F. Store removed forms to prevent damage to form materials or to fresh concrete. Discard damaged forms.

END OF SECTION

SECTION 03 20 00 - CONCRETE REINFORCING**PART 1 GENERAL****1.01 SECTION INCLUDES**

- A. Reinforcing steel for cast-in-place concrete.
- B. Supports and accessories for steel reinforcement.

1.02 RELATED REQUIREMENTS

- A. Section 03 10 00 - Concrete Forming and Accessories.
- B. Section 03 30 00 - Cast-in-Place Concrete.

1.03 REFERENCE STANDARDS

- A. ACI 301 - Specifications for Structural Concrete; 2016.
- B. ACI 318 - Building Code Requirements for Structural Concrete; 2019 (Reapproved 2022).
- C. ACI SP-66 - ACI Detailing Manual; 2004.
- D. ASTM A615/A615M - Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement; 2022.
- E. ASTM A706/A706M - Standard Specification for Deformed and Plain Low-Alloy Steel Bars for Concrete Reinforcement; 2022a.
- F. ASTM A1064/A1064M - Standard Specification for Carbon-Steel Wire and Welded Wire Reinforcement, Plain and Deformed, for Concrete; 2018a.
- G. AWS D1.4/D1.4M - Structural Welding Code - Steel Reinforcing Bars; 2018, with Amendment (2020).
- H. CRSI (DA4) - Manual of Standard Practice; 2009.
- I. CRSI (P1) - Placing Reinforcing Bars; 2011.

1.04 SUBMITTALS

- A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Comply with requirements of ACI SP-66. Include bar schedules, shapes of bent bars, spacing of bars, and location of splices. Include special reinforcing required for openings through concrete structures.
 - 1. Prepare shop drawings under the supervision of a Professional Structural Engineer experienced in design of work of this type and licensed in Kansas.
- C. Manufacturer's Certificate: Certify that reinforcing steel and accessories supplied for this project meet or exceed specified requirements.

1.05 QUALITY ASSURANCE

- A. Perform work of this section in accordance with ACI 301.

PART 2 PRODUCTS**2.01 REINFORCEMENT**

- A. Reinforcement Accessories:
 - 1. Tie Wire: Annealed, minimum 16 gage, 0.0508 inch (1.29 mm).
 - 2. Chairs, Bolsters, Bar Supports, Spacers: Sized and shaped for adequate support of reinforcing bars, dowels and welded wire reinforcement during concrete placement.
 - 3. For slabs-on-grade and footings, use supports with sand plates or horizontal runners where base material will not support chair legs.

4. For exposed-to-view concrete surfaces and directly plastered surfaces, where legs of supports are in contact with forms: Provide stainless steel or plastic components for placement within 1-1/2 inches (38 mm) of weathering surfaces.
5. Slabs-on-grade Joint Dowel Bars: ASTM A615/A615M Grade 60 (420) smooth steel bars, cut true to length with ends square and free of burrs.

2.02 FABRICATION

- A. Fabricate concrete reinforcing in accordance with CRSI (DA4) - Manual of Standard Practice.
- B. Welding of reinforcement is not permitted, except where specifically defined on the drawings. Weld reinforcing bars according to AWS D1.4/D1.4M where specifically required.
- C. Locate reinforcing splices not indicated on drawings at point of minimum stress.
 1. Review locations of splices with Schaefer Architecture.
 2. Clearly define all splice locations on the shop drawing submittal.

PART 3 EXECUTION

3.01 PLACEMENT

- A. Place, support and secure reinforcement against displacement. Do not deviate from required position. Do not tack weld crossing reinforcing bars.
- B. Comply with Concrete Reinforcing Steel Institute's recommended practice for "Placing Reinforcing Bars", for details and methods of reinforcement placement and supports and as specified.
- C. Clean reinforcement of loose rust and mill scale, earth, ice and other materials that reduce or destroy bond with concrete.
- D. Conform to applicable code for concrete cover over reinforcement.
- E. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement operations. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- F. Bond and ground all reinforcement to requirements of Electrical Specifications.

3.02 FIELD QUALITY CONTROL

- A. An independent testing agency, as specified in Section 01 40 00, will inspect installed reinforcement for conformance to contract documents before concrete placement.

END OF SECTION

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE**PART 1 GENERAL****1.01 Section Includes**

- A. Miscellaneous concrete elements, including .
- B. Concrete curing.

1.02 Related Requirements

- A. Section 03 10 00 - Concrete Forming and Accessories: Forms and accessories for formwork.
- B. Section 03 20 00 - Concrete Reinforcing.

1.03 Reference Standards

- A. ACI CODE-318 - Building Code Requirements for Structural Concrete and Commentary; 2019 (Reapproved 2022).
- B. ACI PRC-211.1 - Selecting Proportions for Normal-Density and High Density-Concrete - Guide; 2022.
- C. ACI PRC-213 - Guide for Structural Lightweight-Aggregate Concrete; 2014 (Reapproved 2023).
- D. ACI PRC-302.1 - Guide to Concrete Floor and Slab Construction; 2015.
- E. ACI PRC-304 - Guide for Measuring, Mixing, Transporting, and Placing Concrete; 2000 (Reapproved 2009).
- F. ACI PRC-305 - Guide to Hot Weather Concreting; 2020.
- G. ACI PRC-306 - Guide to Cold Weather Concreting; 2016.
- H. ACI PRC-308 - Curing of Concrete—Guide; 2026.
- I. ACI SPEC-301 - Specifications for Concrete Construction; 2020.
- J. ASTM C33/C33M - Standard Specification for Concrete Aggregates; 2018.
- K. ASTM C39/C39M - Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens; 2021.
- L. ASTM C42/C42M - Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete Standard Test Method for Obtaining and Testing Drilled Cores and Sawed Beams of Concrete; 2020.
- M. ASTM C94/C94M - Standard Specification for Ready-Mixed Concrete; 2021a.
- N. ASTM C109/C109M - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2-in. or (50-mm) Cube Specimens); 2013.
- O. ASTM C143/C143M - Standard Test Method for Slump of Hydraulic-Cement Concrete; 2020.
- P. ASTM C150/C150M - Standard Specification for Portland Cement; 2021.
- Q. ASTM C171 - Standard Specification for Sheet Materials for Curing Concrete; 2007.
- R. ASTM C173/C173M - Standard Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method; 2016.
- S. ASTM C231 - Standard Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method; 2017.

- T. ASTM C260/C260M - Standard Specification for Air-Entraining Admixtures for Concrete; 2010a (Reapproved 2016).
- U. ASTM C330/C330M - Standard Specification for Lightweight Aggregates for Structural Concrete; 2017a.
- V. ASTM C494/C494M - Standard Specification for Chemical Admixtures for Concrete; 2019.
- W. ASTM C595/C595M - Standard Specification for Blended Hydraulic Cements; 2017.
- X. ASTM C618 - Standard Specification for Coal Fly Ash and Raw or Calcined Natural Pozzolan for Use in Concrete; 2019.
- Y. ASTM C881/C881M - Standard Specification for Epoxy-Resin-Base Bonding Systems for Concrete; 2014.
- Z. ASTM C979/C979M - Standard Specification for Pigments for Integrally Colored Concrete; 2016.
- AA. ASTM C1064/C1064M - Standard Test Method for Temperature of Freshly Mixed Hydraulic-Cement Concrete; 2017.
- BB. ASTM C1107/C1107M - Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink); 2014.
- CC. ASTM C1116/C1116M - Standard Specification for Fiber-Reinforced Concrete; 2010a (Reapproved 2015).
- DD. ASTM D1751 - Standard Specification for Preformed Expansion Joint Filler for Concrete Paving and Structural Construction (Nonextruding and Resilient Bituminous Types); 2018.
- EE. ASTM D2103 - Standard Specification for Polyethylene Film and Sheeting; 2015.
- FF. ASTM E96/E96M - Standard Test Methods for Water Vapor Transmission of Materials; 2016.
- GG. ASTM E1155/E1155M - Standard Test Method for Determining FF Floor Flatness and FL Floor Levelness Numbers; 2023.
- HH. ASTM E1643 - Standard Practice for Selection, Design, Installation and Inspection of Water Vapor Retarders Used in Contact with Earth or Granular Fill Under Concrete Slabs; 2018a.
- II. ASTM E1745 - Standard Specification for Plastic Water Vapor Retarders Used in Contact with Soil or Granular Fill under Concrete Slabs; 2017.

1.04 Submittals

- A. See Section 01 30 00 - Administrative Requirements for submittal procedures.
- B. Product Data: Submit manufacturers' data on manufactured products showing compliance with specified requirements and installation instructions.
 - 1. For curing compounds, provide data on method of removal in the event of incompatibility with floor covering adhesives.
- C. Mix Design: Submit proposed concrete mix design(s).
 - 1. Submit reports for each concrete material and each mix design test. Reference Structural Notes for mix design requirements.
- D. Test Reports: Submit report for each test or series of tests specified.
- E. Project Record Documents: Accurately record actual locations of embedded utilities and components that will be concealed from view upon completion of concrete work.

1.05 Quality Assurance

- A. Perform work of this section in accordance with ACI SPEC-301 and ACI CODE-318.

- B. Follow recommendations of ACI PRC-305 when concreting during hot weather.
- C. Follow recommendations of ACI PRC-306 when concreting during cold weather.

PART 2 PRODUCTS

2.01 Formwork

- A. Comply with requirements of Section 03 10 00.

2.02 Reinforcement Materials

- A. Comply with requirements of Section 03 20 00.

2.03 Concrete Materials

- A. Cement: ASTM C150/C150M, Type I and I/II Normal, Portland type or ASTM C595/C595M Portland-Limestone blended hydraulic cement, type IL.
 - 1. Acquire cement for entire project from same source.
- B. Fine and Coarse Aggregates: ASTM C33/C33M.
 - 1. Acquire aggregates for entire project from same source.
 - 2. For exposed exterior surfaces, do not use fine or coarse aggregates that contain substances that cause spalling.
 - 3. Local aggregates not complying with ASTM C33/C33M that have been shown to produce concrete of adequate strength and durability by special tests or actual service may be used when acceptable to Schaefer Architecture.
 - 4. Fine Aggregates: Clean, sharp, natural sand free from loam, clay, lumps or other deleterious substances.
 - 5. Coarse Aggregates: Clean, uncoated, processed from natural rock or stone containing no clay, loam or foreign matter. Unless otherwise noted or mass concrete, use aggregate meeting #57 or #67 grading requirements, except for toppings, aggregates shall meet #7 grading requirements.
- C. Fly Ash: ASTM C618, Class C.
 - 1. Do not use fly ash in exposed, finished concrete.
- D. Water: Clean, potable and not detrimental to concrete.

2.04 Admixtures

- A. Do not use chemicals that will result in soluble chloride ions in excess of 0.1 percent by weight of cement.
 - 1. Do not use calcium chloride or admixtures containing calcium chloride.
- B. Air Entrainment Admixture: ASTM C260/C260M.
- C. High Range Water Reducing and Retarding Admixture: ASTM C494/C494M Type G.
- D. High Range Water Reducing Admixture: ASTM C494/C494M Type F.
- E. Water Reducing and Accelerating Admixture: ASTM C494/C494M Type E.
- F. Water Reducing and Retarding Admixture: ASTM C494/C494M Type D.
- G. Accelerating Admixture: ASTM C494/C494M Type C.
- H. Retarding Admixture: ASTM C494/C494M Type B.
- I. Water Reducing Admixture: ASTM C494/C494M Type A.

2.05 Accessory Materials

- A. Non-Shrink Cementitious Grout: Premixed compound consisting of nonmetallic aggregate, cement, water reducing and plasticizing agents.
 - 1. Minimum Compressive Strength at 48 Hours: 2,000 pounds per square inch (13.7 MPa).

2. Minimum Compressive Strength at 28 Days: 7,000 pounds per square inch (48 MPa).

2.06 Bonding and Jointing Products

- A. See Section 03 01 00 - Maintenance of Concrete and 03 10 00 - Concrete Forming and Accessories.

2.07 Curing Materials

- A. Evaporation Reducer: Liquid thin-film-forming compound that reduces rapid moisture loss caused by high temperature, low humidity, and high winds; intended for application immediately after concrete placement.
 1. Products:
 - a. Euclid Chemical Company ; EUCOBAR: www.euclidchemical.com/#sle.
 - b. SpecChem, LLC; SpecFilm Concentrate or SpecFilm: www.specchemllc.com/#sle.
 - c. W. R. Meadows, Inc; Evapre or Evapre-RTU: www.wrmeadows.com/#sle.
 - d. Metalcrete Industries; Waterhold: www.metalcreteindustries.com.
 - e. L & M Construction Chemicals, Inc.; E-Con: www.lmcc.com.
 - f. Substitutions: See Section 01 60 00 - Product Requirements.
- B. Curing and Sealing Compound: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C309 Type I Class B.
 1. Application: Use at interior and exterior concrete and at applications approved by manufacturer.
 2. Vehicle: Water-based.
 3. Solids by Mass: 15 percent, minimum.
 4. VOC Content: OTC compliant.
 5. Products:
 - a. LATICRETE International, Inc; Dress & Seal WB: www.laticrete.com/#sle.
 - b. SpecChem, LLC; Cure & Seal WB: www.specchemllc.com/#sle.
 - c. Metalcrete Industries; Metcure 0800: www.metalcreteindustries.com.
 - d. Euclid Chemical Company; Aqua-Cure VOX: www.euclidchemical.com.
 - e. W.R, Meadows, Inc.; VOCOMP-20: www.wrmeadows.com.
 - f. BASF Construction Chemicals; MasterKure CC 180 WB: www.buildingsystems.basf.com.
- C. Curing and Sealing Compound, High Gloss: Liquid, membrane-forming, clear, non-yellowing acrylic; complying with ASTM C1315 Type 1 Class A.
 1. Application: Use at interior and exterior concrete and at applications approved by manufacturer.
 2. Vehicle: Water-based.
 3. Solids by Mass: 25 percent, minimum.
 4. VOC Content: OTC compliant.
 5. Products:
 - a. Dayton Superior Corporation Cure & Seal 1315 EF: www.daytonsuperior.com/#sle.
 - b. L & M Construction Chemicals; Dress & Seal WB 25: www.lmcc.com.
 - c. Metalcrete Industries; Metcure 30: www.metalcreteindustries.com.
 - d. SpecChem, LLC; Cure and Seal WB 25: www.specchemllc.com.

- e. W. R. Meadows, Inc; VOCOMP-25: www.wrmeadows.com/#sle.
- f. Substitutions: See Section 01 60 00 - Product Requirements.
- D. Moisture-Retaining Sheet: ASTM C171.
 - 1. Curing paper, regular.
 - 2. Polyethylene film, white opaque, minimum nominal thickness of 4 mil, 0.004 inch (0.102 mm).
 - 3. White-burlap-polyethylene sheet, weighing not less than 3.8 ounces per square yard (1.71 kg/sq m).
- E. Water: Potable, not detrimental to concrete.

2.08 Concrete Mix Design

- A. Proportioning Normal Weight Concrete: Comply with ACI PRC-211.1 recommendations.
- B. Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI SPEC-301.
 - 1. For trial mixtures method, employ independent testing agency acceptable to Schaefer Architecture for preparing and reporting proposed mix designs.
- C. Admixtures: Add acceptable admixtures as recommended in ACI PRC-211.1 and at rates recommended or required by manufacturer.
- D. Normal Weight Concrete:
 - 1. Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: As indicated on drawings.
 - 2. Fly Ash Content: Maximum 20 percent of cementitious materials by weight. In no case shall the amount of the fly ash per cubic yard of concrete exceed 100 pounds (45 kg).
 - 3. Water-Cement Ratio: Locations for each mix are scheduled on Structural Drawings.
 - a. Maximum 45 percent by weight for 4000 psi (27.6 MPa) concrete.
 - b. Maximum 50 percent by weight for 3500 psi (24.2 MPa) concrete.
 - c. Maximum 55 percent by weight for non-air-entrained 3000 psi (20.7 MPa) concrete.
 - d. Maximum 50 percent by weight for air-entrained 3000 psi (20.7 MPa) concrete.
 - 4. Total Air Content: 4 - 7 percent, determined in accordance with ASTM C173/C173M.
 - a. For exterior exposed concrete.
 - 5. Maximum Slump:
 - a. Ramps and sloping slab surfaces: not more than 3 inch (76 mm).
 - b. Reinforced foundation systems: not less than 3 inch (76 mm) and not more than 5 inch (127 mm).
 - c. Concrete containing high-range water-reducing admixture (superplasticizers): not more than 8 inch (203 mm) after adding admixture to site-verified 2 -3 inch (51 - 76 mm) slump concrete.
 - d. Other concrete: not less than 3 inch (76 mm) and not more than 5 inch (127 mm).
 - 6. Aggregates: Proportion aggregates to provide a minimum of 50% coarse aggregate ratio to total aggregate.
 - 7. Maximum Aggregate Size: 3/4 inch (19 mm), unless noted or approved otherwise.
 - 8. Admixtures:
 - a. Use water-reducing admixture or high-range water-reducing admixture (superplasticizers) in concrete, as required, for placement and workability.

- b. Use accelerating admixture in concrete slabs placed at ambient temperatures below 50 deg F (10 deg C).
- c. Use mid-range or high-range water-reducing admixture in pumped concrete, concrete for heavy-use industrial slabs, architectural concrete, parking structure slabs, concrete required to be watertight, and concrete with water-cement ratios below 0.50.
- d. Use air-entraining admixture in exterior exposed concrete unless otherwise indicated. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having total air content of 5 1/2 percent with a tolerance of plus or minus 1 1/2 percent.
- e. Other concrete not exposed to freezing, thawing, or hydraulic pressure, or to receive a surface hardener: 2 to 4 percent air.
- f. Use admixtures for water reduction and set accelerating or retarding in strict compliance with manufacturer's directions.

2.09 Mixing

- A. Transit Mixers: Comply with ASTM C 94/C 94M.
 - 1. The addition of water to a batch at the job site will only be allowed when the Owner, Schaefer Architecture, Structural Engineer and the General Contractor agree to the following defined criteria at the preconstruction meeting. This criteria must be strictly met when water is added to a batch at the job site.
 - a. Water shall only be allowed to be added to a batch at the site if the measured concrete slump is less than 3 inch (76.2 mm).
 - b. When allowed, water should only be added once to the batch on-site and the addition of the water must be completed within 15 minutes from the start of the water addition.
 - c. The on-site added water must be properly mixed to ensure that a homogenous mixture is attained.
 - d. The maximum amount of water which may be added to the batch on-site is 1 gallon (3.78 liter) of water per 1 cu. yd. (0.76 cu. m) of concrete.
 - e. After the on-site added water has been added to the batch and the batch has been properly mixed, the concrete shall have a measured slump within the defined slump range of 3 inches (76.2 mm) to 5 inches (127 mm)
 - f. Concrete shall be rejected if the slump, after the addition of on-site water, does not occur with the slump range of 3 inches (76.2 mm) to 5 inches (127 mm) or is deemed unacceptable for placement.
 - g. The field testing and inspection agency or an approved Representative of the Owner shall monitor the implementation of the slump measurements and the water addition procedures.
 - 2. When air temperature is between 85 deg F (29 deg C) and 90 deg F (32 deg C), reduce mixing and delivery time from 1 1/2 hours to 75 minutes, and when air temperature is above 90 deg F (32 deg C), reduce mixing and delivery time to 60 minutes.

PART 3 EXECUTION

3.01 Examination

- A. Verify lines, levels, and dimensions before proceeding with work of this section.

3.02 Preparation

- A. Verify that forms are clean and free of rust before applying release agent.
- B. Coordinate placement of embedded items with erection of concrete formwork and placement of form accessories.
- C. Where new concrete is to be bonded to previously placed concrete, prepare existing surface by cleaning and applying bonding agent in accordance with bonding agent manufacturer's instructions.
 - 1. Use epoxy bonding system for bonding to damp surfaces, for structural load-bearing applications, and where curing under humid conditions is required.
- D. Where new concrete with integral waterproofing is to be bonded to previously placed concrete, prepare surfaces to be treated in accordance with waterproofing manufacturer's instructions. Saturate cold joint surface with clean water, and remove excess water before application of coat of waterproofing admixture slurry. Apply slurry coat uniformly with semi-stiff bristle brush at rate recommended by waterproofing manufacturer.
- E. In locations where new concrete is doweled to existing work, drill holes in existing concrete, insert steel dowels in holes filled with an approved epoxy or adhesive.

3.03 Placing Concrete

- A. Place concrete in accordance with ACI PRC-304.
- B. Place concrete for floor slabs in accordance with ACI PRC-302.1.
- C. Maintain records of concrete placement. Record date, location, quantity, air temperature, and test samples taken.
- D. Ensure reinforcement and inserts will not be disturbed during concrete placement.
 - 1. Set and build into formwork anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting drawings, diagrams, instructions, and directions provided by suppliers of items to be attached.
- E. Place concrete continuously without construction (cold) joints wherever possible; where construction joints are necessary, before next placement prepare joint surface by removing laitance and exposing the sand and sound surface mortar, by sandblasting or high-pressure water jetting.
- F. Finish floors level and flat, unless otherwise indicated, within the tolerances specified below.
- G. Cold-Weather Placement: Comply with ACI PRC-306 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
 - 1. When average high and low temperature is expected to fall below 40 deg F (4.4 deg C) for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 - 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 - 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mixture designs.
- H. Hot-Weather Placement: Comply with ACI PRC-305 and as follows:

1. Maintain concrete temperature below 90 deg F (32 deg C) at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.04 Slab Jointing

A. Placing Concrete in Forms

1. Deposit concrete in forms in horizontal layers no deeper than 24 inch (600 mm) and in a manner to avoid inclined construction joints. Where placement consists of several layers, place each layer while preceding layer is still plastic to avoid cold joints.
2. Consolidate placed concrete by mechanical vibrating equipment supplemented by hand-spading, rodding, or tamping. Use equipment and procedures for consolidation of concrete complying with ACI 309.
3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations no farther than the visible effectiveness of the machine. Place vibrators to rapidly penetrate placed layer and at least 6 inch (150 mm) into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to set. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mix to segregate.

3.05 Floor Flatness and Levelness Tolerances

A. Minimum F(F) Floor Flatness and F(L) Floor Levelness Values:

1. All Floors: F(F) of 25; F(L) of 20.
2. At Polished Concrete Floors: F(F) of 50; F(L) of 45.
 - a. See Section 03 35 36 - Polished Concrete Floor System for additional requirements.

B. Measure F(F) Floor Flatness and F(L) Floor Levelness in accordance with ASTM E1155/E1155M, within 48 hours after slab installation; report both composite overall values and local values for each measured section.

C. Correct the slab surface if composite overall value is less than specified and if local value is less than two-thirds of specified value or less than F(F) 13/F(L) 10.

D. Correct defects by grinding or by removal and replacement of the defective work. Areas requiring corrective work will be identified. Re-measure corrected areas by the same process.

3.06 Concrete Finishing

- A. Repair surface defects, including tie holes, immediately after removing formwork.
- B. Unexposed Form Finish: Rub down or chip off fins or other raised areas 1/4 inch (6 mm) or more in height.
- C. Exposed Form Finish: Rub down or chip off and smooth fins or other raised areas 1/4 inch (6 mm) or more in height. For surfaces exposed to view or to be covered with a coating material applied directly to concrete, or a covering material applied directly to concrete, such as waterproofing, dampproofing, veneer plaster, painting, or another similar system. Provide finish as follows:

1. Smooth Rubbed Finish: Wet concrete and rub with carborundum brick or other abrasive, not more than 24 hours after form removal.
 2. Grout Cleaned Finish: Wet areas to be cleaned and apply grout mixture by brush or spray; scrub immediately to remove excess grout. After drying, rub vigorously with clean burlap, and keep moist for 36 hours.
 - a. Combine one part portland cement to one and one-half parts fine sand by volume, and a 50:50 mixture of acrylic or styrene butadiene-based bonding admixture and water to form the consistency of thick paint. Blend standard portland cement and white portland cement in amounts determined by trial patches so that final color of dry grout will match adjacent surfaces.
 3. Cork Floated Finish: Immediately after form removal, apply grout with trowel or firm rubber float; compress grout with low-speed grinder, and apply final texture with cork float.
- D. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike-off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces unless otherwise indicated.
- E. Concrete Slabs: Finish to requirements of ACI PRC-302.1 and as follows:
1. Surfaces to Receive Thin Floor Coverings: "Steel trowel" as described in ACI PRC-302.1; thin floor coverings include carpeting, resilient flooring, seamless flooring, resinous matrix terrazzo, thin set quarry tile, and thin set ceramic tile.
 2. Decorative Exposed Surfaces: Trowel as described in ACI 302.1R; use steel-reinforced plastic trowel blades instead of steel blades to avoid black-burnish marks; decorative exposed surfaces include surfaces to be stained or dyed, pigmented concrete, and surfaces to be polished.
 - a. Steel-Reinforced Plastic Trowel Blade Manufacturer: Wagman Metal Products, Inc: www.wagmanmetal.com/#sle.
 - b. After slab has cured and at the time of substantial completion, thoroughly clean and buff exposed concrete floor surfaces and recoat with Curing and Sealing compound per manufacturer's instructions.
 3. Other Surfaces to Be Left Exposed: Trowel as described in ACI PRC-302.1, minimizing burnish marks and other appearance defects.
 - a. Sealer: After slab has cured and at the time of substantial completion, thoroughly clean and buff exposed concrete floor surfaces and recoat with Curing and Sealing Compound per manufacturer's instructions.
 4. Trowel and Fine Broom Finish: Where ceramic or quarry tile is to be installed with thin-set mortar, apply a trowel finish as specified, then immediately follow by slightly scarifying the surface with a fine broom.
 5. Non-Slip Broom Finish: Apply a nonslip broom finish to exterior concrete platforms, steps, and ramps, and elsewhere as indicated.
 - a. Immediately after float finishing, slightly roughen trafficked surface by brooming with fiber-bristle broom perpendicular to main traffic route. Coordinate required final finish with Schaefer Architecture before application.
- F. In areas with floor drains, maintain floor elevation at walls; pitch surfaces uniformly to drains at 1:100 nominal.

1. Approve floor drain elevations with Schaefer Architecture prior to pouring floors. Drain elevations shall be coordinated with type and size of floor tile or other scheduled floor finish.
2. At individual showers, set top of drains 3/4 inch (19 mm) below floor elevation.

3.07 MISCELLANEOUS CONCRETE ITEMS

- A. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.08 Curing and Protection

- A. Comply with requirements of ACI PRC-308. Immediately after placement, protect concrete from premature drying, excessively hot or cold temperatures, and mechanical injury.
- B. Maintain concrete with minimal moisture loss at relatively constant temperature for period necessary for hydration of cement and hardening of concrete.
- C. Evaporation Retarder: In hot, dry, and windy weather apply evaporation retarder to unformed concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq ft x h (1 kg/sq m x h) before and during finishing operations. Apply according to manufacturer's instructions after screeding and bull floating, but before power floating and troweling.
- D. Formed Surfaces: Cure by moist curing with forms in place for full curing period.
 1. Cure formed concrete surfaces, including underside of beams, supported slabs, and other similar surfaces.
- E. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- F. Cure concrete according to ACI PRC-308 ACI 308R, by one or a combination of the following methods:
 1. Moisture Curing: Keep surfaces continuously moist for not less than seven days with the following materials:
 - a. Water.
 - b. Continuous water-fog spray.
 - c. Absorptive cover, water saturated, and kept continuously wet. Cover concrete surfaces and edges with 12 inch (300 mm) lap over adjacent absorptive covers.
 2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inch (300 mm), and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive floor coverings.
 - b. Moisture cure or use moisture-retaining covers to cure concrete surfaces to receive penetrating liquid floor treatments.
 - c. Cure concrete surfaces to receive floor coverings with either a moisture-retaining cover or a curing compound that the manufacturer certifies will not interfere with bonding of floor covering used on Project.

3. Curing Compound: Apply uniformly in continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Maintain continuity of coating and repair damage during curing period.
 - a. Removal: After curing period has elapsed, remove curing compound without damaging concrete surfaces by method recommended by curing compound manufacturer unless manufacturer certifies curing compound will not interfere with bonding of floor covering used on Project.
4. Curing and Sealing Compound: Apply uniformly to floors and slabs indicated in a continuous operation by power spray or roller according to manufacturer's written instructions. Recoat areas subjected to heavy rainfall within three hours after initial application. Repeat process 24 hours later and apply a second coat. Maintain continuity of coating and repair damage during curing period.

3.09 Field Quality Control

- A. An independent testing agency will perform field quality control tests, as specified in Section 01 40 00 - Quality Requirements.
- B. Provide free access to concrete operations at project site and cooperate with appointed firm.
 1. Contractor may perform field tests and cast compression test specimens if specimens are prepared and handled by person(s) trained and CERTIFIED for sampling concrete.
- C. Tests of concrete and concrete materials may be performed at any time to ensure compliance with specified requirements.
- D. Compressive Strength Tests: ASTM C39/C39M, for each test, mold and cure four concrete test cylinders. Obtain one set of four test cylinders for each days pour of each concrete mixture less than 25 cubic yards (19 cu m), plus on set of four test cylinders for each additional 50 cubic yards (38 cu m) or fraction thereof.
 1. One specimen tested at 7 days, two specimens tested at 28 days and one specimen retained in reserve for later testing if required.
- E. Take one additional test cylinder during cold weather concreting, cured on job site under same conditions as concrete it represents.
- F. Perform one slump test for each set of test cylinders taken, following procedures of ASTM C143/C143M.
- G. Air Content Test: ASTM C173/C173M, volumetric method for lightweight or normal weight concrete; ASTM C231, pressure method for normal weight concrete; one for each day's pour of each type of air-entrained concrete.
- H. Concrete Temperature: ASTM C1064/C1064M; one test hourly when air temperature is 40 deg F (4 deg C) and below, when 80 deg F (27 deg C) and above, and one test for each set of compressive-strength specimens.
- I. Test Results: The testing agency shall report test results in writing to Schaefer Architecture and General Contractor within 24 hours of test.
 1. Reports of compressive strength tests shall contain the following:
 - a. Project identification name and number
 - b. Date of concrete placement
 - c. Name of concrete testing service

- d. Concrete type and class
- e. Location of concrete batch in structure
- f. Design compressive strength at 28 days
- g. Concrete mix proportions and materials
- h. Compressive breaking strength
- i. Type of break for both 7-day tests and 28-day tests
- j. Site measured slump, temperature and air-content

3.10 Defective Concrete

- A. Defective Concrete: Concrete not complying with required lines, details, dimensions, tolerances or specified requirements.
 - 1. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, General Contractor shall evaluate current operations and provide corrective procedures for protecting and curing the in-place concrete.
 - 2. Strength level of concrete will be considered satisfactory if averages of sets of three consecutive strength test results equal or exceed specified compressive strength and no individual strength test result falls below specified compressive strength by more than 500 psi (3.4 MPa).
- B. Repair or replacement of defective concrete will be determined by Schaefer Architecture. The cost of additional testing shall be borne by General Contractor when defective concrete is identified.
 - 1. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted but shall not be used as the sole basis for acceptance or rejection.
 - 2. Additional Tests: The testing agency will make additional tests of in-place concrete when test results indicate specified concrete strengths and other characteristics have not been attained in the structure, as directed by Schaefer Architecture. Testing agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C42/C42M, or by other methods as directed.
- C. Do not patch, fill, touch-up, repair, or replace exposed concrete except upon express direction of Schaefer Architecture for each individual area.

3.11 Protection

- A. Do not permit traffic over unprotected concrete floor surface until fully cured.

END OF SECTION

23 05 05 MECHANICAL GENERAL PROVISIONS

PART 1 GENERAL**GENERAL INFORMATION:**

The General Requirements and Supplementary Conditions are part of this contract and govern work under this division.

The Building Automation System (BAS) is to be replaced and modifications to existing equipment is to be provided. The building is occupied and is to remain fully functional throughout the duration of the Project. It is understood that individual pieces of mechanical equipment will have to be shutdown during the project which will need to be coordinated with the County in order to accommodate personnel that may be affected. Temporary heating or cooling provided by the Contractor is not anticipated.

SCOPE OF WORK:

Work by Temperature Controls Contractor: Provide all BAS systems and hardware indicated by the drawings, specified, or as instructed otherwise. Unless specified otherwise, provide all labor, materials, and equipment necessary to provide a complete and operational system. The Temperature Controls Contractor is responsible to identify all BAS related items that require installation by the Mechanical, Electrical, and General Contractors.

Work by Mechanical Contractor: Provide all mechanical systems indicated by the drawings, specified or as instructed otherwise. Unless specified otherwise, provide all labor, materials and equipment necessary to provide a complete and operational system.

Work by Electrical Contractor: Provide all line voltage wiring and install items of equipment furnished by the Mechanical, such as thermostats, remote control panels, etc.

Mechanical and Electrical Coordination: The Mechanical will provide to the Electrical all manufacturer's wiring diagrams and installation data and locate all equipment furnished to the Electrical.

Where work or materials are specified or shown on drawings to be performed by more than one Contractor, each such Contractor will be deemed to have included the cost of the item and the Architect will determine who shall furnish the work and who shall submit the credit to the Owner.

Work by General Contractor: Provide all openings and chases with proper framing and reinforcing as required for Mechanical equipment.

Provide access panels or doors where required for mechanical systems.

Provide concrete pads for all base mounted mechanical equipment.

DEFINITIONS:

Contractor: The contractor performing work under this Division of the Specifications.

Provide: Contractor is responsible to furnish and install component completely.

QUALITY ASSURANCE:

Manufacturers: Acceptable manufacturers are listed in applicable sections of the Specifications and on the drawings.

Drawings and Specifications are complimentary. Requirements indicated in either are binding and the most stringent is to be used.

The Contractor is to review documents for the work, and if any discrepancies occur between the work of this Division and the work of another Division, is to notify the Architect and obtain written instructions for any changes necessary. Any changes in the work by this Division made necessary by the failure or neglect of the Contractor to report such discrepancies will be made by, and at the expense of the Contractor.

Changes in Design or Installation: Refer to the General and Supplementary Conditions for requirements pertaining to changes in design and installation. Mechanical installation will otherwise be in accordance with the Contract Drawings and Specifications.

REGULATORY AGENCIES:

Permits and Fees: The Contractor is to pay for all permits and fees as required by Local or State regulatory agencies.

Codes: Work for this project is to comply with Federal, State and Local codes, ordinances and regulations. All work shall comply the latest adopted edition of the Building Code and associated sections of the National Fire Protection Association.

Work shall be done according to applicable codes in cases of conflict between specifications, plans and codes, except where plans and specifications call for higher standards than the codes.

SUBMITTALS AND SHOP DRAWINGS:

Submit product data and copies of shop drawings for all major pieces of equipment as indicated in the respective sections of this Division.

The intent of shop drawing submittals by the Contractor is to demonstrate to the Architect / Engineer that the Contractor understands the design concept and demonstrates his understanding by indicating and detailing the fabrication and installation methods to be used.

If deviations, discrepancies or conflicts between shop drawing submittals and Contract Documents are discovered either prior to or after shop drawing submittals are processed, the design drawings and specifications shall take precedence.

The Architect / Engineer shall review shop drawings for general conformance with the design concept of the project. The review shall not relieve the Contractor of the responsibility of compliance with the contract documents, installation of equipment per manufacturer's requirements, or errors in the shop drawings.

PRODUCT DELIVERY, STORAGE AND HANDLING:

Make provisions for the delivery and safe storage of all material and make the required arrangements with other trades to coordinate moving large pieces of equipment into the building.

Where materials are indicated to be "Furnished by Others" to the Contractor for installation, these materials shall be checked and their delivery properly receipted. After delivery the Contractor assumes all responsibility for the safekeeping of such equipment.

All materials stored outside are to be covered and protected with weatherproof material.

JOB CONDITIONS:

Verify existing site conditions and location prior to bidding.

Verify existing utilities and the actual location of in reference to location of such as shown on drawings. Any deviations between actual conditions and plan locations will be reviewed with the Architect. Repair, patch or terminate utilities encountered in an acceptable manner regardless of whether shown or not.

GUARANTEE:

The Contractor is to guarantee all materials, equipment, workmanship and operation of all systems for a period of two (2) years from the date of final acceptance of the entire project. Guarantee to repair or replace at Contractor's expense any part of the work which may be defective during that time provided that such defect is, in the opinion of the Architect / Engineer, due to imperfect material or workmanship and not to carelessness or improper use.

PART 2 PRODUCTS**STANDARDS FOR EQUIPMENT AND MATERIALS:**

All material shall be labeled UL, ETL, AGA or other approved independent testing authority. Air conditioning equipment shall be ARI certified.

All pressure rated vessels shall be provided with an ASME stamp, meeting the ASME Code or the Local Authority, whichever is most stringent.

All materials and equipment shall be of the best quality and be new, unused and without damage.

System design is based upon one of the manufacturers listed in the Specifications and/or Plan Sheets and the other named manufacturers are considered equivalent. Any costs attributed in changes in ductwork, piping, plumbing, space clearances or other trades is to be borne by the Contractor when another manufacturer is used in lieu of the basis of design.

MATERIALS OF APPROVED EQUAL:

Unless request for changes in base bid specifications are received and approved ten (10) days prior to the opening of bids, the successful Contractor will be held to furnish specified items under base bid.

PART 3 EXECUTION**PREPARATION:**

Base final installation of all materials and equipment on field dimensions and conditions at the building. The Mechanical Contractor is to inspect all work that affects the work of this Division and

report any deficiencies to the General Contractor and Architect. No extra compensation will be allowed on account of minor differences in actual dimensions and those indicated on the plans.

INSTALLATION:

Workmanship: Perform all work in accordance with good commercial practice.

Supervision: The superintendent shall be responsible for the work of this Division and of all subcontractors under this Division. All questions or directions will be directed through the superintendent.

Installation Procedures:

- A. Field verify exact location, size, routing, elevation and accessibility of existing and new HVAC and plumbing systems.
- B. Properly size and locate all anchors, chases, recesses and openings required for the proper installation of the work.
- C. Piping and equipment located in areas subject to low temperatures shall be installed in a manner to prevent freezing.
- D. All equipment and materials are to be installed as high as possible.
- E. Install equipment and systems in accordance with manufacturer's recommends, accepted industry standards and all applicable Codes.
- F. Provide temporary filters in all air systems during construction. Install new clean filters prior to testing and balancing systems. Provide an extra set of filters to Owner at completion of project.

END OF SECTION

23 05 06 BASIC HVAC MATERIALS AND METHODS

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.

- A. Piping materials and installation instructions common to most piping systems.
- B. Concrete base construction requirements.
- C. Escutcheons.
- D. Dielectric fittings.
- E. Flexible connectors.
- F. Equipment nameplate data requirements.
- G. Nonshrink grout for equipment installations.
- H. Field-fabricated metal and wood equipment supports.
- I. Installation requirements common to equipment specification sections.
- J. Mechanical demolition.
- K. Cutting and patching.
- L. Touchup painting and finishing.

Pipe and pipe fitting materials are specified in Division 23 piping system Sections.

DEFINITIONS:

Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

The following are industry abbreviations for rubber materials:

- A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene propylene diene terpolymer rubber.

SUBMITTALS:

Product Data: For dielectric fittings, flexible connectors, mechanical sleeve seals, and identification materials and devices.

Shop Drawings: Detail fabrication and installation for metal and wood supports and anchorage for mechanical materials and equipment.

QUALITY ASSURANCE:

Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

Equipment Selection: Equipment of higher electrical characteristics, physical dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. Additional costs shall be approved in advance by appropriate Contract Modification for these increases. If minimum energy ratings or efficiencies of equipment are specified, equipment must meet design and commissioning requirements.

DELIVERY, STORAGE, AND HANDLING:

Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and prevent entrance of dirt, debris, and moisture.

Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, if stored inside.

Protect flanges, fittings, and piping specialties from moisture and dirt.

SEQUENCING AND SCHEDULING:

Coordinate mechanical equipment installation with other building components.

Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components, as they are constructed.

Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the Work. Coordinate installation of large equipment requiring positioning before closing in building.

Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies.

Coordinate requirements for access panels and doors if mechanical items requiring access are concealed behind finished surfaces.

Coordinate installation of identifying devices after completing covering and painting, if devices are applied to surfaces. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

MANUFACTURERS:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Dielectric Unions:
 - 1. Capitol Manufacturing Co.
 - 2. Central Plastics Co.
 - 3. Eclipse, Inc.; Rockford-Eclipse Div.
 - 4. Epco Sales Inc.
 - 5. Hart Industries International, Inc.
 - 6. Watts Industries, Inc.; Water Products Div.
 - 7. Zurn Industries, Inc.; Wilkins Div.
- B. Dielectric Flanges:
 - 1. Capitol Manufacturing Co.
 - 2. Central Plastics Co.
 - 3. Epco Sales Inc.
 - 4. Watts Industries, Inc.; Water Products Div.
- C. Dielectric-Flange Insulating Kits:
 - 1. Calpico, Inc.
 - 2. Central Plastics Co.
- D. Dielectric Couplings:
 - 1. Calpico, Inc.
 - 2. Lochinvar Corp.
- E. Dielectric Nipples:
 - 1. Grinnell Corp.; Grinnell Supply Sales Co.
 - 2. Perfection Corp.
 - 3. Victaulic Co. of America.
- F. Metal, Flexible Connectors:
 - 1. ANAMET Industrial, Inc.
 - 2. Central Sprink, Inc.
 - 3. Flexicraft Industries.
 - 4. Flex-Weld, Inc.
 - 5. Grinnell Corp.; Grinnell Supply Sales Co.
 - 6. Hyspan Precision Products, Inc.
 - 7. McWane, Inc.; Tyler Pipe; Gustin-Bacon Div.
 - 8. Mercer Rubber Co.
 - 9. Metraflex Co.
 - 10. Proco Products, Inc.
 - 11. Uniflex, Inc.

12. Flexonics.

G. Mechanical Sleeve Seals:

1. Calpico, Inc.
2. Metraflex Co.
3. Thunderline/Link-Seal.

PIPE AND PIPE FITTINGS:

Refer to individual Division 23 piping Sections for pipe and fitting materials and joining methods.

Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

JOINING MATERIALS:

Refer to individual Division 23 piping Sections for special joining materials not listed below.

Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

- A. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, unless thickness or specific material is indicated.
 1. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 2. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

Solder Filler Metals: ASTM B 32.

- A. Alloy Sn95 or Alloy Sn94: Approximately 95 percent tin and 5 percent silver, with 0.10 percent lead content.
- B. Alloy E: Approximately 95 percent tin and 5 percent copper, with 0.10 percent maximum lead content.

Brazing Filler Metals: AWS A5.8.

- A. BCuP Series: Copper-phosphorus alloys.
- B. BAg1: Silver alloy.

Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon-steel bolts and nuts.

Couplings: Iron-body sleeve assembly, fabricated to match OD of plain-end, pressure pipes.

- A. Sleeve: ASTM A 126, Class B, gray iron.
- B. Followers: ASTM A 47 (ASTM A 47M) malleable iron or ASTM A 536 ductile iron.

- C. Gaskets: Rubber.
- D. Bolts and Nuts: AWWA C111.
- E. Finish: Enamel paint.

DIELECTRIC FITTINGS:

General: Assembly or fitting with insulating material isolating joined dissimilar metals, to prevent galvanic action and stop corrosion.

Description: Combination of copper alloy and ferrous; threaded, solder, plain, and weld-neck end types and matching piping system materials.

Insulating Material: Suitable for system fluid, pressure, and temperature.

Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).

Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

Dielectric-Flange Insulation Kits: Field-assembled, companion-flange assembly, full-face or ring type. Components include neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

- A. Provide separate companion flanges and steel bolts and nuts for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

FLEXIBLE CONNECTORS:

General: Fabricated from materials suitable for system fluid and that will provide flexible pipe connections. Include 125-psig (860-kPa) minimum working-pressure rating, unless higher working pressure is indicated, and ends according to the following:

- A. 2-Inch NPS (DN50) and Smaller: Threaded.
- B. 2-1/2-Inch NPS (DN65) and Larger: Flanged.
- C. Option for 2-1/2-Inch NPS (DN65) and Larger: Grooved for use with keyed couplings.

Stainless-Steel-Hose/Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include steel nipples or flanges, welded to hose.

Stainless-Steel-Hose/Stainless-Steel Pipe, Flexible Connectors: Corrugated, stainless-steel, inner tubing covered with stainless-steel wire braid. Include stainless-steel nipples or flanges, welded to hose.

GROUT:

Nonshrink, Nonmetallic Grout: ASTM C 1107, Grade B.

- A. Characteristics: Post-hardening, volume-adjusting, dry, hydraulic-cement grout, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
- B. Design Mix: 5000-psig (34.5-MPa), 28-day compressive strength.
- C. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

PIPING SYSTEMS - COMMON REQUIREMENTS:

General: Install piping as described below, unless piping Sections specify otherwise. Individual Division 23 piping Sections specify unique piping installation requirements.

General Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated, unless deviations to layout are approved on Coordination Drawings.

Install piping at indicated slope.

Install components with pressure rating equal to or greater than system operating pressure.

Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.

Install piping free of sags and bends.

Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, unless otherwise indicated.

Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow for ceiling panel removal.

Install piping to allow application of insulation plus 1-inch (25-mm) clearance around insulation.

Locate groups of pipes parallel to each other, spaced to permit valve servicing.

Install fittings for changes in direction and branch connections.

Install couplings according to manufacturer's written instructions.

Verify final equipment locations for roughing-in.

Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

Piping Joint Construction: Join pipe and fittings as follows and as specifically required in individual piping specification Sections:

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Construct joints according to AWS's "Soldering Manual," Chapter "The Soldering of Pipe and Tube"; or CDA's "Copper Tube Handbook."
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."
- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Note internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
 - 2. Apply appropriate tape or thread compound to external pipe threads, unless dry seal threading is specified.
 - 3. Align threads at point of assembly.
 - 4. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
 - 5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12, "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe," using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

Piping Connections: Make connections according to the following, unless otherwise indicated:

- A. Install unions, in piping 2-inch NPS (DN50) and smaller, adjacent to each valve and at final connection to each piece of equipment with 2-inch NPS (DN50) or smaller threaded pipe connection.
- B. Install flanges, in piping 2-1/2-inch NPS (DN65) and larger, adjacent to flanged valves and at final connection to each piece of equipment with flanged pipe connection.
- C. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.
- D. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

EQUIPMENT INSTALLATION - COMMON REQUIREMENTS:

Install equipment to provide maximum possible headroom, if mounting heights are not indicated.

Install equipment according to approved submittal data. Portions of the Work are shown only in diagrammatic form. Refer conflicts to Architect.

Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

Install mechanical equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other

installations. Extend grease fittings to accessible locations.

Install equipment giving right of way to piping installed at required slope.

Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

PAINTING AND FINISHING:

Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

CONCRETE BASES:

Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit. Follow supported equipment manufacturer's setting templates for anchor bolt and tie locations. Use 3000-psig (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Division 3 Section "Cast-in-Place Concrete."

ERECTION OF METAL SUPPORTS AND ANCHORAGE:

Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor mechanical materials and equipment.

Field Welding: Comply with AWS D1.1, "Structural Welding Code--Steel."

DEMOLITION:

Disconnect, demolish, and remove Work specified in Division 23 Sections.

If pipe, ductwork, insulation, or equipment to remain is damaged or disturbed, remove damaged portions and install new products of equal capacity and quality.

Accessible Work: Remove indicated exposed pipe and ductwork in its entirety.

Work Abandoned in Place: Cut and remove underground pipe a minimum of 2 inches (50 mm) beyond face of adjacent construction. Cap and patch surface to match existing finish.

Removal: Remove indicated equipment from Project site.

Temporary Disconnection: Remove, store, clean, reinstall, reconnect, and make operational equipment indicated for relocation.

CUTTING AND PATCHING:

Cut, channel, chase, and drill floors, walls, partitions, ceilings, and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of trades involved.

Repair cut surfaces to match adjacent surfaces.

GROUTING:

Install nonmetallic, nonshrink, grout for mechanical equipment base bearing surfaces, pump and other equipment base plates, and anchors. Mix grout according to manufacturer's written instructions.

Clean surfaces that will come into contact with grout.

Provide forms as required for placement of grout.

Avoid air entrapment during placing of grout.

Place grout, completely filling equipment bases.

Place grout on concrete bases to provide smooth bearing surface for equipment.

Place grout around anchors.

Cure placed grout according to manufacturer's written instructions.

END OF SECTION

23 05 13 COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes basic requirements for factory-installed and field-installed motors.

Related Sections include the following:

Division 23 Sections for application of motors and reference to specific motor requirements for motor-driven equipment.

SUBMITTALS:

Product Data: Show nameplate data and ratings; characteristics; mounting arrangements; size and location of winding termination lugs, conduit entry, and grounding lug; and coatings.

Factory Test Reports: For specified tests.

Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

QUALITY ASSURANCE:

Comply with NFPA 70.

Listing and Labeling: Provide motors specified in this Section that are listed and labeled.

- A. Terms "Listed and Labeled": As defined in the National Electrical Code, Article 100.
- B. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

PART 2 PRODUCTS**BASIC MOTOR REQUIREMENTS:**

Basic requirements apply to mechanical equipment motors, unless otherwise indicated.

Motors 1/2 HP and Larger: Polyphase, unless otherwise noted.

Motors Smaller than 1/2 HP: Single phase.

Frequency Rating: 60 Hz.

Voltage Rating: Determined by voltage of circuit to which motor is connected.

Service Factor: 1.15, unless otherwise indicated.

Capacity and Torque Characteristics: Rated for continuous duty and sufficient to start, accelerate, and operate connected loads at designated speeds, in indicated environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

Enclosure: Open dripproof, unless otherwise indicated.

POLYPHASE MOTORS:

Description: NEMA MG 1, medium induction motor.

- A. Design Characteristics: NEMA MG 1, Design B, unless otherwise indicated.
- B. Energy-Efficient Design: High efficiency.
- C. Starter: Copper windings, unless otherwise indicated. Multispeed motors have separate winding for each speed.
- D. Rotor: Squirrel cage, unless otherwise indicated.
- E. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading.
- F. Temperature Rise: Match insulation rating, unless otherwise indicated.
- G. Insulation: Class F, unless otherwise indicated.

Motors Used with Reduced-Inrush Controllers: Match wiring connection requirements for indicated controller, with required motor leads brought to motor terminal box to suit control method.

Motors Used with Variable-Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

- A. Critical vibration frequencies are not within operating range of controller output.
- B. Temperature Rise: Match rating for Class B insulation.
- C. Insulation: Class H.
- D. Thermal Protection: Where indicated, conform to NEMA MG 1 requirements for thermally protected motors.
- E. Equip with a maintenance free, conductive micro-fiber, shaft grounding ring with a minimum of two rows of circumferential fibers to discharge shaft voltages away from bearings to ground. Motors up to 100 HP to be provided with one shaft ring installed on either end. Bond motor to system ground per manufacturer's requirements.

Source Quality Control: Perform the following routine tests according to NEMA MG 1:

- A. Measurement of winding resistance.
- B. No-load readings of current and speed at rated voltage and frequency.
- C. Locked rotor current at rated frequency.
- D. High-potential test.
- E. Alignment.

SINGLE-PHASE MOTORS:

Type: As indicated or selected by manufacturer from one of the following, to suit starting torque and other requirements of specific motor application.

- A. Permanent-split capacitor.
- B. Split-phase start, capacitor run.

C. Capacitor start, capacitor run.

Shaded-Pole Motors: Do not use, unless motors are smaller than 1/20 hp.

Thermal Protection: Where indicated or required, internal protection automatically opens power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal protection device automatically resets when motor temperature returns to normal range, unless otherwise indicated.

Bearings: Ball-bearing type for belt-connected motors and other motors with high radial forces on motor shaft. Sealed, prelubricated sleeve bearings for other single-phase motors.

PART 3 EXECUTION

ADJUSTING:

Use adjustable motor mounting bases for belt-driven motors.

Align pulleys and install belts.

Tension according to manufacturer's written instructions.

END OF SECTION

23 05 19 METERS AND GAGES FOR HVAC PIPING

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes meters and gages for mechanical.

SUBMITTALS:

Product Data: Include scale range, ratings, and calibrated performance curves for each meter, gage, fitting, specialty, and accessory specified. Include schedule indicating manufacturer's number, scale range, fittings, and location for each meter and gage.

Maintenance Data: For meters and gages to include in maintenance manuals specified in Division 1. Include data for the following:

- A. Flow-measuring systems.
- B. Flowmeters.
- C. Thermal-energy flowmeters.
- D. Water meters.

PART 2 PRODUCTS**MANUFACTURERS:**

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Liquid-in-Glass Thermometers:
 - 1. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
 - 2. Ernst Gage Co.
 - 3. Marsh Bellofram.
 - 4. Palmer Instruments, Inc.
 - 5. Terice: H. O. Terice Co.
 - 6. Weksler.
- B. Direct-Mounting, Filled-System Dial Thermometers:
 - 1. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
 - 2. Marsh Bellofram.
 - 3. Terice: H. O. Terice Co.
 - 4. Weksler.
- C. Insertion Dial Thermometers:
 - 1. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
 - 2. Terice: H. O. Terice Co.
 - 3. Weiss Instruments, Inc.

4. Weksler.

D. Pressure Gages:

1. Dresser Industries, Inc.; Instrument Div.; Weksler Instruments Operating Unit.
2. Ernst Gage Co.
3. Marsh Bellofram.
4. Weiss Instruments, Inc.
5. Weksler.

E. Test Plugs:

1. Peterson Equipment Co., Inc.
2. Trerice: H. O. Trerice Co.
3. Watts Industries, Inc.; Water Products Div.

F. Thermal-Energy Flowmeters:

1. Hersey Measurement Co.
2. Onicon, Inc.
3. Preso Meters Corp.

THERMOMETERS, GENERAL:

Scale Range: Temperature ranges for services listed are as follows:

- A. Condenser Water: 0 to 160 deg F, with 2-degree scale divisions (minus 18 to plus 70 deg C, with 1-degree scale divisions).
- B. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions (minus 18 to plus 38 deg C, with 1-degree scale divisions).
- C. Heating Water: 0 to 250 deg F, with 2-degree scale divisions (10 to 205 deg C, with 1-degree scale divisions).

Accuracy: Plus or minus 1 percent of range span or plus or minus one scale division to maximum of 1.5 percent of range span.

LIQUID-IN-GLASS THERMOMETERS:

Description: ASTM E 1.

Case: Die cast and aluminum finished in baked-epoxy enamel, glass front, spring secured, 9 inches (230 mm) long.

Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

Tube: Red or blue reading, organic-liquid filled with magnifying lens.

Scale: Satin-faced nonreflective aluminum with permanently etched markings.

Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

DIRECT-MOUNTING, FILLED-SYSTEM DIAL THERMOMETERS:

Description: Vapor-actuated, universal-angle dial type.

Case: Drawn steel or cast aluminum, with 4-1/2-inch- (115-mm-) diameter, glass lens.

Adjustable Joint: Finish to match case, 180-degree adjustment in vertical plane, 360-degree adjustment in horizontal plane, with locking device.

Thermal Bulb: Copper with phosphor-bronze bourdon pressure tube.

Movement: Brass, precision geared.

Scale: Progressive, satin-faced nonreflective aluminum with permanently etched markings.

Stem: Copper-plated steel, aluminum, or brass for separable socket; of length to suit installation.

INSERTION DIAL THERMOMETERS:

Description: ASME B40.3, bimetal type.

Dial: 1-inch (25-mm) diameter.

Case: Stainless steel.

Stem: Dustproof and leakproof 1/8-inch- (3-mm-) diameter, tapered-end stem with nominal length of 5 inches (125 mm).

SEPARABLE SOCKETS:

Description: Fitting with protective socket for installation in threaded pipe fitting to hold fixed thermometer stem.

- A. Material: Brass, for use in copper piping.
- B. Material: Steel, for use in steel piping.
- C. Extension-Neck Length: Nominal thickness of 2 inches (50 mm), but not less than thickness of insulation. Omit extension neck for sockets for piping not insulated.
- D. Insertion Length: To extend to center of pipe.
- E. Heat-Transfer Fluid: Oil or graphite.

THERMOMETER WELLS:

Description: Fitting with protective well for installation in threaded pipe fitting to hold test thermometer.

- A. Material: Brass, for use in copper piping.
- B. Material: Steel, for use in steel piping.
- C. Extension-Neck Length: Nominal thickness of 2 inches (50 mm), but not less than thickness of insulation. Omit extension neck for wells for piping not insulated.
- D. Insertion Length: To extend to center of pipe.
- E. Heat-Transfer Fluid: Oil or graphite.

PRESSURE GAGES:

Description: ASME B40.1, phosphor-bronze bourdon-tube type with bottom connection; dry type, unless liquid-filled-case type is indicated.

Case: Drawn steel, brass, or aluminum with 4-1/2-inch- (115-mm-) diameter, glass lens.

Connector: Brass, NPS 1/4 (DN8).

Scale: White-coated aluminum with permanently etched markings.

Accuracy: Grade A, plus or minus 1 percent of middle 50 percent of scale.

Range: Comply with the following:

- A. Vacuum: 30 inches Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
- B. Fluids under Pressure: Two times the operating pressure.

PRESSURE-GAGE FITTINGS:

Valves: NPS 1/4 (DN8) brass or stainless-steel needle type.

Syphons: NPS 1/4 (DN8) coil of brass tubing with threaded ends.

Snubbers: ASME B40.5, NPS 1/4 (DN8) brass bushing with corrosion-resistant porous-metal disc of material suitable for system fluid and working pressure.

TEST PLUGS:

Description: Nickel-plated, brass-body test plug in NPS 1/2 (DN15) fitting.

Body: Length as required to extend beyond insulation.

Pressure Rating: 500 psig (3450 kPa) minimum.

Core Inserts: Two self-sealing valves, suitable for inserting 1/8-inch (3-mm) OD probe from dial-type thermometer or pressure gage.

Core Material for Air, Water, Oil, and Gas: 20 to 200 deg F (Minus 7 to plus 93 deg C), chlorosulfonated polyethylene synthetic rubber.

Test-Plug Cap: Gasketed and threaded cap, with retention chain or strap.

FLOW-MEASURING SYSTEMS:

System includes calibrated flow element, separate meter, hoses or tubing, valves, fittings, and conversion chart compatible with flow element, meter, and system fluid.

- A. Flow range of flow-measuring element and meter covers operating range of equipment or system where used.
- B. Display: Visual instantaneous rate of flow.

FLOWMETER:

Ultrasonic Flow Meter: Clamp-on model for piping and sensing clean liquids. 11-28VDC @0.25A power required. Reverse polarity and surge suppression protection. Rated for fluid velocity of 0.1 to 40 FPS. 4-20mA output with 12 bit resolution. Integral LCD display of 2 line of 8 characters each

minimal. NEMA 3 enclosure.

PART 3 EXECUTION

METER AND GAGE INSTALLATION, GENERAL:

Install meters, gages, and accessories according to manufacturer's written instructions for applications where used.

THERMOMETER INSTALLATION:

Install thermometers and adjust vertical and tilted positions.

Install in the following locations:

- A. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.

Install remote-reading dial thermometers in control panels with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

Install separable sockets in vertical position in piping tees where fixed thermometers are indicated.

- A. Install with socket extending to center of pipe.
- B. Fill sockets with oil or graphite.

Install thermometer wells in vertical position in piping tees where test thermometers are indicated.

- A. Install with stem extending to center of pipe.
- B. Fill wells with oil or graphite and secure caps.

PRESSURE-GAGE INSTALLATION:

Install pressure gages in piping tees with pressure-gage valve located on pipe at most readable position.

Install liquid-filled-type pressure gages at suction and discharge of each pump.

Install pressure-gage needle valve and snubber in piping to pressure gages.

Exception: Install syphon instead of snubber in piping to steam pressure gages.

FLOWMETER INSTALLATION:

Install flowmeters and components according to manufacturer's written instructions.

CONNECTIONS:

Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping and specialties. The following are specific connection requirements:

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance.
- B. Connect flow-measuring-system elements to meters.

C. Connect flowmeter transmitters to meters.

Electrical Contractor to make connections to power supply and electrically operated meters and devices.

Ground electrically operated meters.

Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

Install electrical connections for power and devices.

Electrical power, wiring, and connections are specified in Division 16 Sections.

ADJUSTING AND CLEANING:

Calibrate meters according to manufacturer's written instructions, after installation.

Adjust faces of meters and gages to proper angle for best visibility.

Clean windows of meters and gages and clean factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer's touchup paint.

END OF SECTION

23 05 23 GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes general duty valves common to several mechanical piping systems.

Related Sections: The following Sections contain requirements that relate to this Section:

- A. Special purpose valves are specified in Division 23 piping system Sections.
- B. Valve tags and charts are specified in Division 23 Section "Mechanical Identification."

SUBMITTALS:

General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

Product Data for each valve type. Include body material, valve design, pressure and temperature classification, end connection details, seating materials, trim material and arrangement, dimensions and required clearances, and installation instructions. Include list indicating valve and its application.

Maintenance data for valves to include in the operation and maintenance manual specified in Division 1. Include detailed manufacturer's instructions on adjusting, servicing, disassembling, and repairing.

QUALITY ASSURANCE:

Single-Source Responsibility: Comply with the requirements specified in Division 1 Section "Materials and Equipment," under "Source Limitations" Paragraph.

ASME Compliance: Comply with ASME B31.9 for building services piping and ASME B31.1 for power piping.

MSS Compliance: Comply with the various MSS Standard Practice documents referenced.

DELIVERY, STORAGE, AND HANDLING:

Prepare valves for shipping as follows:

- A. Protect internal parts against rust and corrosion.
- B. Protect threads, flange faces, grooves, and weld ends.
- C. Set globe closed to prevent rattling.
- D. Set ball and plug valves open to minimize exposure of functional surfaces.
- E. Set butterfly valves closed or slightly open.
- F. Block check valves in either closed or open position.

Use the following precautions during storage:

- A. Maintain valve end protection.
- B. Store indoors and maintain valve temperature higher than ambient dew-point temperature.
If outdoor storage is necessary, store valves off the ground in watertight enclosures.

Use a sling to handle large valves. Rig to avoid damage to exposed parts. Do not use handwheels and stems as lifting or rigging points.

PART 2 PRODUCTS

MANUFACTURERS:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Ball Valves:
 - 1. Hammond Valve Corporation.
 - 2. Milwaukee Valve Company, Inc.
 - 3. NIBCO Inc.
 - 4. Stockham Valves & Fittings, Inc.
 - 5. Victaulic Company of America.
 - 6. Apollo.
- B. Plug Valves:
 - 1. NIBCO Inc.
 - 2. Stockham Valves & Fittings, Inc.
 - 3. Victaulic Company of America.
- C. Globe Valves:
 - 1. Hammond Valve Corporation.
 - 2. Milwaukee Valve Company, Inc.
 - 3. NIBCO Inc.
 - 4. Stockham Valves & Fittings, Inc.
- D. Butterfly Valves:
 - 1. Center Line, Mark Controls Corporation.
 - 2. Hammond Valve Corporation.
 - 3. Keystone Valve USA, Inc.
 - 4. Milwaukee Valve Company, Inc.
 - 5. NIBCO Inc.
 - 6. Stockham Valves & Fittings, Inc.
 - 7. Victaulic Company of America.
- E. Swing Check Valves:
 - 1. Hammond Valve Corporation.
 - 2. Milwaukee Valve Company, Inc.
 - 3. NIBCO Inc.
 - 4. Stockham Valves & Fittings, Inc.
 - 5. Victaulic Company of America.

BASIC, COMMON FEATURES:

Design: Rising stem or rising outside screw and yoke stems, except as specified below.

Nonrising stem valves may be used only where headroom prevents full extension of rising stems.

Pressure and Temperature Ratings: As indicated in the "Application Schedule" of Part 3 of this Section and as required to suit system pressures and temperatures.

Sizes: Same size as upstream pipe, unless otherwise indicated.

Operators: Use specified operators and handwheels, except provide the following special operator features:

- A. Handwheels: For valves other than quarter turn.
- B. Lever Handles: For quarter-turn valves 6 inches (DN150) and smaller, except for plug valves, which shall have square heads. Furnish Owner with 1 wrench for every 10 plug valves.
- C. Chain-Wheel Operators: For valves 4 inches (DN100) and larger, installed 84 inches (2400 mm) or higher above finished floor elevation.
- D. Gear-Drive Operators: For quarter-turn valves 8 inches (DN200) and larger.

Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

Threads: ASME B1.20.1.

Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

Solder Joint: ASME B16.18.

Caution: Where soldered end connections are used, use solder having a melting point below 840 deg F (450 deg C) for gate, globe, and check valves; below 421 deg F (216 deg C) for ball valves.

BALL VALVES:

Ball Valves, 4 Inches (DN100) and Smaller: MSS SP-110, Class 150, 600-psi (4140-kPa) CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for 1/2-inch (DN15) valves and smaller and full port for 3/4-inch (DN20) valves and larger; blowout proof; bronze or brass stem; teflon seats and seals; threaded or soldered end connections:

Operator: Vinyl-covered steel lever handle, unless noted otherwise.

PLUG VALVES:

Plug Valves: MSS SP-78, 175-psi (1200-kPa) CWP, ASTM A 126 cast-iron body and bonnet, cast-iron plug, Buna N, Viton, or teflon packing, flanged or grooved end connections:

Operator: Lever.

GLOBE VALVES:

Globe Valves, 2-1/2 Inches (DN65) and Smaller: MSS SP-80; Class 125, 200-psi (1380-kPa) CWP, or Class 150, 300-psi (2070-kPa) CWP; ASTM B 62 cast-bronze body and screwed bonnet, rubber, bronze, or teflon disc, silicon bronze-alloy stem, teflon-impregnated packing with bronze nut, threaded or soldered end connections; and with aluminum or malleable-iron handwheel.

Globe Valves, 3 Inches (DN80) and Larger: MSS SP-85, Class 125, 200-psi (1380-kPa) CWP, ASTM A 126 cast-iron body and bolted bonnet with bronze fittings, renewable bronze seat and disc, brass-alloy stem, outside screw and yoke, teflon-impregnated packing with cast-iron follower, flanged end connections; and with cast-iron handwheel.

BUTTERFLY VALVES:

Butterfly Valves: MSS SP-67, 200-psi (1380-kPa) CWP, 150-psi (1035- kPa) maximum pressure differential, ASTM A 126 cast-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals, wafer, lug, or grooved style:

Disc Type: Aluminum bronze.

Operator for Sizes 2 Inches (DN50) to 6 Inches (DN150): Standard lever handle with memory stop.

Operator for Sizes 8 Inches (DN200) to 24 Inches (DN600): Gear operator with position indicator and chain wheel if operator is higher than 84" above floor.

CHECK VALVES:

Swing Check Valves, 2-1/2 Inches (DN65) and Smaller: MSS SP-80; Class 125, 200-psi (1380-kPa) CWP, or Class 150, 300-psi (2070-kPa) CWP; horizontal swing, Y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections, non-slam.

Swing Check Valves, 3 Inches (DN80) and Larger: MSS SP-71, Class 125, 200-psi (1380-kPa) CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end connections, non-slam.

PART 3 EXECUTION

EXAMINATION:

Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

Operate valves from fully open to fully closed positions. Examine guides and seats made accessible by such operation.

Examine threads on valve and mating pipe for form and cleanliness.

Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

Do not attempt to repair defective valves; replace with new valves.

INSTALLATION:

Install valves as indicated, according to manufacturer's written instructions.

Piping installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

Install valves with unions or flanges at each piece of equipment arranged to allow servicing, maintenance, and equipment removal without system shutdown.

Locate valves for easy access and provide separate support where necessary.

Install valves in horizontal piping with stem at or above the center of the pipe.

Install valves in a position to allow full stem movement.

For chain-wheel operators, extend chains to 60 inches (1500 mm) above finished floor elevation.

Install check valves for proper direction of flow as follows in a horizontal or vertical position with hinge pin level.

SOLDERED CONNECTIONS:

Cut tube square and to exact lengths.

Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

Open ball and globe valves to fully open position.

Remove the cap and disc holder of swing check valves having composition discs.

Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder starts cooling, remove excess amounts around the joint with a cloth or brush.

THREADED CONNECTIONS:

Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

Align threads at point of assembly.

Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

Assemble joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

FLANGED CONNECTIONS:

Align flange surfaces parallel.

Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

For dead-end service, butterfly valves require flanges both upstream and downstream for proper shutoff and retention.

VALVE END SELECTION:

Select valves with the following ends or types of pipe/tube connections:

- A. Copper Tube Size, 2-1/2 Inches (DN65) and Smaller: Solder ends, except provide threaded ends for heating hot water and low-pressure steam service.
- B. Steel Pipe Sizes, 2 Inches (DN65) and Smaller: Threaded or grooved end.
- C. Steel Pipe Sizes, 2-1/2 Inches (DN80) and Larger: Grooved end or flanged.

APPLICATION SCHEDULE:

General Application: Use ball and butterfly valves for shutoff duty; globe, ball, and butterfly for throttling duty. Refer to piping system Specification Sections for specific valve applications and arrangements.

- A. Heating Water Systems: Use the following valve types:
 - 1. Ball Valves: Class 150, 600-psi (4140-kPa) CWP, with stem extension and memory stop.
 - 2. Globe Valves: Class 150, bronze or cast-iron body to suit piping system, and bronze disc.
 - 3. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or epoxy-coated ductile iron disc; EPDM or Buna N sleeve and stem seals.
 - 4. Bronze Swing Check: Class 150, with composition seat.
- B. Chilled-Water Systems: Use the following valve types:
 - 1. Ball Valves: Class 150, 600-psi (4140-kPa) CWP, with stem extension and memory stop.
 - 2. Plug Valves: Buna N packing.
 - 3. Globe Valves: Class 125, bronze body with bronze or teflon disc; or Class 125, cast-iron body.
 - 4. Butterfly Valves: Nickel-plated ductile iron, aluminum bronze, or elastomer-coated ductile iron disc; EPDM sleeve and stem seals.
 - 5. Check Valves: Class 125, bronze body swing check with rubber seat; Class 125, cast-iron body swing check; Class 125, cast-iron body wafer check; or Class 125, cast-iron body lift check.
- C. Condenser Water Systems: Use the following valve types:
 - 1. Ball Valves: Class 150, 600-psi (4140-kPa) CWP, with memory stop.

2. Plug Valves: Buna N packing.
3. Globe Valves: Class 125, bronze body with bronze or teflon disc; or Class 125, cast-iron body.
4. Butterfly Valves: Aluminum bronze, epoxy-coated ductile iron disc; EPDM sleeve and stem seals.
5. Check Valves: Class 125, bronze body swing check with rubber seat; Class 125, cast-iron body swing check.

ADJUSTING:

Adjust or replace packing after piping systems have been tested and put into service, but before final adjusting and balancing. Replace valves if leak persists.

END OF SECTION

23 05 29 HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes hangers and supports for mechanical system piping and equipment.

DEFINITIONS:

MSS: Manufacturers Standardization Society for the Valve and Fittings Industry.

Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

PERFORMANCE REQUIREMENTS:

Design channel support systems for piping to support multiple pipes capable of supporting combined weight of supported systems, system contents, and test water.

SUBMITTALS:

Product Data: For each type of pipe hanger, channel support system component, and thermal-hanger shield insert indicated.

Welding Certificates: Copies of certificates for welding procedures and operators.

QUALITY ASSURANCE:

Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

PART 2 PRODUCTS**MANUFACTURERS:**

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Pipe Hangers:
 - 1. AAA Technology and Specialties Co., Inc.
 - 2. B-Line Systems, Inc.
 - 3. Erico.
 - 4. Globe Pipe Hanger Products, Inc.
 - 5. Grinnell Corp.
 - 6. GS Metals Corp.
 - 7. National Pipe Hanger Corp.
 - 8. PHD Manufacturing, Inc.

9. PHS Industries, Inc.
10. Piping Technology & Products, Inc.

B. Channel Support Systems:

1. B-Line Systems, Inc.
2. Erico.
3. Grinnell Corp.; Power-Strut Unit.
4. GS Metals Corp.
5. National Pipe Hanger Corp.
6. Thomas & Betts Corp.
7. Unistrut Corp.

C. Thermal-Hanger Shield Inserts:

1. PHS Industries, Inc.
2. Pipe Shields, Inc.
3. Rilco Manufacturing Co., Inc.
4. Value Engineered Products, Inc.

D. Powder-Actuated Fastener Systems:

1. Gunnebo Fastening Corp.
2. Hilti, Inc.
3. ITW Ramset/Red Head.
4. Masterset Fastening Systems, Inc.

MANUFACTURED UNITS:

Pipe Hangers, Supports, and Components: MSS SP-58, factory-fabricated components. Refer to "Hanger and Support Applications" Article in Part 3 for where to use specific hanger and support types.

- A. Galvanized, Metallic Coatings: For piping and equipment that will not have field-applied finish.
- B. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

Channel Support Systems: MFMA-2, factory-fabricated components for field assembly.

- A. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.
- B. Nonmetallic Coatings: On attachments for electrolytic protection where attachments are in direct contact with copper tubing.

Thermal-Hanger Shield Inserts: 100-psi (690-kPa) minimum compressive-strength insulation, encased in sheet metal shield.

- A. Material for Piping: ASTM C 552, Type I cellular glass or high density polyisocyanurate insulation.
- B. For Trapeze or Clamped System: Insert and shield cover entire circumference of pipe.
- C. For Clevis or Band Hanger: Insert and shield cover lower 180 degrees of pipe.
- D. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield.

MISCELLANEOUS MATERIALS:

Powder-Actuated Drive-Pin Fasteners: Powder-actuated-type, drive-pin attachments with pull-out

and shear capacities appropriate for supported loads and building materials where used.

Mechanical-Anchor Fasteners: Insert-type attachments with pull-out and shear capacities appropriate for supported loads and building materials where used.

Structural Steel: ASTM A 36/A 36M, steel plates, shapes, and bars, black and galvanized.

Grout: ASTM C 1107, Grade B, factory-mixed and -packaged, nonshrink and nonmetallic, dry, hydraulic-cement grout.

- A. Characteristics: Post hardening and volume adjusting; recommended for both interior and exterior applications.
- B. Properties: Nonstaining, noncorrosive, and nongaseous.
- C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 EXECUTION

HANGER AND SUPPORT APPLICATIONS:

Specific hanger requirements are specified in Sections specifying equipment and systems.

Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Specification Sections.

All hangers are to be sized to allow for continuous installation of insulation and thermal insulation shield. Hangers are to be sized to match the O.D. of insulated pipes or O.D. of uninsulated pipes.

Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

- A. Adjustable Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN15 to DN750).

Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

- A. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500).
- B. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN20 to DN500), if longer ends are required for riser clamps.

Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

- A. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches (150 mm) for heavy loads.
- B. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
- C. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
- D. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
- E. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

Building Attachments: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

- A. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction to attach to top flange of structural shape.
- B. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
- C. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
- D. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
- E. C-Clamps (MSS Type 23): For structural shapes.
- F. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
- G. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
- H. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
- I. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
- J. Malleable Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
- K. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - 1. Light (MSS Type 31): 750 lb (340 kg).
 - 2. Medium (MSS Type 32): 1500 lb (675 kg).
 - 3. Heavy (MSS Type 33): 3000 lb (1350 kg).
- L. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- M. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
- N. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where head room is limited.

Steel or Malleable Concrete Inserts (MSS Type 18) for upper attachment to suspend pipe hangers from concrete ceiling/floor are not acceptable.

Saddles and Shields: Unless otherwise indicated and except as specified in piping system Specification Sections, install the following types:

- A. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
- B. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
- C. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi (690-kPa) minimum compressive-strength, high density polyisocyanurate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

HANGER AND SUPPORT INSTALLATION:

Pipe Hanger and Support Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

Channel Support System Installation: Arrange for grouping of parallel runs of piping and support

together on field-assembled channel systems.

- A. Field assemble and install according to manufacturer's written instructions.

Install building attachments within concrete slabs or attach to structural steel. Space attachments within maximum piping span length indicated in MSS SP-69. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, and expansion joints, and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

Install powder-actuated drive-pin fasteners in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.

Install mechanical-anchor fasteners in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.

Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

Install hangers and supports to allow controlled thermal movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.

Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9, "Building Services Piping," is not exceeded.

Insulated Piping: Comply with the following:

- A. Attach clamps and spacers to piping.
 - 1. Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - 2. Do not exceed pipe stress limits according to ASME B31.9.
- B. Install MSS SP-58, Type 39 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - 1. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
- C. Install MSS SP-58, Type 40 protective shields on cold piping with vapor barrier. Shields shall span arc of 180 degrees.
 - 1. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
- D. Shield Dimensions for Pipe: Not less than the following:
 - 1. NPS 1/4 to NPS 3-1/2 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - 2. NPS 4 (DN100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - 3. NPS 5 and NPS 6 (DN125 and DN150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - 4. NPS 8 to NPS 14 (DN200 to DN350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.

- mm) thick.
5. NPS 16 to NPS 24 (DN400 to DN600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

- E. Insert Material: Length at least as long as protective shield.
- F. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

EQUIPMENT SUPPORTS:

Fabricate structural-steel stands to suspend equipment from structure above or to support equipment above floor.

Grouting: Place grout under supports for equipment and make smooth bearing surface.

METAL FABRICATION:

Cut, drill, and fit miscellaneous metal fabrications for heavy-duty steel trapezes and equipment supports.

Fit exposed connections together to form hairline joints. Field-weld connections that cannot be shop-welded because of shipping size limitations.

Field Welding: Comply with AWS D1.1 procedures for shielded metal arc welding, appearance and quality of welds, and methods used in correcting welding work, and with the following:

- A. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
- B. Obtain fusion without undercut or overlap.
- C. Remove welding flux immediately.
- D. Finish welds at exposed connections so no roughness shows after finishing and contours of welded surfaces match adjacent contours.

ADJUSTING:

Hanger Adjustment: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.

PAINTING:

Touching Up: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

- A. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

23 05 93 TESTING AND BALANCING

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes testing, adjusting, and balancing HVAC systems to produce design objectives, including the following:

- A. Balancing airflow and water flow within distribution systems, including submains, branches, and terminals, to indicated quantities according to specified tolerances.
- A. Adjusting total HVAC systems to provide indicated quantities.
- B. Measuring electrical performance of HVAC equipment.
- C. Setting quantitative performance of HVAC equipment.
- D. Verifying that automatic control devices are functioning properly.
- E. Reporting results of the activities and procedures specified in this Section.

Related Sections include the following:

- A. Testing and adjusting requirements unique to particular systems and equipment are included in the Sections that specify those systems and equipment.
- B. Field quality-control testing to verify that workmanship quality for system and equipment installation is specified in system and equipment Sections.

The intent of balancing for this project is to be for the following:

- A. Terminal Units: Traverse supply duct to calibrate new controller. If there isn't adequate straight duct off the unit, the existing diffusers may need to be measured to determine airflow. Heating water flow is to be measured and adjusted if needed, diversity will need to be accounted for, not all equipment is to be balanced.
- B. Air Handlers: Existing supply airflow is to be measured to verify against the original design. System total static is to be read. Traversing the supply duct is acceptable. The outside airflow is to be set per these documents. Chilled and heating water flows are to be measured and adjusted if needed, diversity will need to be accounted for, not all equipment is to be balanced.
- C. Fan Coil Units: Existing supply airflow is to be measured to verify against the original design. System total static is to be read. Traversing the supply duct is acceptable. Chilled and heating water flows are to be measured and adjusted if needed, diversity will need to be accounted for, not all equipment is to be balanced.
- D. Pumps: Water flow and system pressures are to be measured to be verified against the original design.
- E. Chillers: Water flow is to be measured and adjusted for the evaporator and condenser on each chiller.

DEFINITIONS:

Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to design quantities.

Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

Report Forms: Test data sheets for recording test data in logical order.

Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

Test: A procedure to determine quantitative performance of a system or equipment.

Testing, Adjusting, and Balancing Agent: The entity responsible for performing and reporting the testing, adjusting, and balancing procedures.

AABC: Associated Air Balance Council.

AMCA: Air Movement and Control Association.

NEBB: National Environmental Balancing Bureau.

SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.

SUBMITTALS:

Quality-Assurance Submittals: Within 30 days from the Contractor's Notice to Proceed, submit 2 copies of evidence that the testing, adjusting, and balancing Agent and this Project's testing, adjusting, and balancing team members meet the qualifications specified in the "Quality Assurance" Article below.

Certified Testing, Adjusting, and Balancing Reports: Submit electronic copy of reports prepared, as specified in this Section, on approved forms certified by the testing, adjusting, and balancing Agent.

Warranty: Submit electronic copy of special warranty specified in the "Warranty" Article below.

QUALITY ASSURANCE:

Agent Qualifications: Engage a testing, adjusting, and balancing agent certified by either AABC or NEBB.

Testing, Adjusting, and Balancing Conference: Meet with the Owner's and the Architect's representatives on approval of the testing, adjusting, and balancing strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of testing, adjusting, and balancing team members, equipment manufacturers' authorized service representatives, HVAC controls Installer, and other support personnel. Provide 7 days' advance notice of scheduled meeting time and location.

- A. Agenda Items: Include at least the following:
1. Submittal distribution requirements.
 2. Contract Documents examination report.
 3. Testing, adjusting, and balancing plan.
 4. Work schedule and Project site access requirements.
 5. Coordination and cooperation of trades and subcontractors.
 6. Coordination of documentation and communication flow.

Certification of Testing, Adjusting, and Balancing Reports: Certify the testing, adjusting, and balancing field data reports. This certification includes the following:

- A. Review field data reports to validate accuracy of data and to prepare certified testing, adjusting, and balancing reports.
- B. Certify that the testing, adjusting, and balancing team complied with the approved testing, adjusting, and balancing plan and the procedures specified and referenced in this Specification.

Testing, Adjusting, and Balancing Reports: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."

Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

Instrumentation Calibration: Calibrate instruments at least every 6 months or more frequently if required by the instrument manufacturer.

PROJECT CONDITIONS:

Full Owner Occupancy: The Owner will occupy the site and existing building during the entire testing, adjusting, and balancing period. Cooperate with the Owner during testing, adjusting, and balancing operations to minimize conflicts with the Owner's operations.

COORDINATION:

Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist testing, adjusting, and balancing activities.

Notice: Provide 7 days' advance notice for each test. Include scheduled test dates and times.

Perform testing, adjusting, and balancing after leakage and pressure tests on air and water

distribution systems have been satisfactorily completed.

WARRANTY:

General Warranty: The national project performance guarantee specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

Special Guarantee: Provide a guarantee on NEBB forms stating that NEBB will assist in completing the requirements of the Contract Documents if the testing, adjusting, and balancing Agent fails to comply with the Contract Documents. Guarantee includes the following provisions:

- A. The certified Agent has tested and balanced systems according to the Contract Documents.

PART 2 PRODUCTS**CONTRACTORS:**

Contractors: Subject to compliance with requirements, provide services by one of the following:

- A. Testing, Balancing and Controls:
 - 1. QTAB.
 - 2. EMC2.
 - 3. Pro Balance.
 - 4. PEC Field Services.

PART 3 EXECUTION**EXAMINATION:**

Examine Contract Documents to become familiar with project requirements and to discover conditions in systems' designs that may preclude proper testing, adjusting, and balancing of systems and equipment.

- A. Contract Documents are defined in the General and Supplementary Conditions of the Contract.
- B. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

Examine approved submittal data of HVAC systems and equipment.

Examine project record documents described in Division 1 Section "Project Record Documents."

Examine Architect's and Engineer's design data, including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.

Examine equipment performance data, including fan and pump curves. Relate performance data to project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system. Calculate system effect factors to reduce the performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Specification Sections have been performed.

Examine system and equipment test reports.

Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

Examine air-handling equipment to ensure clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

Examine terminal units, such as variable-air-volume boxes and mixing boxes, to verify that they are accessible and their controls are connected and functioning.

Examine strainers for clean screens and proper perforations.

Examine 3-way valves for proper installation for their intended function of diverting or mixing fluid flows.

Examine heat-transfer coils for correct piping connections and for clean and straight fins.

Report deficiencies discovered before and during performance of testing, adjusting, and balancing procedures.

PREPARATION:

Prepare a testing, adjusting, and balancing plan that includes strategies and step-by-step procedures.

Complete system readiness checks and prepare system readiness reports. Verify the following:

- A. Permanent electrical power wiring is complete.
- B. Hydronic systems are filled, clean, and free of air.
- C. Automatic temperature-control systems are operational.
- D. Equipment and duct access doors are securely closed.
- E. Balance, smoke, and fire dampers are open.
- F. Isolating and balancing valves are open and control valves are operational.

GENERAL TESTING AND BALANCING PROCEDURES:

Perform testing and balancing procedures on each system according to the procedures contained in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and this Section.

Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to the insulation Specifications for this Project.

Mark equipment settings with paint or other suitable, permanent identification material, including damper-control positions, valve indicators, fan-speed-control levers, and similar controls and devices, to show final settings.

FUNDAMENTAL AIR SYSTEMS' BALANCING PROCEDURES:

Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

Prepare schematic diagrams of systems' "as-built" duct layouts.

For variable-air-volume systems, develop a plan to simulate diversity.

Determine the best locations in main and branch ducts for accurate duct airflow measurements.

Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

Check for proper sealing of air-handling unit components.

CONSTANT-VOLUME AIR SYSTEMS' BALANCING PROCEDURES:

The procedures in this Article apply to constant-volume supply-, return-, and exhaust-air systems. Additional procedures are required for variable-air-volume, multizone, dual-duct, induction-unit supply-air systems and process exhaust-air systems. These additional procedures are specified in other articles in this Section.

Adjust fans to deliver total design airflows within the maximum allowable rpm listed by the fan manufacturer.

- A. Measure fan static pressures to determine actual static pressure as follows:
 1. Measure outlet static pressure as far downstream from the fan as practicable and upstream from restrictions in ducts such as elbows and transitions.
 2. Measure static pressure directly at the fan outlet or through the flexible connection.
 3. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from flexible connection and downstream from duct restrictions.
 4. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
- B. Measure static pressure across each air-handling unit component.
 1. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
- C. Measure static pressures entering and leaving other devices such as sound traps, heat

recovery equipment, and air washers under final balanced conditions.

- D. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
- E. Adjust fan speed higher or lower than design with the approval of the Architect. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
- F. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure no overload will occur. Measure amperage in full cooling, full heating, and economizer modes to determine the maximum required brake horsepower.

Adjust volume dampers for main duct, submain ducts, and major branch ducts to design airflows within specified tolerances.

- A. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
 - 1. Where sufficient space in submains and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
- B. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submains and branch ducts to design airflows within specified tolerances.

Measure terminal outlets and inlets without making adjustments.

- A. Measure terminal outlets using a direct-reading hood or the outlet manufacturer's written instructions and calculating factors.

Adjust terminal outlets and inlets for each space to design airflows within specified tolerances of design values. Make adjustments using volume dampers rather than extractors and the dampers at the air terminals.

- A. Adjust each outlet in the same room or space to within specified tolerances of design quantities without generating noise levels above the limitations prescribed by the Contract Documents.
- B. Adjust patterns of adjustable outlets for proper distribution without drafts.

VARIABLE-AIR-VOLUME SYSTEMS' ADDITIONAL PROCEDURES:

Compensating for Diversity: When the total airflow of all terminal units is more than the fan design airflow volume, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the design airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:

- A. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
- B. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of the terminal unit manufacturer's

recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge duct losses.

- C. Measure total system airflow. Adjust to within 10 percent of design airflow.
- D. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use the terminal unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
- E. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
 - 1. If air outlets are out of balance at minimum airflow, report the condition but leave the outlets balanced for maximum airflow.
- F. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
- G. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure adequate static pressure is maintained at the most critical unit.
- H. Record the final fan performance data.

FUNDAMENTAL PROCEDURES FOR HYDRONIC SYSTEMS:

Prepare test reports with pertinent design data and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against approved pump flow rate. Correct variations that exceed plus or minus 5 percent.

Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:

- A. Open all manual valves for maximum flow.
- B. Check expansion tank liquid level.
- C. Check makeup-water-station pressure gage for adequate pressure for highest vent.
- D. Check flow-control valves for specified sequence of operation and set at design flow.
- E. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type, unless several terminal valves are kept open.
- F. Set system controls so automatic valves are wide open to heat exchangers.
- G. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
- H. Check air vents for a forceful liquid flow exiting from vents when manually operated.

HYDRONIC SYSTEMS' BALANCING PROCEDURES:

Determine water flow at pumps. Use the following procedures, except for positive-displacement pumps:

- A. Verify impeller size by operating the pump with the discharge valve closed. Verify with the pump manufacturer that this will not damage pump. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on the manufacturer's pump curve at zero flow and confirm that the pump has the intended impeller size.
- B. Check system resistance. With all valves open, read pressure differential across the pump and mark the pump manufacturer's head-capacity curve. Adjust pump discharge

valve until design water flow is achieved.

- C. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on the pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
- D. Report flow rates that are not within plus or minus 5 percent of design.

Set calibrated balancing valves, if installed, at calculated presettings.

Measure flow at all stations and adjust, where necessary, to obtain first balance.

- A. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

Adjust balancing stations to within specified tolerances of design flow rate as follows:

- A. Determine the balancing station with the highest percentage over design flow.
- B. Adjust each station in turn, beginning with the station with the highest percentage over design flow and proceeding to the station with the lowest percentage over design flow.
- C. Record settings and mark balancing devices.

Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures, including outdoor-air temperature.

Measure the differential-pressure control valve settings existing at the conclusions of balancing.

VARIABLE-FLOW HYDRONIC SYSTEMS' ADDITIONAL PROCEDURES:

Balance systems with automatic 2- and 3-way control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

MOTORS:

Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

- A. Manufacturer, model, and serial numbers.
- B. Motor horsepower rating.
- C. Motor rpm.
- D. Efficiency rating if high-efficiency motor.
- E. Nameplate and measured voltage, each phase.
- F. Nameplate and measured amperage, each phase.
- G. Starter thermal-protection-element rating.

Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

CHILLERS:

Balance water flow through each evaporator and condenser to within specified tolerances of design flow with all pumps operating. With only one chiller operating in a multiple chiller installation, do not exceed the flow for the maximum tube velocity recommended by the chiller manufacturer. Measure and record the following data with each chiller operating at design

conditions:

- A. Evaporator water entering and leaving temperatures, pressure drop, and water flow.
- B. Condenser water entering and leaving temperatures, pressure drop, and water flow.
- C. Evaporator and condenser refrigerant temperatures and pressures, using instruments furnished by the chiller manufacturer.

HEAT-TRANSFER COILS:

Water Coils: Measure the following data for each coil:

- A. Entering- and leaving-water temperatures.
- B. Water flow rate.
- C. Water pressure drop.
- D. Dry-bulb temperatures of entering and leaving air.
- E. Wet-bulb temperatures of entering and leaving air for cooling coils designed for less than 7500 cfm (3540 L/s).
- F. Airflow.
- G. Air pressure drop.

TOLERANCES:

Set HVAC system airflow and water flow rates within the following tolerances:

- A. Supply, Return, and Exhaust Fans: Plus 5 to plus 10 percent.
- B. Air Outlets and Inlets: 0 to minus 10 percent.
- C. Heating-Water Flow Rate: 0 to minus 10 percent.
- D. Cooling-Water Flow Rate: 0 to minus 5 percent.

FINAL REPORT:

General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in 3-ring binder, tabulated and divided into sections by tested and balanced systems.

Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.

- A. Include a list of the instruments used for procedures, along with proof of calibration.

General Report Data: In addition to the form titles and entries, include the following data in the final report, as applicable:

- A. Title page.
- B. Name and address of testing, adjusting, and balancing Agent.
- C. Project name.
- D. Project location.
- E. Architect's name and address.
- F. Engineer's name and address.
- G. Contractor's name and address.
- H. Report date.
- I. Signature of testing, adjusting, and balancing Agent who certifies the report.
- J. Summary of contents, including the following:
 - 1. Design versus final performance.
 - 2. Notable characteristics of systems.

3. Description of system operation sequence if it varies from the Contract Documents.
- K. Nomenclature sheets for each item of equipment.
- L. Data for terminal units, including manufacturer, type size, and fittings.
- M. Notes to explain why certain final data in the body of reports vary from design values.
- N. Test conditions for fans and pump performance forms, including the following:
 1. Settings for outside-, return-, and exhaust-air dampers.
 2. Condition of filters.
 3. Cooling coil, wet- and dry-bulb conditions.
 4. Fan drive settings, including settings and percentage of maximum pitch diameter.
 5. Settings for supply-air, static-pressure controller.
 6. Other system operating conditions that affect performance.

Air-Handling Unit Test Reports: For air-handling units with coils, include the following:

- A. Unit Data: Include the following:
 1. Unit identification.
 2. Location.
 3. Make and type.
 4. Model number and unit size.
 5. Manufacturer's serial number.
 6. Unit arrangement and class.
 7. Discharge arrangement.
 8. Sheave make, size in inches (mm), and bore.
 9. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
 10. Number of belts, make, and size.
 11. Number of filters, type, and size.
- B. Motor Data: Include the following:
 1. Make and frame type and size.
 2. Horsepower and rpm.
 3. Volts, phase, and hertz.
 4. Full-load amperage and service factor.
 5. Sheave make, size in inches (mm), and bore.
 6. Sheave dimensions, center-to-center and amount of adjustments in inches (mm).
- C. Test Data: Include design and actual values for the following:
 1. Total airflow rate in cfm (L/s).
 2. Total system static pressure in inches wg (Pa).
 3. Fan rpm.
 4. Discharge static pressure in inches wg (Pa).
 5. Preheat coil static-pressure differential in inches wg (Pa).
 6. Cooling coil static-pressure differential in inches wg (Pa).
 7. Heating coil static-pressure differential in inches wg (Pa).
 8. Outside airflow in cfm (L/s).
 9. Outside-air damper position.

Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

- A. Report Data: Include the following:
 1. System and air-handling unit number.
 2. Location and zone.
 3. Traverse air temperature in deg F (deg C).

4. Duct static pressure in **inches wg** (Pa).
5. Duct size in **inches** (mm).
6. Duct area in **sq. ft.** ((sq. m)).
7. Design airflow rate in **cfm** (L/s).
8. Design velocity in **fpm** (m/s).
9. Actual airflow rate in **cfm** (L/s).
10. Actual average velocity in **fpm** (m/s).
11. Barometric pressure in **psig** (Pa).

Air-Terminal-Device Reports: For terminal units, include the following:

- A. Unit Data: Include the following:
 1. System and air-handling unit identification.
 2. Location and zone.
 3. Test apparatus used.
 4. Area served.
 5. Air-terminal-device make.
 6. Air-terminal-device number from system diagram.
 7. Air-terminal-device type and model number.
 8. Air-terminal-device size.
 9. Air-terminal-device effective area in **sq. ft.** ((sq. m)).
- B. Test Data: Include design and actual values for the following:
 1. Airflow rate in **cfm** (L/s).
 2. Air velocity in **fpm** (m/s).
 3. Preliminary airflow rate as needed in **cfm** (L/s).
 4. Preliminary velocity as needed in **fpm** (m/s).
 5. Final airflow rate in **cfm** (L/s).
 6. Final velocity in **fpm** (m/s).
 7. Space temperature in **deg F** (deg C).

System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

- A. Unit Data: Include the following:
 1. System and air-handling unit identification.
 2. Location and zone.
 3. Room or riser served.
 4. Coil make and size.
 5. Flowmeter type.
- B. Test Data: Include design and actual values for the following:
 1. Airflow rate in **cfm** (L/s).
 2. Entering-water temperature in **deg F** (deg C).
 3. Leaving-water temperature in **deg F** (deg C).
 4. Water pressure drop in **feet of head or psig** (kPa).
 5. Entering-air temperature in **deg F** (deg C).
 6. Leaving-air temperature in **deg F** (deg C).

Pump Test Reports: For pumps, include the following data. Calculate impeller size by plotting the shutoff head on pump curves.

- A. Unit Data: Include the following:
 1. Unit identification.
 2. Location.

3. Service.
 4. Make and size.
 5. Model and serial numbers.
 6. Water flow rate in **gpm (L/s)**.
 7. Water pressure differential in **feet of head or psig (kPa)**.
 8. Required net positive suction head in **feet of head or psig (kPa)**.
 9. Pump rpm.
 10. Impeller diameter in **inches (mm)**.
 11. Motor make and frame size.
 12. Motor horsepower and rpm.
 13. Voltage at each connection.
 14. Amperage for each phase.
 15. Full-load amperage and service factor.
 16. Seal type.
- B. Test Data: Include design and actual values for the following:
1. Static head in **feet of head or psig (kPa)**.
 2. Pump shutoff pressure in **feet of head or psig (kPa)**.
 3. Actual impeller size in **inches (mm)**.
 4. Full-open flow rate in **gpm (L/s)**.
 5. Full-open pressure in **feet of head or psig (kPa)**.
 6. Final discharge pressure in **feet of head or psig (kPa)**.
 7. Final suction pressure in **feet of head or psig (kPa)**.
 8. Final total pressure in **feet of head or psig (kPa)**.
 9. Final water flow rate in **gpm (L/s)**.
 10. Voltage at each connection.
 11. Amperage for each phase.

Instrument Calibration Reports: For instrument calibration, include the following:

- A. Report Data: Include the following:
1. Instrument type and make.
 2. Serial number.
 3. Application.
 4. Dates of use.
 5. Dates of calibration.

END OF SECTION

23 07 13 DUCT INSULATION

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes semirigid and flexible duct, plenum, and breeching insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

Related Sections include the following:

- A. Division 23 Section "Pipe Insulation" for insulation for piping systems.
- B. Division 23 Section "Metal Ducts" for duct liner.

SUBMITTALS:

Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

Shop Drawings: Show fabrication and installation details for the following:

- A. Removable insulation sections at access panels.
- B. Application of field-applied jackets.
- C. Applications at linkages for control devices.

Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

QUALITY ASSURANCE:

Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

- A. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.
- B. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

DELIVERY, STORAGE, AND HANDLING:

Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

COORDINATION:

Coordinate clearance requirements with duct Installer for insulation application.

SCHEDULING:

Schedule insulation application after testing duct systems. Insulation application may begin on segments of ducts that have satisfactory test results.

PART 2 PRODUCTS**MANUFACTURERS:**

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Mineral-Fiber Insulation:
 - 1. CertainTeed Manson.
 - 2. Knauf FiberGlass GmbH.
 - 3. Owens-Corning Fiberglas Corp.
 - 4. John Manville.

INSULATION MATERIALS:

Mineral-Fiber Board Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IB, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

Mineral-Fiber Blanket Thermal Insulation: Glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II, without facing and with all-service jacket manufactured from kraft paper, reinforcing scrim, aluminum foil, and vinyl film.

FIELD-APPLIED JACKETS:

General: ASTM C 921, Type 1, unless otherwise indicated.

Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

ACCESSORIES AND ATTACHMENTS:

Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd. (270 g/sq. m).

- A. Tape Width: 4 inches (100 mm).

Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:

- A. Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.

- B. Galvanized Steel: 0.005 inch (0.13 mm) thick.
- C. Aluminum: 0.007 inch (0.18 mm) thick.

Wire: 0.080-inch (2.0-mm), nickel-copper alloy; 0.062-inch (1.6-mm), soft-annealed, stainless steel; or 0.062-inch (1.6-mm), soft-annealed, galvanized steel.

Weld-Attached Anchor Pins and Washers: Copper-coated steel pin for capacitor-discharge welding and galvanized speed washer. Pin length sufficient for insulation thickness indicated.

- A. Welded Pin Holding Capacity: 100 lb (45 kg) for direct pull perpendicular to the attached surface.

Adhesive-Attached Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

- A. Adhesive: Recommended by the anchor pin manufacturer as appropriate for surface temperatures of ducts, plenums, and breechings; and to achieve a holding capacity of 100 lb (45 kg) for direct pull perpendicular to the adhered surface.

Self-Adhesive Anchor Pins and Speed Washers: Galvanized steel plate, pin, and washer manufactured for attachment to duct and plenum with adhesive. Pin length sufficient for insulation thickness indicated.

VAPOR RETARDERS:

Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 EXECUTION

EXAMINATION:

Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.

Proceed with installation only after unsatisfactory conditions have been corrected.

PREPARATION:

Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

GENERAL APPLICATION REQUIREMENTS:

Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; and free of voids throughout the length of ducts and fittings.

Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each duct system.

Use accessories compatible with insulation materials and suitable for the service. Use accessories

that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

Apply multiple layers of insulation with longitudinal and end seams staggered.

Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

Keep insulation materials dry during application and finishing.

Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

Apply insulation with the least number of joints practical.

Apply insulation over fittings and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic. Apply insulation continuously through hangers and around anchor attachments.

Insulation Terminations: For insulation application where vapor retarders are indicated, seal ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

Apply insulation with integral jackets as follows:

- A. Pull jacket tight and smooth.
- B. Joints and Seams: Cover with tape and vapor retarder as recommended by insulation material manufacturer to maintain vapor seal.
- C. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to duct flanges and fittings.

Cut insulation according to manufacturer's written instructions to prevent compressing insulation to less than 75 percent of its nominal thickness.

Install vapor-retarder mastic on ducts and plenums scheduled to receive vapor retarders.

- A. Ducts with Vapor Retarders: Overlap insulation facing at seams and seal with vapor-retarder mastic and pressure-sensitive tape having same facing as insulation. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-retarder seal.
- B. Ducts without Vapor Retarders: Overlap insulation facing at seams and secure with outward clinching staples and pressure-sensitive tape having same facing as insulation.

MINERAL-FIBER INSULATION APPLICATION:

Blanket Applications for Ducts and Plenums: Secure blanket insulation with adhesive and anchor pins and speed washers.

- A. Apply adhesives according to manufacturer's recommended coverage rates per square foot.
- A. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
- B. Install anchor pins and speed washers on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - 1. On duct sides with dimensions 18 inches (450 mm) and smaller, along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.

2. On duct sides with dimensions larger than 18 inches (450 mm). Space 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 3. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 4. Do not overcompress insulation during installation.
- C. Impale insulation over anchors and attach speed washers.
 - D. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 - E. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch (13-mm) staples, 1 inch (25 mm) o.c., and cover with pressure-sensitive tape having same facing as insulation.
 - F. Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. Secure with steel band at end joints and spaced a maximum of 18 inches (450 mm) o.c.
 - G. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 - H. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface with 6-inch- (150-mm-) wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches (150 mm) o.c.
 - I. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

Board Applications for Ducts and Plenums: Secure board insulation with adhesive and anchor pins and speed washers.

- A. Apply adhesives according to manufacturer's recommended coverage rates per square foot.
- B. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
- C. Space anchor pins as follows:
 1. On duct sides with dimensions 18 inches (450 mm) and smaller, along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) o.c.
 2. On duct sides with dimensions larger than 18 inches (450 mm). Space 16 inches (400 mm) o.c. each way, and 3 inches (75 mm) maximum from insulation joints. Apply additional pins and clips to hold insulation tightly against surface at cross bracing.
 3. Anchor pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 4. Do not overcompress insulation during installation.
- D. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
- E. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation segment with 1/2-inch (13-mm) staples, 1 inch (25 mm) o.c., and cover with pressure-sensitive tape having same facing as insulation.
- F. Apply insulation on rectangular duct elbows and transitions with a full insulation segment for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Apply insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
- G. Insulate duct stiffeners, hangers, and flanges that protrude beyond the insulation surface

with 6-inch- (150-mm-) wide strips of the same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with anchor pins spaced 6 inches (150 mm) o.c.

- H. Apply vapor-retarder mastic to open joints, breaks, and punctures for insulation indicated to receive vapor retarder.

DUCT SYSTEM APPLICATIONS:

Insulation materials and thicknesses are specified in schedules at the end of this Section. Materials and thicknesses for systems listed below are specified in schedules at the end of this Section.

Insulate the following plenums and duct systems:

- A. Indoor concealed supply-, return-, and outside-air ductwork.
- B. Indoor exposed supply-, return-, and outside-air ductwork.

Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

- A. Fibrous-glass ducts.
- B. Metal ducts with duct liner.
- C. Factory-insulated flexible ducts.
- D. Factory-insulated plenums, casings, terminal boxes, and filter boxes and sections.
- E. Flexible connectors.
- F. Vibration-control devices.
- G. Testing agency labels and stamps.
- H. Nameplates and data plates.
- I. Access panels and doors in air-distribution systems.

INDOOR DUCT AND PLENUM APPLICATION SCHEDULE:

Service: Rectangular, low pressure supply and return-air ducts are to be lined. Reference Section 23 31 13.

Service: Round and rectangular, medium and high pressure supply-air ducts.

- A. Material: Mineral-fiber board or mineral-fiber blanket.
- B. Thickness: 2 inches (50 mm).
- C. Number of Layers: One.
- D. Field-Applied Jacket: Foil and paper.
- E. Vapor Retarder Required: Yes.

Service: Round, supply-air ducts, concealed.

- A. Material: Mineral-fiber blanket.
- B. Thickness: 2 inches (50 mm).
- C. Number of Layers: One.
- D. Field-Applied Jacket: Foil and paper.
- E. Vapor Retarder Required: Yes.

Service: Rectangular, outside-air ducts, concealed.

- A. Material: Mineral-fiber board or mineral-fiber blanket.

- B. Thickness: 2 inches (50 mm).
- C. Number of Layers: One.
- D. Field-Applied Jacket: Foil and paper.
- E. Vapor Retarder Required: Yes.

END OF SECTION

23 07 19 PIPE INSULATION

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes preformed, rigid and flexible pipe insulation; insulating cements; field-applied jackets; accessories and attachments; and sealing compounds.

Related Sections include the following:

- A. Division 23 Section "Duct Insulation" for insulation for ducts and plenums.
- B. Division 23 Section "Hangers and Supports" for pipe insulation shields and protection saddles.

SUBMITTALS:

Product Data: Identify thermal conductivity, thickness, and jackets (both factory and field applied, if any), for each type of product indicated.

Shop Drawings: Show fabrication and installation details for the following:

- A. Application of protective shields, saddles, and inserts at pipe hangers for each type of insulation and hanger.
- B. Insulation application at pipe expansion joints for each type of insulation.
- C. Insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
- D. Removable insulation at piping specialties and equipment connections.
- E. Application of field-applied jackets.

Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets with requirements indicated. Include dates of tests.

Installer Certificates: Signed by the Contractor certifying that installers comply with requirements.

QUALITY ASSURANCE:

Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the U.S. Department of Labor, Bureau of Apprenticeship and Training.

Fire-Test-Response Characteristics: As determined by testing materials identical to those specified in this Section according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and sealer and cement material containers with appropriate markings of applicable testing and inspecting agency.

- A. Insulation Installed Indoors: Flame-spread rating of 25 or less, and smoke-developed rating of 50 or less.

- B. Insulation Installed Outdoors: Flame-spread rating of 75 or less, and smoke-developed rating of 150 or less.

DELIVERY, STORAGE, AND HANDLING:

Packaging: Ship insulation materials in containers marked by manufacturer with appropriate ASTM specification designation, type and grade, and maximum use temperature.

COORDINATION:

Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports."

Coordinate clearance requirements with piping Installer for insulation application.

SCHEDULING:

Schedule insulation application after testing piping systems and, where required, after installing and testing heat-trace tape. Insulation application may begin on segments of piping that have satisfactory test results.

PART 2 PRODUCTS**MANUFACTURERS:**

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Mineral-Fiber Insulation:
 - 1. CertainTeed Manson.
 - 2. Knauf FiberGlass GmbH.
 - 3. Owens-Corning Fiberglas Corp.
 - 4. Johns Manville.

INSULATION MATERIALS:

Mineral-Fiber Insulation: Glass fibers bonded with a thermosetting resin complying with the following:

- A. Preformed Pipe Insulation: Comply with ASTM C 547, Type 1, with factory-applied, all-purpose, vapor-retarder jacket.
- B. Blanket Insulation: Comply with ASTM C 553, Type II, without facing.
- C. Fire-Resistant Adhesive: Comply with MIL-A-3316C in the following classes and grades:
 - 1. Class 1, Grade A for bonding glass cloth and tape to unfaced glass-fiber insulation, for sealing edges of glass-fiber insulation, and for bonding lagging cloth to unfaced glass-fiber insulation.
 - 2. Class 2, Grade A for bonding glass-fiber insulation to metal surfaces.
- D. Vapor-Retarder Mastics: Fire- and water-resistant, vapor-retarder mastic for indoor applications. Comply with MIL-C-19565C, Type II.
- E. Mineral-Fiber Insulating Cements: Comply with ASTM C 195.
- F. Expanded or Exfoliated Vermiculite Insulating Cements: Comply with ASTM C 196.
- G. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.

Prefabricated Thermal Insulating Fitting Covers: Comply with ASTM C 450 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

FIELD-APPLIED JACKETS:

General: ASTM C 921, Type 1, unless otherwise indicated.

Foil and Paper Jacket: Laminated, glass-fiber-reinforced, flame-retardant kraft paper and aluminum foil.

PVC Jacket: High-impact, ultraviolet-resistant PVC; 20 mils (0.5 mm) thick; roll stock ready for shop or field cutting and forming.

- A. Adhesive: As recommended by insulation material manufacturer.
- B. PVC Jacket Color: White or gray.
- C. PVC Jacket Color: Color-code piping jackets based on materials contained within the piping system.

Standard PVC Fitting Covers: Factory-fabricated fitting covers manufactured from 20-mil- (0.5-mm) thick, high-impact, ultraviolet-resistant PVC.

- A. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories for the disabled.
- B. Adhesive: As recommended by insulation material manufacturer.

ACCESSORIES AND ATTACHMENTS:

Glass Cloth and Tape: Comply with MIL-C-20079H, Type I for cloth and Type II for tape. Woven glass-fiber fabrics, plain weave, presized a minimum of 8 oz./sq. yd. (270 g/sq. m).

- A. Tape Width: 4 inches (100 mm).

Bands: 3/4 inch (19 mm) wide, in one of the following materials compatible with jacket:

- A. Stainless Steel: ASTM A 666, Type 304; 0.020 inch (0.5 mm) thick.
- B. Galvanized Steel: 0.005 inch (0.13 mm) thick.
- C. Aluminum: 0.007 inch (0.18 mm) thick.

Wire: 0.080-inch (2.0-mm), nickel-copper alloy; 0.062-inch (1.6-mm), soft-annealed, stainless steel; or 0.062-inch (1.6-mm), soft-annealed, galvanized steel.

VAPOR RETARDERS:

Mastics: Materials recommended by insulation material manufacturer that are compatible with insulation materials, jackets, and substrates.

PART 3 EXECUTION

EXAMINATION:

Examine substrates and conditions for compliance with requirements for installation and other

conditions affecting performance of insulation application.

Proceed with installation only after unsatisfactory conditions have been corrected.

PREPARATION:

Surface Preparation: Clean and dry pipe and fitting surfaces. Remove materials that will adversely affect insulation application.

GENERAL APPLICATION REQUIREMENTS:

Apply insulation materials, accessories, and finishes according to the manufacturer's written instructions; with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.

Refer to schedules at the end of this Section for materials, forms, jackets, and thicknesses required for each piping system.

Use accessories compatible with insulation materials and suitable for the service. Use accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

Apply insulation with longitudinal seams at top and bottom of horizontal pipe runs.

Apply multiple layers of insulation with longitudinal and end seams staggered.

Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

Seal joints and seams with vapor-retarder mastic on insulation indicated to receive a vapor retarder.

Keep insulation materials dry during application and finishing.

Apply insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by the insulation material manufacturer.

Apply insulation with the least number of joints practical.

Apply insulation over fittings, valves, and specialties, with continuous thermal and vapor-retarder integrity, unless otherwise indicated. Refer to special instructions for applying insulation over fittings, valves, and specialties.

Hangers and Anchors: Where vapor retarder is indicated, seal penetrations in insulation at hangers, supports, anchors, and other projections with vapor-retarder mastic.

- A. Apply insulation continuously through hangers and around anchor attachments.
- B. For insulation application where vapor retarders are indicated, extend insulation on anchor legs at least 12 inches (300 mm) from point of attachment to pipe and taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.
- C. Install insert materials and apply insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by the insulation material manufacturer.
- D. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect the jacket from tear or puncture by the hanger, support, and shield.

Insulation Terminations: For insulation application where vapor retarders are indicated, taper insulation ends. Seal tapered ends with a compound recommended by the insulation material manufacturer to maintain vapor retarder.

Apply adhesives and mastics at the manufacturer's recommended coverage rate.

Apply insulation with integral jackets as follows:

- A. Pull jacket tight and smooth.
- B. Circumferential Joints: Cover with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip and spaced 4 inches (100 mm) o.c.
- C. Longitudinal Seams: Overlap jacket seams at least 1-1/2 inches (40 mm). Apply insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches (100 mm) o.c.
 - 1. Exception: Do not staple longitudinal laps on insulation having a vapor retarder.
- D. Vapor-Retarder Mastics: Where vapor retarders are indicated, apply mastic on seams and joints and at ends adjacent to flanges, unions, valves, and fittings.
- E. At penetrations in jackets for thermometers and pressure gages, fill and seal voids with vapor-retarder mastic.

MINERAL-FIBER INSULATION APPLICATION:

Apply insulation to straight pipes and tubes as follows:

- A. Secure each layer of preformed pipe insulation to pipe with wire, tape, or bands without deforming insulation materials.
- B. Where vapor retarders are indicated, seal longitudinal seams and end joints with vapor-retarder mastic. Apply vapor retarder to ends of insulation at intervals of 15 to 20 feet (4.5 to 6 m) to form a vapor retarder between pipe insulation segments.
- C. For insulation with factory-applied jackets, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
- D. For insulation with factory-applied jackets with vapor retarders, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by the insulation material manufacturer and seal with vapor-retarder mastic.

Apply insulation to flanges as follows:

- A. Apply preformed pipe insulation to outer diameter of pipe flange.
- B. Make width of insulation segment the same as overall width of the flange and bolts, plus twice the thickness of the pipe insulation.
- C. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
- D. Apply canvas jacket material with manufacturer's recommended adhesive, overlapping seams at least 1 inch (25 mm), and seal joints with vapor-retarder mastic.

Apply insulation to fittings and elbows as follows:

- A. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
- B. When premolded insulation elbows and fittings are not available, apply mitered sections of pipe insulation, or glass-fiber blanket insulation, to a thickness equal to adjoining pipe

insulation. Secure insulation materials with wire, tape, or bands.

- C. Cover fittings with standard PVC fitting covers.
- D. Cover fittings with heavy PVC fitting covers. Overlap PVC covers on pipe insulation jackets at least 1 inch (25 mm) at each end. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.

Apply insulation to valves and specialties as follows:

- A. Apply premolded insulation sections of the same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
- B. When premolded insulation sections are not available, apply glass-fiber blanket insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation. For check valves, arrange insulation for access to stainer basket without disturbing insulation.
- C. Apply insulation to flanges as specified for flange insulation application.
- D. Use preformed standard PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- E. Use preformed heavy PVC fitting covers for valve sizes where available. Secure fitting covers with manufacturer's attachments and accessories. Seal seams with tape and vapor-retarder mastic.
- F. For larger sizes where PVC fitting covers are not available, seal insulation with canvas jacket and sealing compound recommended by the insulation material manufacturer.

FIELD-APPLIED JACKET APPLICATION:

Apply glass-cloth jacket, where indicated, directly over bare insulation or insulation with factory-applied jackets.

- A. Apply jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
- B. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of jacket manufacturer's recommended adhesive.
- C. Completely encapsulate insulation with jacket, leaving no exposed raw insulation.

Foil and Paper Jackets: Apply foil and paper jackets where indicated.

- A. Draw jacket material smooth and tight.
- B. Apply lap or joint strips with the same material as jacket.
- C. Secure jacket to insulation with manufacturer's recommended adhesive.
- D. Apply jackets with 1-1/2-inch (40-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
- E. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-retarder mastic.

Apply PVC jacket on exposed piping in finished spaces, with 1-inch (25-mm) overlap at longitudinal seams and end joints, except for mechanical rooms. Seal with manufacturer's recommended adhesive.

PIPING SYSTEM APPLICATIONS:

Insulation materials and thicknesses are specified in schedules at the end of this Section.

Items Not Insulated: Unless otherwise indicated, do not apply insulation to the following systems, materials, and equipment:

- A. Flexible connectors.
- B. Vibration-control devices.
- C. Chrome-plated pipes and fittings, unless potential for personnel injury.
- D. Air chambers, unions, strainers, check valves, plug valves, and flow regulators.

FIELD QUALITY CONTROL:

Insulation applications will be considered defective if sample inspection reveals noncompliance with requirements. Remove defective Work and replace with new materials according to these Specifications.

Reinstall insulation and covers on fittings and valves uncovered for inspection according to these Specifications.

INSULATION APPLICATION SCHEDULE, GENERAL:

Refer to insulation application schedules for required insulation materials, vapor retarders, and field-applied jackets.

Application schedules identify piping system and indicate pipe size ranges and material, thickness, and jacket requirements.

INTERIOR INSULATION APPLICATION SCHEDULE:

Service: Chilled-water supply and return.

- A. Operating Temperature: 35 to 75 deg F (2 to 24 deg C).
- B. Insulation Material: Mineral fiber.
- C. Insulation Thickness: Apply the following insulation thicknesses:
 - 1. NPS 1-1/2" pipe and smaller: 1-1/2 inch.
 - 2. NPS 2" pipe and larger: 2 inch.
- D. Field-Applied Jacket: PVC exposed in finished rooms.
- E. Vapor Retarder Required: Yes.
- F. Finish: None.

Service: Heating hot-water supply and return.

- A. Operating Temperature: 100 to 200 deg F (38 to 93 deg C).
- B. Insulation Material: Mineral fiber.
- C. Insulation Thickness: Apply the following insulation thicknesses:
 - 1. NPS 2" pipe and smaller: 1 inch.
 - 2. NPS 2-1/2" and larger: 1-1/2 inch.
- D. Field-Applied Jacket: PVC exposed in finished rooms.
- E. Vapor Retarder Required: Yes.
- F. Finish: None.

END OF SECTION

23 09 00 INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 GENERAL**SUMMARY**

This Section includes control equipment and installation for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-furnished controls.

RELATED DOCUMENTS

Drawings and Specification Sections of the Contract, including General and Supplementary Conditions, apply to this Section.

- A. Section 23 05 93 – Testing, Adjusting, and Balancing for HVAC
- B. Section 26 05 19 – Low Voltage Electrical Power Conductors and Cables
- C. Section 26 05 33 – Raceway and Boxes for Electrical Systems

DEFINITIONS

BACnet: An industry standard data communication protocol for Building Automation and Control Networks. Refer to AHSRAE standard 135-2010

BIBB: BACnet Interoperability Building Blocks

DDC: Direct digital controls

IP: Internet Protocol

I/O: Input/Output

LAN: Local area network.

TCP: Transfer Control Protocol

LonTalk: Communications based on the EIA-709.1

SNVT: LonTalk standard network variable

Scope Terminology:

- A. Provide = Furnish equipment, engineer, program and install.
- B. Furnish = Furnish equipment, engineer and program.
- C. Mount = securely fasten or pipe.
- D. Install = mount and wire.
- E. Wire = wire only

SYSTEM DESCRIPTION

System Communications:

- A. Each workstation, building controller, and equipment controller communication interface

shall utilize the BACnet™ protocol with an Ethernet (IEEE 802.3, 802.11), RS485 (EIA-485).

- B. All system controllers shall be BTL listed as a BACnet Building Controller (B-BC) as defined in ANSI®/ASHRAE® Standard 135-2012.
- C. All documented status and control points, schedule, alarm, and data-log services or objects shall be available as standard object types as defined in ANSI®/ASHRAE® Standard 135-2012.
- D. Each System Controller shall communicate with a network of Custom Application and Application Specific Controllers utilizing one or more of the interfaces documented within Field Bus Communications below.

Field Bus Communications:

- A. BACnet™
 - 1. All equipment and plant controllers shall be BTL listed as a BACnet Application Specific Controller (B-ASC) or a BACnet Advanced Application Controller (B-AAC) as defined in ANSI®/ASHRAE® Standard 135-2012.
 - 2. All communication shall conform to ANSI®/ASHRAE® Standard 135-2012.
 - 3. System Controller shall function as a BACnet router to each unit controller providing a globally unique BACnet Device ID for all BACnet controllers within the system.
 - 4. BACnet over MS/TP
 - a. Communication between System Controller and equipment/plant controllers shall utilize BACnet over MS/TP as defined in ANSI®/ASHRAE® Standard 135-2012.

Provide standalone controls where called for on the drawings or sequences.

WORK INCLUDED

The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation, or identification number and sequence of operation all bearing the name of the manufacturer.

Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all system controllers, logic controllers, and all input/output devices. Items of work included are as follows:

- A. Provide a submittal that meets the requirements below for approval.
- B. Coordinate installation schedule with the mechanical contractor and general contractor.
- C. Provide installation of all panels and devices unless otherwise stated.
- D. Provide all low voltage (less than 120V) control wiring for the DDC system.
- E. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit commissioning reports for approval.
- F. Participate in commissioning for all equipment that is integrated into the BAS (Refer to Commissioning sections of the equipment or systems in other parts of this specification.)
- G. Provide testing, demonstration and training as specified below.

SYSTEM PERFORMANCE

Comply with the following performance requirements:

- A. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 5 seconds.
- B. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data

within 5 seconds.

- C. Object Command: Reaction time of less than 5 seconds between operator command of a binary object and device reaction.
- D. Object Scan: Transmit change of state and change of analog values to control units or workstation within 5 seconds.
- E. Alarm Response Time: Annunciate alarm at workstation within 2 seconds. Multiple workstations must receive alarms within five seconds of each other.
- F. Program Execution Frequency: Programmable controllers shall execute DDC PI control loops, and scan and update process values and outputs at least once per second.
- G. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - 1. Water Temperature: Plus or minus 1 deg F.
 - 2. Water Flow: Plus or minus 5 percent of full scale.
 - 3. Water Pressure: Plus or minus 2 percent of full scale.
 - 4. Space Temperature: Plus or minus 1 deg F.
 - 5. Ducted Air Temperature: Plus or minus 1 deg F.
 - 6. Outside Air Temperature: Plus or minus 2 deg F.
 - 7. Dew Point Temperature: Plus or minus 3 deg F.
 - 8. Temperature Differential: Plus or minus 0.25 deg F.
 - 9. Relative Humidity: Plus or minus 2 percent.
 - 10. Airflow (Pressurized Spaces): Plus or minus 3 percent of full scale.
 - 11. Airflow (Measuring Stations): Plus or minus 5 percent of full scale.
 - 12. Airflow (Terminal): Plus or minus 10 percent of full scale.
 - 13. Air Pressure (Space): Plus or minus 0.01-inch wg.
 - 14. Air Pressure (Ducts): Plus or minus 0.1-inch wg.
 - 15. Carbon Monoxide: Plus or minus 5 percent of reading.
 - 16. Carbon Dioxide: Plus or minus 50 ppm.
 - 17. Electrical: Plus or minus 5 percent of reading.

SUBMITTALS

Provide submittals for fast track items that need to be approved and released to meet the schedule of the project. Provide submissions for the following items separately:

- A. Valve schedule and cut sheets
- B. Factory mounting and wiring diagrams and cut sheets
- C. Thermostat locations
- D. Floor plan showing proposed communications cable routing.
- E. Once control system has been started, submit completed point to point I/O report.
- F. Submit training agenda as described in part 3 sections.

Provide a complete submittal with all controls system information for approval before construction starts. Include the following:

- A. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, and control devices.
- B. Wiring Diagrams: Power, signal, and control wiring.
- C. Details of control panel, including arrangement of gutters, conduits, Panduit, power supplies, transformers, convenience receptacles, control hard-ware, instruments, and labeling.
- D. Schedule of dampers and actuators including size, actuator torque and flow characteristics.
- E. Schedule of valve and actuators including size, pipe size, pressure drop, close off pressure and Cv.

- F. If dampers are existing or furnished by other, submit a damper actuator schedule coordinating actuator sizes with the damper schedule. Schedule must include damper size and minimum actuator torque, and normal position.
- G. Written description of the Sequence of Operations.
- H. Network riser diagram showing wiring types, network protocols, locations of floor penetrations and number of control panels. Label control panels with network addresses and/or device instance numbers. Show all routers, switches, hubs and repeaters.
- I. Point list for each system controller including both inputs and outputs (I/O), point numbers, controlled device associated with each I/O point, and location of I/O device. Refer to points summary shown on control details.
- J. Points list containing alarm definitions including type, threshold limits, return to normal, delays, modes and parent points. Refer to points summary shown on control details.
- K. Points list containing trend definitions including type, number of samples, and intervals. Refer to points summary shown on control details.
- L. Starter and variable frequency drive wiring details of all automatically controlled motors.
- M. Reduced size floor plan drawings showing locations of control panels, thermostats and any devices mounted in occupied space.

Product Data: Include manufacturer's technical literature for each control device indicated, labeled with setting or adjustable range of control. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated. Submit a write-up of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.

Submit a description of the application software that will be used on the operator workstation including revision level, functionality and software applications required to meet the specifications.

Wiring Diagrams: Detail the wiring of the control devices and the panels. Show point-to-point wiring from field devices to the control panel. Show point-to-point wiring of hardwired interlocks. Show a ladder diagram or schematic of wiring internal to the panels, including numbered terminals. Clearly designate wiring that is done at a factory, at a panel shop or in the field.

Submit sample graphics for approval before starting system commissioning.

Variance letter: Submit a letter detailing each item in the submission that varies from the contract specification or sequence of operation in any way.

After the BAS system is approved for construction, submit sample operator workstation graphics for typical systems for approval. Print and submit the graphics that the operator will use to view the systems, change setpoints, modify parameters and issue manual commands. Programming shall not commence until typical graphics are approved.

QUALITY ASSURANCE

Codes:

- A. Perform all wiring in accordance with Division 26, NEC, local codes and Owner's requirements.
- B. Uniform Building Code (UBC)
- C. Electrical Components, Devices, and Accessories: Listed and labeled as de-fined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- D. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."
- E. Comply with ASHRAE 135-2010 BACNet: A Data Communication Protocol for Building Automation and Control Networks.
- F. All equipment shall be UL listed and approved and shall meet with all applicable NFPA standards, including UL 916 - PAZX Energy Management Systems,
- G. Provide UL 864 – UUKL Smoke Control, where controllers and networks are used for that purpose.
 - 1. Provide written approvals and certifications after installation has been completed.
- H. Provide written approvals and certifications after installation has been completed.
- I. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

Qualifications:

- A. Installer Qualifications: An experienced installer who is the authorized representative of the automatic control system manufacturer for both installation and maintenance of controls required for this Project.
- B. Engineering, drafting, programming, and graphics generation shall be performed by the local branch engineers and technicians directly employed by the Building Automation System Contractor.
- C. Supervision, checkout and commissioning of the system shall be by the local branch engineers and technicians directly employed by the Building Automation System Contractor. They shall perform commissioning and complete testing of the BAS system.

The BAS contractor shall maintain a service organization consisting of factory trained service personnel.

Final determination of compliance with these specifications shall rest solely with the Engineers and Owner who will require proof of prior satisfactory performance.

For any BAS system and equipment submitted for approval, the BAS contractor shall state what, if any, specific points of system operation differ from these specifications.

DELIVERY, STORAGE, AND HANDLING

Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control de-vices to unit manufacturer.

COORDINATION

Coordinate location of thermostats, humidistats, panels, and other exposed control components with plans and room details before installation.

Coordinate equipment with the existing fire alarm to achieve compatibility with equipment that interfaces with that system.

Coordinate power for control units and operator workstation with electrical contractor.

Coordinate equipment with provider of starters and drives to achieve compatibility with motor starter control coils and VFD control wiring.

Coordinate scheduling with the mechanical contractor and general contractor. Submit a schedule for approval based upon the installation schedule of the mechanical equipment.

Products Furnished but Not Installed Under This Section

- A. Hydronic Piping:
 - 1. Control Valves
 - 2. Temperature Sensor Wells and Sockets
 - 3. Flow Switches
 - 4. Flow Meters
- B. Sheetmetal Accessories
 - 1. Dampers
 - 2. Airflow Stations

Integrate to equipment as called for in the automation riser details and sequence of operations.

WARRANTY

Conform to the warranty requirement of the Contract Documents, General Requirements and this section or a minimum of 24 months from owner acceptance.

Warranty shall cover all costs for parts, labor, associated travel, and expenses for a period of three years from completion of system demonstration.

Hardware and software personnel supporting this warranty agreement shall provide on-site or off-site service in a timely manner after failure notification to the vendor. The maximum acceptable response time to provide this service at the site shall be 24 hours.

During normal building occupied hours, failure of items that are critical for system operation shall be provided within 4 hours of notification from the Owner's Representative.

This warranty shall apply equally to both hardware and software.

PART 2 PRODUCTS**MANUFACTURERS:**

Vendor & Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Control Systems:
 - 1. Building Controls and Services – Siemens.
 - 2. C&C Group – Schneider Electric.
 - 3. Dynamic Control Systems – Automated Logic.
 - 4. Five Star Mechanical – Reliable Controls.
 - 5. JCI - Johnson Controls.
 - 6. Sandifer Engineering & Controls. – Schneider Electric.
 - 7. The Trane Co. – Trane Controls.

The vendors and products listed shall comply with these specifications. It shall not be assumed that standard products and methods will be acceptable without prior approval. Exceptions shall be noted during the bid process and documented in the submittal process.

The vendor shall have service technicians and parts supplies located within 60 miles of the

project site. Service technicians shall be available on-site within 24 hours of a standard service call and within 2 hours for an emergency call.

The vendor shall provide examples of existing projects of relative size and complexity relative to this project.

BAS NETWORK

All networked control products provided for this project shall be comprised of an industry standard open protocol internetwork. Communication over ethernet between user workstation and building control units shall conform to ASHRAE 135-2010 BACnet standard. Communication between equipment controllers and building level controllers shall be BACnet protocol over TP/FT-10 channel type using transceivers that conform to the ISO/IEC 14908-2 Free-Topology Twisted Pair Channel Specification.

Access to system data shall not be restricted by the hardware configuration of the building management system. The hardware configuration of the BMS network shall be totally transparent to the user when accessing data or developing control pro-grams.

- A. Software applications, features, and functionality, including administrative configurations, shall not be separated into several network control engines working together.

Provide BAS Server with server application software for the site.

BAS Server shall be capable of simultaneous direct connection and communication with BACnet/IP, OPC and TCP/IP corporate level networks without the use of interposing devices.

Any break in Ethernet communication from the PC to the controllers on the Primary Network shall result in a notification at the PC.

The network architecture shall consist of three levels of networks:

- A. The Management level shall utilize BACnet/IP over Ethernet along with other standardized protocol, such as web services, html, JAVA, SOAP, XML, etc., to transmit data to non-BAS software and databases.
- B. The Automation level network shall be BACnet/IP over Ethernet. It shall network the Automation Server, Operator workstations, and building level controllers. Provide network media converters, routers and switches as necessary for a complete network.
- C. The Floor level network shall be BACnet MSTP over twister pair cable conforming to EIA-709.1. It shall network to all of the DDC controlled equipment on a floor or in a system and network to a router that connects to the Automaton level BAS backbone.

The primary backbone network between the building level controllers, BAS Server and Operator Workstations shall be based upon BACnet/IP.

The Building Level Controllers shall be able to support subnetwork protocols that may be needed depending on the type of equipment or application. Subnetworks shall be limited to:

- A. BACnet MS/TP
- B. Modbus

BACnet MSTP Setup rules:

- A. Addressing for the MSTP devices shall start at 00 and continue sequentially for the

- number of devices on the subnetwork.
- B. No gaps shall be allowed in the addresses.
- C. Set the MaxMaster property to the highest address of the connected device.
- D. MaxMaster property shall be adjusted when devices are added to the sub-network.

Application specific controllers for smaller single zone, supplemental or special systems can reside on the BACnet/IP network or on a subnetwork.

Floor level controllers, terminal units, package AC units, auxiliary equipment, VFDs, meters shall reside on one of the subnetworks.

Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for the internetwork.

Use fiber optic cabling for all Ethernet runs longer than 300 ft and between buildings.

Controllers and software shall be BTL or LonMark listed at the time of installation.

Provide all communication media, connectors, repeaters, bridges, switches, and routers necessary for the internetwork.

The system shall meet peer-to-peer communication services such that the values in any one enterprise or AAC level controller can be read or changed from all other controllers with the need for intermediary devices. The software shall provide transparent transfer of all data, control programs, schedules, trends, and alarms from any one controller through the internetwork to any other controller, regardless of sub-network routers.

Systems that use variations of BACnet using Point-to-Point (PTP) between controllers, gateways, bridges or networks that are not peer-to-peer are not allowed.

Remote Communications: Provide a TCP/IP compatible communication port for connection to the Owner's network for remote communications. Remote communications must be capable of viewing entire system from a single IP address. Viewing via multiple connections is not acceptable. Provide coordination with the Owner for addressing and router configuration on both ends of the remote network.

Where a smoke control application is required, provide UUKL listed network switches, and NFPA approved cabling, enclosures and installation methods.

The system shall be installed with a 20% spare capacity on each subnetwork for the addition of future controllers.

DISTRIBUTED CONTROL REQUIREMENTS

The loss of any one DDC controller shall not affect the operation of other HVAC systems, only for the points connected to the DDC controller.

The system shall be scalable in nature and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, DDC Controllers, and operator devices.

System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC Controller shall operate independently by performing its own specified control, alarm management, operator I/O, and data collection. The failure of any single component or network connection shall not interrupt the execution of any control

strategy, reporting, alarming and trending function, or any function at any operator interface device.

The DDC control panel shall be mounted in the same mechanical room as the equipment being controlled, or an adjacent utility room.

Multiple systems can be programmed on the same controller as long as they are in the same room. Systems on separate floors shall have separate controllers.

VAV boxes subnetworks shall be connected to the AHU controller that feeds those boxes. If multiple subnetworks are needed, then the VAV shall be grouped into subnetworks in an orderly method, such as per floor, per wing, etc.

Remote sensors shall be wired to the control panel of the equipment it is controlling, not across the network.

Signals to remote motor control centers shall be hard wired to the control panel, not across the network.

Terminal units shall each have their own controller. Only exceptions are:

- A. Auxillary heating coils
- B. Groups of exhaust fans

BUILDING AUTOMATION SERVER HARDWARE

Where required and as indicated in floor plans, provide a PC for the BAS Server database. Provide workstation that has been tested and recommended by the software manufacturer. PC shall operate on the latest version of manufacture approved operating system and contain the latest model of the nominal speed, RAM and memory as recommended by software supplier. Minimum requirements and accessories shall be:

- A. USB Ports.
- B. NIC Card.
- C. 101 key enhanced keyboard, Mouse, power strip.
- D. UPS for 15-minute backup.

Provide an active-matrix LCD, flat panel type monitor that is Energy Star compliant. The display shall have a minimum of 20-inch visible area in diagonal measurement. Separate controls shall be provided for color, contrasts, and brightness. The screen shall be non-reflective.

Printer: Provide a compatible inkjet or laser printer for alarms, operator transactions and system reports. Provide drivers.

Locate the BAS Server in a clean, secure, dry, and temperature-controlled environment. Coordinate with owner for exact location.

The server shall reside on the same BACnet/IP protocol network as the System Controllers.

Provide software licenses for interfacing to the BAS. Load software, configure and setup for viewing the BAS system.

Software: Provide the following application software licenses, preloaded on the laptop for the Owner: MS Office or owner approve word processing software, PC anywhere or terminal services,

owner approved internet browser, owner approved email client, Bluebeam Revu. Set up an icon on the desktop to take the Owner directly to the BAS system login page.

OPERATOR INTERFACE APPLICATION SOFTWARE

Graphical User Interface (GUI): The GUI shall provide a completely interactive user interface and must offer the following features as a minimum:

- A. View Trending
- B. View Scheduling
- C. Downloading Memory to field devices
- D. Real time 'live' Graphic Programs with auto refresh
- E. System Name and Geographic Navigation methods
- F. Parameter changes of all adjustable object properties
- G. Setpoint Adjustments
- H. Viewing Alarms and Events
- I. Operators' Usage
- J. Hyperlinks
- K. On line help menus

BACNET:

- A. The BAS server and Operator Workstations shall meet the BACnet device profile of an Advanced Workstation Server (B-AWS) and Operator Work-station (B-OWS) and shall support the following BACnet BIBBs:
 - 1. Data Sharing
 - a. Data Sharing-Read Property-Initiate, Execute (DS-RP-A,B)
 - b. Data Sharing-Read Property Multiple-Initiate, Execute (DS-RPM-A,B)
 - c. Data Sharing-Write Property-Initiate, Execute (DS-WP-A,B)
 - d. Data Sharing-Write Property Multiple-Initiate (DS-WPM-A)
 - e. Data Sharing-COV-Initiate (DS-COV-A)
 - 2. Scheduling
 - a. Scheduling-Initiate (SCHED-A)
 - 3. Trending
 - a. Trending-Viewing and Modifying Trends-Initiate (T-VMT-A)
 - b. Trending-Automated Trend Retrieval-Initiate (T-ATR-A)
 - 4. Network Management
 - a. Network Management-Connection Establishment-Initiate (NM-CE-A)
 - 5. Alarming
 - a. Alarm and Event-Notification-Initiate (AE-N-A)
 - b. Alarm and Event-ACK-Initiate (AE-ACK-A)
 - c. Alarm and Event -Alarm Summary-Initiate (AE-ASUM-A)
 - d. Alarm and Event -Enrollment Summary-Initiate (AE-ESUM-A)
 - e. Alarm and Event -Information-Initiate (AE-INFO-A)
 - 6. Device Management
 - a. Device Management-Dynamic Device Binding- Initiate, Execute (DM-DDB-A, B)
 - b. Device Management-Dynamic Object Binding- Initiate, Execute (DM-DOB-A,B)
 - c. Device Management-Device Communication Control- Initiate (DM-DCC-A)
 - d. Device Management-Private Transfer- Initiate, Execute (DM-PT-A,B)

- e. Device Management-Text Message-Execute (DM-TM-B)
 - f. Device Management-Time Synchronization- Initiate (DM-TS-A)
 - g. Device Management-UTC Time Synchronization- Initiate (DM-UTC-A)
 - h. Device Management-Reinitialize Device- Initiate (DM-RD-A)
 - i. Device Management-Backup and Restore- Initiate (DM-BR-A)
 - j. Device Management-List Manipulation- Initiate, Execute (DM-LM-A,B)
 - k. Device Management-Object Creation and Deletion- Initiate (DM-OCD-A)
- B. The BAS Server and Workstations shall support the following Data Link Layers:
- 1. BACnet IP Annex J
 - 2. BACnet IP Annex J Foreign Device
 - 3. ISO 8802-3, Ethernet (Clause 7)
- C. The BAS Server and Workstations shall be able to interact with all of the BACnet objects in the controllers. In addition, the software shall be able to support the following objects as they relate to features in the workstation software:
- 1. Calendar – Creatable, Deletable
 - 2. Command – Creatable, Deletable
 - 3. Event Enrollment – Creatable, Deletable
 - 4. Notification Class – Creatable, Deletable
 - 5. Schedule - Creatable, Deletable
- D. The BAS Server and Workstations shall support transmitting and receiving segmented messages.

Provide software (or all software if there are multiple) used to program and download sequences to controllers. Provide a backup of the all of the programs used in the system for storage by the Owner. Determine the number of seats required by owner prior to submission of bid.

The system software shall have the following Base features:

- A. System software applications will run as a service to allow communication with Primary Network Controllers without the need for user log in. Closing the application or logging off shall not prevent the processing of alarms, network status, panel failures, and trend information.
- B. System Database Save and Restore. The software shall store on the hard disk a copy of the current database of each DDC Controller. This database shall be updated whenever an operator initiates a save command.
- C. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any DDC controller. The operator shall be able to clear a panel database via the network and may initiate a download of a specified database to any panel in the system from the network.
- D. System Configuration. The software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection.
- E. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application.
- F. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
- G. Alarm Messages. Alarm messages shall use the English language descriptor for the object

in alarm, in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.

- H. Alarm Reactions. The operator shall be able to determine (by object) what if any actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation.
- I. Trend Logs. The operator shall be able to define a custom trend log for any data object in the system. This definition shall include change-of-value digital, change-of-value analog, time interval, start time, and stop time. Trend data shall be sampled and stored on the DDC controller, and be uploaded and archived on the hard disk and be retrievable for use in spreadsheets and standard database programs.
- J. Alarm and Event Log. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms.
- K. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs. The software shall have the capability to create, delete and sup-port the following Objects:
 - 1. Analog input, analog output and analog value
 - 2. Binary input, binary output and binary value
 - 3. Calendar
 - 4. Device
 - 5. Event Enrollment (Alarming)
 - 6. File
 - 7. Loop (PID)
 - 8. Notification Class
 - 9. Program
 - 10. Schedule
 - 11. Trend Log
- L. Report Generation
 - 1. Reports shall be generated on demand schedule, and directed to PC displays, printers, file or email address.
 - 2. The Operator shall be able to trigger the report from an event in the system, such that recent data is captured with the event happens.
 - 3. As a minimum, provide the following pre-defined templates:
 - a. A general listing of all or selected points in the network
 - b. List of all points currently in alarm
 - c. List of all points currently in override status
 - d. List of all disabled points
 - e. List of all points currently locked out
 - f. List of user accounts and access levels
 - g. List all weekly schedules and events
 - h. List of holiday programming
 - i. List of control limits and deadbands
 - j. System diagnostic reports including, list of Building panels online and communicating, status of all Building terminal unit device points
 - k. List of programs
 - l. List of point definitions
 - m. List of logical point groups
 - n. List of alarm strategy definitions
 - o. List of Building Control panels
 - p. Point totalization report
 - q. Point Trend data listings

- r. Initial Values report
 - s. User activity report
4. Provide templates for reports that are defined the Sequence of Operations.

ELECTRONIC DOCUMENTATION

Provide software applications and files to view documentation through the GUI.

Provide all controls cut sheets in PDF format. Make them available to any user accessing the system over the Internet.

Provide a text version of the sequence of operation. Make the written sequence available from the graphic that represents each system. The sequence shall pop up in a printable format such as HTML or PDF.

CONTROLLER SOFTWARE (I.E. BUILDING CONTROLLER SOFTWARE, DDC SOFTWARE, FIELD PANEL SOFTWARE)

Provide a full capability user license to the owner for the operator to be able to see, modify, create, upload, download and save control programs to the DDC controllers.

The software program shall be provided as an integral part of DDC Controllers and shall not be dependent upon any higher-level computer or another controller for execution.

The software application shall be accessible from a PC using the Windows environment, but shall use all of its own services and data files so as to not be susceptible to Microsoft Windows operating systems-based viruses.

The software shall be provided with an interactive HELP function to assist operators with syntax, abbreviations, commands and saving programs.

Point naming and communication format:

- A. All points, panels, and programs shall be identified in accordance with owners naming standards. In the absence of owner standards, identification shall be in accordance with control contractors written standards.

System Security

- A. User access shall be secured using individual security passwords and user names.
- B. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
- C. User Log On/Log Off attempts shall be recorded.
- D. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.
- E. Use of workstation resident security as the only means of access control is not an acceptable alternative to resident system security in the DDC controller software.

User Defined Control Applications: The applications software shall program DDC routines to meet the sequences of operations.

- A. Building Controllers shall have the ability to perform energy management routines including but not limited to time of day scheduling, calendar-based scheduling, holiday

scheduling, temporary schedule overrides, start stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/cooling interlock, supply temperature re-set, priority load shedding, and power failure restart.

- B. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.
- C. Each controller shall support plain language text comment lines in the operating program to allow for quick troubleshooting, documentation, and historical summaries of program development.

Peer-to-peer access to other DDC controllers

- A. It shall be possible to use any actual or virtual point data or status, any system calculated data, a result from any process, or any user-defined constant in any controller in the system.
- B. Any process shall be able to issue commands to points in any and all other controllers in the system.
- C. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a message to a specified device or cause the execution of an advanced annunciation feature, such as:
 - 1. Generate a report
 - 2. Annunciate an alarm
 - 3. Issue a text message or email

Alarm Management

- A. Alarm management shall be provided within the controller software to monitor and direct alarm information to operator devices.
- B. Each Building Controller shall perform distributed, independent alarm analysis, minimize network traffic and prevent alarms from being lost. At no time shall the Building Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.
- C. Conditional alarming shall allow generation of alarms based upon user de-fined multiple criteria such as system modes or status of parent equipment.
- D. An Alarm "shelving" feature shall be provided to disable alarms during testing. (Pull the Plug, etc.).
- E. Binary Alarms. Each binary alarm object shall be set to alarm based on the operator-specified state. Provide the capability to automatically and manually disable alarming.
- F. Analog Alarms. Each analog alarm object shall have both high and low alarm limits. Alarming must be able to be automatically and manually disabled.
- G. All alarm shall include the point's user-defined language description and the time and date of occurrence.
- H. Alarm reports and messages shall be routed to user-defined list of operator workstations, or other devices based on time and other conditions. An alarm shall be able to start programs, print reports, be logged in the event log, generate custom messages, and display graphics.
- I. The user shall be able to add a 200-character alarm message to each alarm point to more fully describe the alarm condition or direct operator response. Each Building Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assigned to any number of points in the Controller.
- J. Operator-selected alarms shall be capable of initiating a trigger to an advanced annunciation, such as text, email, etc.
- K. An alarm history log shall report the start of the alarm condition, acknowledgement by a user and return of the alarm to normal condition.

Scheduling:

- A. Provide a comprehensive menu driven program to automatically start and stop designated multiple objects or events in the system according to a stored time.
- B. Schedules shall reside in the building controller and shall not rely on external processing or network.
- C. It shall be possible to define a group of objects as a custom event (i.e., meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.
- D. For points assigned to one common load group, it shall be possible to assign variable time delays between each successive start and/or stop within that group.
- E. The operator shall be able to define the following information:
 - 1. Time, day
 - 2. Commands such as on, off, auto, etc.
 - 3. Time delays between successive commands.
 - 4. There shall be provisions for manual overriding of each schedule by an authorized operator.
- F. It shall be possible to schedule calendar-based events up to one year in advance based on the following:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop, and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.
 - 2. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.

Automatic Daylight Savings Time Switchover. The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

Loop Tuning

- A. Building Controllers shall also provide high resolution sampling capability for verification of DDC control loop performance. Documented evidence of tuned control loop performance shall be provided on a monthly, seasonal, quarterly, annual period.
- B. For PID control loops, operator-initiated automatic and manual loop tuning algorithms shall be provided for all operator-selected PID control loops. Evidence of tuned control loop performance shall be provided via graphical plots or trended data logs for all loops.
 - 1. In automatic mode, the controller shall perform a step response test with a minimum one-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.
 - 2. Loop tuning shall be capable of being initiated either locally at the Building Controller, from a network workstation or remotely using dial-in modems. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

Staggered Start:

- A. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable in an application and

shall not require written scripts or ladder logic.

- B. Upon the resumption of power, each Building Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

Totalization Features:

- A. Run-Time Totalization. Building Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.
- B. Consumption totalization. Building Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.
- C. Event totalization. Building Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

Data Collection:

- A. A variety of historical data collection utilities shall be provided to manually or automatically sample, store, and display system data for all points.
- B. Building Controllers shall store point history data for selected analog and digital inputs and outputs:
- C. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each Building Controllers point group.
- D. Each Building Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.
- E. Trend data shall be stored at the Building Controllers and uploaded to the workstation when retrieval is desired. Uploads shall occur based upon either user-defined interval, manual command or when the trend buffers are full. All trend data shall be available for use in third-party personal computer ap-plications.

BUILDING CONTROLLERS (B-BC)

Provide all necessary hardware for a complete operating system as required. The Building Controller shall be able to operate as a standalone panel and shall not be dependent upon any higher-level computer or another controller for operation.

Building level controller (BLC):

- A. The Building Level Controller shall support transmitting and receiving segmented messages.
- B. The Building Level Controller shall have the capability to be the BACnet/IP Broadcast Management Device (BBMD) and support foreign devices.
- C. The Building Level Controller shall have the capability to act as a BACnet router between MS/TP, Modbus RS-485 and LonTalk subnetworks and BACnet/IP.

This level of controller shall be used for the following types of systems:

- A. Chiller plant systems
- B. Heating plant systems
- C. Cooling Towers

- D. Pumping systems
- E. VAV air handlers
- F. Air handlers over 15,000 cfm
- G. Systems with over 16 input/output points

Input and Output Points Hardware

- A. Input/output point modules as required including spare capacity.
- B. Monitoring of the status of all hand off auto switches.
- C. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
- D. Local status indication for each digital input and output for constant, up to date verification of all point conditions without the need for an opera-tor I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.
- E. Graduated intensity LEDs or analog indication of value for each analog out-put.

Code compliance

- A. Approvals and standards: UL916; CE; FCC

Accessories:

- A. Appropriate NEMA rated metal enclosure.
- B. Power supplies as required for all associated modules, sensors, actuators, etc.

The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on-board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. Provide hand/off/auto switch for each digital output, including spares.

Each Building Level Control Panel shall continuously perform self-diagnostics on all hardware modules and network communications. The System Level Control Panel shall provide both local and remote annunciation of any detected component failures, low battery conditions or repeated failure to establish communication with any system.

Panel setup, point definitions and sequencing diagrams shall be backed up on EEPROM memory.

Power loss. In the event of the loss of power, there shall be an orderly shutdown of all Building Controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 30 days.

Building Level control panels shall provide at least two serial data communication ports for operation of operator I/O devices such as industry standard printers, opera-tor terminals, modems and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal communications, operation of permanently connected modems, printers or terminals.

Building Level Controllers shall have the capability to serve as a gateway between Modus subnetworks and BACnet objects. Provide software, drives and programming.

Isolation shall be provided at all primary control panel terminations, as well as all field point

terminations to suppress induced voltage transients consistent with IEEE Standards 587 1980.

Spare Capacity: Provide enough inputs and outputs to handle the equipment shown to be "future" on drawings and 10% more of each point type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

Environment:

- A. Controller hardware shall be suitable for the anticipated ambient conditions.
- B. Controllers used outdoors and/or in wet ambient conditions shall be mount-ed within waterproof enclosures and shall be rated for operation at 32°F to 120°F.
- C. Controllers used in conditioned space shall be mounted in dust-proof enclosures and shall be rated for operation at 32°F to 120°F.

Immunity to power and noise.

- A. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
- B. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.
- C. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
 - 1. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.
 - 2. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8 kV air discharge, 4 kV contact.
 - 3. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1 kV power.
 - 4. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
- D. Isolation shall be provided at all Building Controller's AC input terminals to suppress induced voltage transients consistent with:
 - 1. IEEE Standard 587 1980
 - 2. UL 864 Supply Line Transients
 - 3. Voltage Sags, Surge, and Dropout per EN 61000-4-11 (EN 1000-4-11)

ADVANCED APPLICATION CONTROLLERS

Provide all necessary hardware for a complete operating system as required. The Advanced Application level control panel shall be able to operate as a standalone panel and shall not be dependent upon any higher level computer or another con-troller for operation.

Communication:

- A. Communication between System Controller and equipment/plant controllers shall utilize BACnet over Zigbee as defined in ANSI®/ASHRAE® Standard 135-2012.
- B. Each equipment controller wireless communication interface shall self-heal to maintain operation in the event of network communication failure.
- C. Each zone sensor wireless communication interface shall be capable of many-to-one sensors per controller to support averaging, monitoring, and multiple zone applications. Sensing options shall include temperature, relative humidity, CO2, and occupancy.
- D. BACnet over MS/TP

This level of controller shall be used for the following types of systems:

- A. Systems with custom sequences that meet all of the criteria below:
- B. No primary pumping systems
- C. Secondary Pumping systems that are remote from Central Plants
- D. Air handlers up to 15,000 cfm
- E. Systems up to 16 input/output points
- F. Room control sequences that do not fit into an ASC controller
- G. BAS Network or Architecture or Sequences do not require the system to be on an IP network
- H. No systems that require integration to meters, VFDs or other smart equipment
- I. Integration to smart thermostats is allowed

Input/Outputs:

- A. Inputs shall be 16-bit minimum digital resolution
- B. Outputs shall be 10-bit minimum digital resolution
- C. The following I/O port types shall be available on the controller
 - 1. Universal Input (software configurable):
 - a. Digital Input choices:
 - 1) Pulse Accumulator
 - 2) Contact Closure Sensing
 - 3) Dry Contact/Potential Free inputs only
 - 4) Digital Input (10 ms settling time)
 - 5) Counter inputs up to 20 Hz, minimum pulse duration 20 ms (open or closed)
 - b. Analog Input Choices:
 - 1) 0-10 Vdc
 - 2) 4-20 mA
 - 3) 1K Ni RTD @ 32°F (Siemens, JCI, DIN Ni 1K)
 - 4) 1K Pt RTD (375 or 385 alpha) @ 32°F
 - 5) 10K NTC Type 2 or Type 3 Thermistor
 - 6) 100K NTC Type 2 Thermistor
 - 2. Universal Input or Output (software configurable):
 - a. All of the above input types
 - b. Analog Output Types:
 - c. 0 to 10 Vdc @ 1 mA max
 - 3. Super Universal Input or Output (software configurable):
 - a. All of the above input types
 - b. All of the above output types
 - c. Super digital output type:
 - 1) 0 to 24 Vdc, 22 mA max. (for controlling pilot relay)
 - d) Super Analog Output Choices:
 - 1) 0 to 20 mA @ 650 Ω max.
- C. Provide software configurable I/O ports such that a programmer make a port either an input or an output

Each System Level Control Panel shall, at a minimum, be provided with:

- A. Each Advanced Application Controller shall have sufficient memory, to support its own operating system and databases, including control processes, and operator I/O.

- B. Local status indication for each digital input and output for constant, up to date verification of all point conditions without the need for an operator I/O device.
- C. Each control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.

Power loss. In the event of the loss of power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for the operating system software and firm-ware.

- A. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
- B. Brownout protection and power recovery circuitry protect the controller board from power fluctuations.
- C. Battery backup shall be provided to support the real-time clock for 10 years
- D. The program and database information stored SDRAM memory shall be battery backed for a minimum of 30 days and up to 60 days. This eliminates the need for time consuming program and database re-entry in the event of an extended power failure.

Database Restore: Each AAC controller shall automatically save the latest programmed database. The controller shall be able to automatically restore a lost or corrupt database without involvement from the operator.

APPLICATION SPECIFIC CONTROLLERS

Each Application Level Control Panel shall operate as a stand-alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each application specific controller shall be a microprocessor based, multi-tasking, real-time digital control processor.

The following types of equipment (if applicable):

- 1. Constant Air Volume (CAV) boxes
- 2. Chilled beams
- 3. Duct mounted reheat coils
- 4. Fan coil Units
- 5. Fan Powered Variable Air Volume (VAV) Boxes
- 6. Reheat Coils
- 7. Supplemental AC units
- 8. Variable Air Volume (VAV) Boxes
- 9. Other terminal equipment

Each Application Specific Controller shall, at a minimum, be provided with:

- A. Power supplies as required for all associated modules, sensors, actuators, etc.
- B. Software as required for all sequences of operation, logic sequences and energy management routines.
- C. A portable operator terminal connection port
- D. Each controller measuring air volume shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time
- E. Each controller measuring air volume shall include a differential pressure transducer
- F. Approvals and standards: UL916; CE; FCC

Each Application Specific Controller shall continuously perform self-diagnostics on all hardware

and secondary network communications. The Application Specific Controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failure to establish communication to the system.

Provide each Application Specific Controller with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration.

The Application Specific Controller shall be powered from a 24 VAC source provided by this contractor and shall function normally under an operating range of 18 to 28 VAC (25% to +17%), allowing for power source fluctuations and voltage drops. Install plenum data line and sensor cable in accordance with local code and NEC. The controllers shall also function normally under ambient conditions of 32 to 122 F and 10% to 95%RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly.

ROUTERS

Provide a router for each subnetwork to connect the floor level network to the base building backbone level network. The router shall connect to BACnet over Ethernet.

CONTROL PANELS

Controllers in mechanical rooms shall be mounted in NEMA 1 enclosures.

Mount on walls at an approved location or provide a free-standing rack.

Enclosure mounting must include a wiring trough 6" longer than the enclosure width and have a minimum of 5 raceway connecting the trough and the enclosure. (3) 2" raceway feed left, middle and right wire ways. (2) 1" raceway are used for line voltage and communication cabling.

Panels shall be constructed of 16 gauge, furniture-quality steel, or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with ANSI 61 polyester-powder painted finish, UL listed. Provide common keying for all panels.

Provide power supplies for control voltage power.

Dedicate 1 power supply to the DDC controller. Other devices shall be on a separate power supply, unless the power for the control device is derived from the controller terminations. Control panel should have a minimum of two power supplies.

Power supplies for controllers shall be a transformer with a fuse or circuit breaker. Power supplies for other devices can be plain transformers.

All power supplies for 24V low voltage wiring shall be class 2 rated and less than 100VA. If low voltage devices require more amps, then provide multiple power supplies. If a single device requires more amps, then provide a dedicated power supply in a separate enclosure and run a separate, non-class 2 conduit to the device.

Backplane mounted uninterruptible power supply sized for 200% of the theoretical ampacity of the control panel and associated end devices including actuators, transmitters and accessories. UPS shall provide 30 minutes of battery capacity.

Surge transient protection shall be incorporated in design of system to protect electrical

components in all DDC Controllers and operator's workstations.

All devices in a panel shall be permanently mounted, including network switches, modems, media converters, etc.

Provide a pocket to hold documentation.

GENERAL SPECIFICATIONS FOR DEVICES

Provide mounting hardware for all devices, including actuator linkages, wells, installation kits for insertion devices, wall boxes and fudge plates, brackets, etc.

If a special tool is required to mount a device, provide that tool.

SENSORS:

Electronic Sensors: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

- A. Thermistor temperature sensors as follows:
 - 1. Accuracy: Plus or minus **0.5 deg F (0.3 deg C)** at calibration point.
 - 2. Wire: Twisted, shielded-pair cable.
 - 3. Insertion Elements in Ducts: Single point, **8 inches (20 cm)** long; use where not affected by temperature stratification or where ducts are smaller than **9 sq. ft. (1 sq. m)**.
 - 4. Averaging Elements in Ducts: Minimum **36 inches (91 cm)** long, flexible; use where prone to temperature stratification or where ducts are larger than **9 sq. ft. (1 sq. m)**; length as required.
 - 5. Insertion Elements for Liquids: Brass socket with minimum insertion length of **2-1/2 inches (64 mm)**.
 - 6. Room Sensors: Match room thermostats, locking cover.
 - 7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- B. Resistance Temperature Detectors: Platinum.
 - 1. Accuracy: Plus or minus 0.2 percent at calibration point.
 - 2. Wire: Twisted, shielded-pair cable.
 - 3. Insertion Elements in Ducts: Single point, **8 inches (20 cm)** long; use where not affected by temperature stratification or where ducts are smaller than **9 sq. ft. (1 sq. m)**.
 - 4. Averaging Elements in Ducts: Minimum **36 inches (91 cm)** long, flexible; use where prone to temperature stratification or where ducts are larger than **9 sq. ft. (1 sq. m)**; length as required.
 - 5. Insertion Elements for Liquids: Brass socket with minimum insertion length of **2-1/2 inches (64 mm)**.
 - 6. Room Sensors: Match room thermostats, locking cover.
 - 7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
- C. Humidity Sensors: Bulk polymer sensor element.
 - 1. Bulk polymer sensor element.
 - 2. Accuracy: 2 percent full range with linear output.
 - 3. Room Sensors: With locking cover matching room thermostats, span of 25 to 90 percent relative humidity.
 - 4. Duct and Outside-Air Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

- D. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - 1. Non-directional sensor with suitable range for expected input and temperature compensated.
 - 2. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - 3. Output: 4 to 20 mA.
 - 4. Building Static-Pressure Range: 0 to 0.25 inch wg (0 to 62 Pa).
 - 5. Duct Static-Pressure Range: 0 to 5 inches wg (0 to 1243 Pa).
- E. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; proportional output 4 to 20 mA.

Equipment operation sensors as follows:

- A. Status Inputs for Electric Motors: Current-sensing relay with current transformers, adjustable and set to 175 percent of rated motor current.
- B. Status Inputs for Pumps: Adjustable type current sensing relay or current transformer with 4-20 mA transmitter attached.
- C. Status Inputs for direct drive electric motors: Current-sensing relay with current transformers, adjustable and sized for 175 percent of rated motor current.
- D. Status inputs for belt drive electric motors: Current sensing transmitter with linear 4-20mA output.

Electronic Valve/Damper Position Indication: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

Water-Flow Switches: Pressure-flow switches of bellows-actuated mercury or snap-acting type, with appropriate scale range and differential adjustment, with stainless-steel or bronze paddle. For chilled-water applications, provide vaporproof type.

Air Differential Pressure Switches: Diaphragm type air differential pressure switches with die cast aluminum housing, adjustable setpoint, minimum 5-amp switch rating at 120VAC, SPDT switches, and the switch pressure range shall be suited for the application. Provide Dwyer or equal. These switches shall be utilized for filter status.

Leak detectors: Provide spot leak detectors that can be secured to the floor or secured to a drain pan. The detection shall use a microchip controlled energized probes. The detector shall operate on 24V or less. Provide a way to adjust the height of the leak probes. The SPDT contacts shall be inside a watertight enclosure.

Current switches: Adjustable trip point. Detection of belt loss and motor failure and LED status. Dry contact output. Sizing according to motor load.

Airflow Monitoring Station: Ebtron. Provide where indicated, a complete, dedicated Airflow Measurement System capable of directly measuring the airflow through a duct and providing the measured airflow values via a local display, multiple analog outputs, and a single serial output for BACnet or Modbus.

- A. Provide one thermal airflow measuring device (AMD) for each location indicated on the plans, schedules and/or control diagrams.
- B. Each AMD shall provide the velocity-weighted temperature of the airstream that may be used for temperature measurement when indicated on the plans, schedules, points list, or control diagrams.

- C. Each AMD shall use the principle of thermal dispersion to determine the actual or mass airflow rate of the airstream. Differential pressure-based devices, including pitot tubes, pitot arrays, fan inlet piezo-rings, and devices measuring the pressure drop across a louver, damper or obstruction are not acceptable.
- D. Each AMD shall be provided with one or more sensor probes having one or more sensor nodes per probe.
- E. Each sensor node shall consist of two hermetically sealed bead-in-glass thermistors. The airflow of each sensor node shall be determined using one self-heated and ambient temperature sensing thermistor. Devices using indirectly heated thermistors to determine the airflow rate are not acceptable. Devices using chip thermistors of any type or packaging are not acceptable. Devices using platinum wire RTDs or similar "hot wire" devices are not acceptable.
- F. Thermistors shall be potted in an engineering thermoplastic assembly using water-proof, marine epoxy and shall not be damaged by moisture, direct contact with water or exposure to atmospheric acids. Provide a copy of an independent laboratory report to verify compliance with this requirement.
- G. All internal wiring in the probe tube shall be chemical and abrasion resistant Kynar® coated copper.
- H. All connections to internal wires in the probe tube shall be solder joints or welds. Connectors of any type in the probe tube are not acceptable.
- I. Each thermistor shall be independently calibrated to NIST traceable temperature standards to establish the resistance-temperature characteristics for the determination of airflow and temperature. Devices using interchangeable, curve-matched, thermistors are not acceptable.
- J. Each sensor node shall be independently processed by the transmitter prior to averaging and output.
- K. The specified sensor accuracy shall include the combined uncertainty of the sensor nodes and transmitter. Devices whose overall accuracy is based on individual accuracy specifications of the sensor probes and transmitter shall demonstrate compliance with the specified sensor accuracy over the entire operating range.
- L. Installed accuracy shall include the uncertainty of the AMD and the additional uncertainty that results from the placement of the AMD in the airstream. The specified installed accuracy is based on the AMD being installed in accordance with manufacturers published placement and installation guidelines.
- M. Transmitters shall be microprocessor-based and operate automatically after brownouts and/or transient power interruptions.
- N. All printed circuit boards shall have gold plated interconnects, edge fingers, and test points.
- O. Remote transmitters shall have an LCD and four-button user interface.
- P. Remote transmitters shall be mounted in a location protected from moisture, rain and snow with an ambient temperature between -20 and 120 °F [-28.9 to 48.9 °C] and a humidity range between 5 and 95% RH (non-condensing). Provide a weatherproof enclosure (by others) and mount away from direct sunlight when outdoor mounting is required.
- Q. Probes with remote transmitters shall be "plug and play", not require matching to the transmitter, and be provided with a UL listed, FEP jacketed, plenum rated cable and connector plug. Devices using PVC jacketed cables to connect sensor probes to the transmitter are not acceptable.
- R. All components of each device shall be RoHS2 compliant.
- S. Each device shall be FCC-Part 15 compliant. Compliance shall be demonstrated by an independent test laboratory.
- T. Each AMD shall be UL/cUL listed as a final assembly.
- U. European shipments shall be CE marked. Compliance shall be demonstrated by an independent test laboratory.

V. Devices with a BACnet network connection shall be BTL tested and listed.

Provide one to four gold anodized 6063 aluminum probes and one remote transmitter. Provide polished 316 stainless steel tubes when indicated on the plans or schedules.

- A. Probes shall have integral 304 stainless steel mounting brackets for insertion, internal, or standoff mounting.
- B. Each sensor node shall be individually wind-tunnel calibrated at 16 points to NIST traceable airflow standards and have an accuracy of $\pm 2\%$ of reading over the entire operating range. Provide a copy of the NIST calibration report for the reference standard used to calibrate the production tunnels used to calibrate individual sensor nodes. Reference standards calibrated to third-party NIST traceable labs are not acceptable. Devices claiming AMCA certification are not acceptable.
- C. Provide up to 16 sensing nodes per measurement location as required for the opening size and published sensor density tables to achieve an installed airflow accuracy of $\pm 3\%$ of reading ($\pm 5\%$ of reading on close coupled outdoor air intakes) between 0 and 5,000 fpm [0 to 25.4 m/s] over a temperature range of -20 to 160 °F [-28.9 to 71.1 °C] and a humidity range between 0 and 100% RH (non-condensing).
- D. Velocity-weighted temperature accuracy shall be better than ± 0.15 °F [0.08 °C].
- E. Provide low and high airflow alarms with a user defined setpoint and tolerance.
- F. Transmitters shall be provided with a 16-character by two-line, backlit, alpha-numeric LCD.
 - 1. The airflow rate, temperature, airflow alarm, system status alarm, and active trouble codes shall be visible on the transmitter display. Humidity and either enthalpy or dewpoint shall be visible on the transmitter display when the humidity sensor is provided.
- G. Building Automation System Analog Signal Connections:
 - 1. Provide three isolated, field selectable (4-20mA, 0-5/0-10 VDC) analog output signals.
 - 2. Analog output signals shall provide:
 - a. One output signal for airflow (linear)
 - b. One output signal shall be field configurable for:
 - (i) velocity-weighted temperature (linear), or
 - (ii) airflow alarm (binary), or
 - (iii) system status alarm (binary)
 - c. One output signal that shall be field configurable for
 - (i) velocity-weighted humidity (linear), or
 - (ii) velocity-weighted enthalpy (linear), or dewpoint (linear), when the humidity option is provided.
- H. Building Automation System Network Connection Options:
 - 1. Provide one of the following when required:
 - a. One isolated RS-485, field selectable (BACnet MS/TP or Modbus RTU) network connection.
 - b. One isolated Ethernet, field selectable (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP) network connection.
 - c. One isolated RS-485, field selectable (BACnet MS/TP or Modbus RTU) network connection and one isolated Ethernet, field selectable (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP) network connection.
 - d. Two isolated Ethernet, field selectable for
 - (i) Single connection to B.A.S. (BACnet Ethernet, BACnet IP, Modbus TCP or TCP/IP), or
 - (ii) Daisy-chain connection to B.A.S. (BACnet Ethernet, BACnet IP, Modbus TCP or

TCP/IP)

- e. One isolated Lonworks Free Topology network connection.
 - f. One USB Flash Drive (Thumb drive) memory device for logging average and individual airflow rates, temperatures, and psychrometric measurements at user specified time intervals.
2. Network connections shall provide the airflow, velocity-weighted temperature, velocity-weighted-humidity, velocity-weighted-enthalpy, dewpoint, airflow alarm status, individual sensor node airflow and temperature data, and device fault status.
- I. Provide a Bluetooth, low-energy interface and free Android® or iOS® software that allows real-time airflow, temperature and humidity monitoring and airflow and temperature traverses. Software shall capture, save and/or e-mail airflow/temperature/humidity data, transmitter settings and diagnostics information. [replace section with the following for installations that do not allow any radio devices: Transmitters shall not be provided with any radio transmitter or receiver.
 - J. Each AMD shall be powered by 24 VAC (22.8 to 26.4 VAC under load) and have a maximum power requirement of 22 V-A.

THERMOSTATS:

The sensor may be either RTD or thermistor type providing the following minimum performance requirements are met:

- A. Accuracy: $\pm 1^{\circ}\text{F}$ ($\pm 0.6^{\circ}\text{C}$)
- B. Operating Range: 35° to 115°F (2° to 46°)
- C. Set Point Adjustment Range: 55° to 95°F (2° to 30°C)
- D. Set Point Modes: Independent Heating, Cooling, Night Setback-Heating, Night Setback-cooling
- E. Calibration Adjustments: None required
- F. Installation: Up to 100' from controller

Each room temperature sensor shall include a terminal jack integral to the sensor assembly. The terminal jack shall be used to connect a portable operator's terminal to control and monitor all hardware and software points associated with the controller. In lieu of an internal jack, provide a separate terminal jack mounted on a stainless steel wall plate adjacent to the sensor to facilitate direct access to the controller via the terminal.

Each room sensor shall also include the following auxiliary devices:

- A. Setpoint Adjustment
- B. Digital Temperature Indicator
- C. Override Button

The setpoint adjustment shall allow for modification of the temperature by the occupant. Setpoint adjustment may be locked out, overridden or limited as to time or temperature through software by an authorized operator at the central workstation, Main Controller, or via the portable operator's terminal.

An override switch shall initiate override of the night setback mode to normal (day) operation when activated by the occupant. The override function may be locked out, overridden or limited as to the time through software by an authorized operator at the central workstation, Main Controller or via the portable operator's terminal.

Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater.

Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature, with copper capillary and bulb, unless otherwise indicated.

- A. Bulbs in water lines with separate wells of same material as bulb.
- B. Bulbs in air ducts with flanges and shields.
- C. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit, adequately supported.
- D. Scale settings and differential settings are clearly visible and adjustable from front of instrument.
- E. On-Off Thermostat: With precision snap switches, with electrical ratings required by application.
- F. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

Room Thermostat Cover Construction: Manufacturer's standard locking covers.

- A. Set-Point Adjustment: Concealed.
- B. Set-Point Indication: Concealed.
- C. Thermometer: Concealed.
- D. Color: Standard manufacturer's color.
- E. Orientation: Vertical.

Room thermostat accessories include the following:

- A. Insulating Bases: For thermostats located on exterior walls.
- B. Thermostat Guards: Locking; heavy-duty, transparent plastic; mounted on separate base, where indicated.
- C. Adjusting Key: As required for calibration and cover screws.
- D. Aspirating Boxes: For flush-mounted aspirating thermostats.
- E. Set-Point Adjustment: diameter, adjustment knob.

Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

Airstream Thermostats: Two-pipe, fully proportional, single-temperature type, with adjustable set point in middle of range and adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

Electric Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, automatic-reset switch that trips when temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.

- A. Bulb Length: Minimum 20 feet (6 m).
- B. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

Electric space thermostats: Provide a charged element type stat with snap acting SPDT switch. The switch shall be rated for 16A or 1HP at 120V.

Aquastat: Provide a charged element type stat with snap acting SPDT switch. The switch shall be rated for 16A or 1HP at 120V.

ACTUATORS:

Manufactures:

- A. Belimo
- B. Siemens

Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

- A. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
- B. Nonspring-Return Motors for Valves Larger Than **NPS 2-1/2 (DN 65)**: Size for running torque of **150 in. x lbf (16.9 N x m)** and breakaway torque of **300 in. x lbf (33.9 N x m)**.
- C. Spring-Return Motors for Valves Larger Than **NPS 2-1/2 (DN 65)**: Size for running and breakaway torque of **150 in. x lbf (16.9 N x m)**.
- D. Nonspring-Return Motors for Dampers Larger Than **25 Sq. Ft. (2.3 sq. m)**: Size for running torque of **150 in. x lbf (16.9 N x m)** and breakaway torque of **300 in. x lbf (33.9 N x m)**.
- E. Spring-Return Motors for Dampers Larger Than **25 Sq. Ft. (2.3 sq. m)**: Size for running and breakaway torque of **150 in. x lbf (16.9 N x m)**.

Electronic Damper / Large-Valve Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

- A. Valves: Size for torque required for valve close-off at maximum pump differential pressure.
- B. Dampers: Size for running torque calculated as follows:
 - 1. Parallel-Blade Damper with Edge Seals: **7 inch-pounds/sq. ft. (86.8 kg-cm/sq. m)** of damper.
 - 2. Opposed-Blade Damper with Edge Seals: **5 inch-pounds/sq. ft. (62 kg-cm/sq. m)** of damper.
 - 3. Dampers with **2 to 3 Inches wg (500 to 750 Pa)** of Pressure Drop or Face Velocities of **1000 to 2500 FPM (5 to 13 m/s)**: Multiply the minimum full-stroke cycles above by 1.5.
 - 4. Dampers with **3 to 4 Inches wg (750 to 1000 Pa)** of Pressure Drop or Face Velocities of **2500 to 3000 FPM (13 to 15 m/s)**: Multiply the minimum full-stroke cycles above by 2.0.
- C. Coupling: V-bolt and V-shaped, toothed cradle.
- D. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
- E. 100% surplus power to move the actuator from full open to full closed travel.
- F. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on non-spring-return actuators.
- G. Power Requirements (Two-Position Spring Return): 24-V ac.
- H. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
- I. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
- J. Temperature Rating: Minus 22 to plus 122 deg F (**minus 30 to plus 50 deg C**).
- K. Temperature Rating (Smoke Dampers): **Minus 22 to plus 250 deg F (minus 30 to plus 121 deg C)**.

- L. Run Time: 30 seconds.
- M. Listed under UL Standard 873 and manufactured under ISO 9001.
- N. 2-year manufacturer's warranty, starting at date of substantial completion.

CONTROL VALVES:

Manufacturers:

- A. Belimo.
- B. Siemens.

Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

Globe Valves NPS 2 (DN 50) and Smaller: Bronze body, bronze or stainless steel trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

Globe Valves NPS 2-1/2 (DN 65) and Larger: Iron body, bronze or stainless steel trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.

Hydronic system globe valves shall have the following characteristics:

- A. Rating: Class 125 for service at 125 psig (862 kPa) and 250 deg F (121 deg C) operating conditions.
- B. Internal Construction: Replaceable plugs and seats of stainless steel or brass.
 - 1. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom of guided plugs.
 - 2. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom of guided plugs.
- C. Sizing: 5-psig (35-kPa) maximum pressure drop at design flow rate.
- D. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Operators shall close valves against pump shutoff head.

Butterfly Valves: 200-psig (1380-kPa), 150-psig (1035-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.

- A. Body Style: Wafer or Grooved.
- B. Disc Type: Nickel-plated ductile iron, elastomer-coated ductile iron or epoxy-coated ductile iron.
- C. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.

Terminal Unit Control Valves: Bronze body, bronze trim, two- or three-port as indicated, replaceable plugs and seats, union and threaded ends.

- A. Rating: Class 125 for service at 125 psig (862 kPa) and 250 deg F (121 deg C) operating conditions.
- B. Sizing: 5-psig (35-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
- C. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

FLOWMETER:

Ultrasonic Flow Meter: Onicon. Clamp-on ultrasonic model for piping and sensing clean liquids. 11-28VDC @0.25A power required. Reverse polarity and surge suppression protection. Rated for fluid velocity of 0.1 to 40 FPS. 4-20mA output with 12 bit resolution. Integral LCD display of 2 line of 8 characters each minimal. NEMA 3 enclosure.

DAMPERS:

Dampers: AMCA-rated, parallel-blade design, unless noted otherwise; 0.1084-inch (2.8-mm) minimum, galvanized-steel frames with holes for duct mounting; damper blades shall not be less than 0.0635-inch (1.6-mm) galvanized steel with maximum blade width of 8 inches (203 mm).

- A. Blades shall be secured to 1/2-inch- (13-mm-) diameter, zinc-plated axles using zinc-plated hardware, with nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
- B. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
- C. Low-leakage design with inflatable seal blade edging, or replaceable rubber seals, rated for leakage at less than 10 cfm per sq. ft. (51 L/s per sq. m) of damper area, at differential pressure of 4 inches wg (995 Pa) when damper is being held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

REFRIGERANT DETECTOR:

HFC and HCFC Refrigerant Gas Detection Monitoring System

The manufacturer shall warrant the gas monitor for a period of 5 years.

- A. Gas monitors must be capable of field calibration.
- B. Sensing element technology shall be non-dispersive infrared (NDIR) dual channel.
- C. as monitors shall be installed per the manufacturer's mounting height and coverage area recommendations.
- D. Power supply: 24V AC/DC.
- E. Measuring range: HFC/HCFC 0-2000 ppm.
- F. Operating temperature: -4 to 104 °F (-20 to 40 °C).
- G. Humidity: 15-90% rH continuous, 0-99% rH intermittent, non-condensing.
- H. Degree of protection IP20 UL94 5VA. Foam seal, drainage channel and water outlet to protect electronics from water and condensation buildup.
- I. Indicators for 3 levels of alarm: Red LED for alarm level 1 and 2; high intensity white strobe LED and horn for alarm level 3, rated to 80 db at 3.3 feet (1 meter).
- J. Backlit LCD display shows gas type, gas concentration, and alarm level status.
- K. CAN bus network operation as addressable nodes allow for a wired connection from any single gas monitor to the exhaust fans circuit. Dampers and exhaust fans shall be initiated from any gas monitor on the network.
- L. Gas monitoring system can be standalone with peer to peer connection without the need for a central controller.
- M. BTL listed BACnet MS/TP RS485 for integration to the building automation system from any communication module on the CAN bus network. Supervisory controller not required.
- N. Agency listing: ETL listed to 61010-1/-2-201, CSA C22.2 #61010-1-12/-2-201.

VARIABLE FREQUENCY DRIVE:

Shall be for use with a standard NEMA B induction motor. All units are to be started up at the job site by a factory trained authorized representative and a five year parts and labor warranty.

Manufacturers:

- A. ABB.
- B. Danfoss.
- C. Yaskawa.

Drive must include the following:

- A. Maximum 5 percent total harmonic distortion of both voltage and amperage per IEEE 519. Input displacement power factor of 0.95 or higher at all operating speeds and loads. The VFD shall be a microprocessor based digital Pulse Width Modulated (PWM) design. Current source designs and SCR-type units are not acceptable.

The PWM VFD shall provide the following design features as standard.

- A. Microprocessor Logic: The VFD shall be microprocessor based and utilize digital input for all parameter adjustments. Use of potentiometers for parameter adjustment is not acceptable.
- B. Auto Restart: The VFD shall automatically attempt to restart after a malfunction or an interruption of power. The number of attempted restarts shall be customer selectable (0 to 5). If the drive reaches the limit of restarts without successfully restating and running for a customer selectable length of time (60 to 600 seconds), the restart circuit shall lockout and shall provide contact annunciation. Delay between attempts to restart shall be customer selectable from 3 to 300 seconds.
- C. Current Limit: a current limit circuit shall be provided to limit motor current to a preset adjustable maximum level by reducing the drive operation speed or acceleration rate when the limit is reached. Range of adjustment shall be from 50 to 100 percent.
- D. Digital Output Displays and Input Parameter Programming: The VFD shall include a digital display and digital input programming capability on the main logic board. The display shall be programmable for indication of output speed in rpm, frequency, and percent of base speed, motor amps, output motor volts, and output load, the display shall also function as a first fault indicator.
- E. Firestat/Freezestat: The VFD shall provide terminals for connecting normally closed remote safety devices. This emergency shutdown shall operate in any mode of operation.
- F. Critical Frequency Avoidance: The VFD shall provide a minimum of two (2) selectable frequency jump points, in 1.5 Hz increments.
- G. Input Signal Follower: The input signal follower circuit shall have selectable differential inputs and accept an electrical speed command from an external source rated a t4-20 mA or voltage signals of 0-10 VDC. The input follower circuit shall be capable of operating directly or inversely proportional to the listed speed commands.
- H. Motor Overload Protection: Electronic motor protection shall be provided which is capable of predicting motor winding temperature based on inputting motor full load amps. The protection shall provide an orderly shutdown should the motor's thermal capabilities be exceeded. This protection also eliminates the requirement for motor overload relays on single motor applications when a bypass is not used.
- I. Open Collector Outputs: The VFD shall include one (1) open collector outputs to indicate drive run, drive fault, and drive ready. (2) Form C relays (open controller outputs require separate 24V. power supply).

- J. Output Signals: The VFD shall include analog output signals for output load, output speed, and motor load. The signals shall be 0 to 10 Vdc @ 1 mA, 2-10 VDC, 4-20 mA or 12 VDC pulse.
- K. Stop Mode Functions: The VFD stopping mode functions shall be selectable for coast-to-rest or stopping at programmed decel rate.
- L. V/Hz Profiles: The VFD shall provide up to four (4) selectable V/Hz profiles.
- M. Loss of Control Signal: The VFD shall revert to the last speed on loss of input control signal. Owner shall be able to field select a preset speed for the VFD to run when control signal is lost, if preferred. In either case, an open collector output shall be selected to indicate loss of control signal for remote indication purposes.
- N. The PWM VFD design shall provide the following:
 - 1. Input Section: Full wave rectification shall be achieved with input diodes in a conventional bridge configuration and shall be used to supply voltage to the DC bus.
 - 2. DC Bus: The DC shall be filtered by a series choke between the input section and one or more capacitors to provide ripple free dc current. An additional series choke shall be located between the bus capacitors and the inverter to provide enhanced output short circuit and ground fault protection. VFDs which use only bus capacitors require that input isolation transformers or input line filters be supplied.
 - 3. Output Section: The inverter shall use GTB transistors to provide three phase output power to the motor.
- O. The VFD supplier shall provide the same design / technology to cover the HP range for all VFD's. VFD supplier to provide the following documentation:
 - 1. Documentation showing that the VFD is the same basic design.
 - 2. One Instruction Manual to cover the full HP range for all VFDs.
 - 3. Explanation of commonality of spare parts for all VFDs.
- P. Output ratings. The VFD shall operate within the following ratings:
 - 1. Frequency range, 1-66 Hz.
 - 2. Frequency resolution, .1 percent of base speed with analog input .025 percent with digital input.
 - 3. Frequency accuracy within .05 percent of set point.
 - 4. Overload rating, 110 percent for one minute.
- Q. Motor performance.
 - 1. The VFD shall provide 3 percent speed regulation.
 - 2. Input power. The VFD shall operate within the following parameters:
208V (+10%/-15%), or 240V (+10%/-15%), or 480V (+10%/-15%)
- R. Set-up adjustments. Standard setup adjustments shall include:
 - 1. Minimum speed, 0 to 100 percent.
 - 2. Maximum speed, 0 to 100 percent.
 - 3. Linear accel, .5 to 600 seconds.
 - 4. Linear decel, .5 to 600 seconds.
 - 5. Maximum output voltage, adjustable.
 - 6. V/Hz, adjustable with selectable profiles.
 - 7. Current limit, 50 to 110 percent.
- S. Environmental ratings. The VFD shall operate within the following parameters without the requirements for derating:
 - 1. Operating temperature, 0 degree C to 40 degrees C.
 - 2. Altitude to 100m (3,300 ft.).
 - 3. Humidity, 95 percent non-condensing.

- T. Enclosure. The drive shall be furnished in NEMA 1 enclosure unless protection requires NEMA 12 for dusty or oily environments. Finned heatsinks and/or cooling fans shall be provided as necessary for proper heat dissipation. Inlet filters are required on all cooling fans, unless they are outside the drive enclosure and no circulated air passes circuit boards, transistors, or other electrical components. For indoor - NEMA 1.
- U. Codes and standards. The VFD shall meet the following standards:
1. CSA.
 2. ETL (UL 508).
 3. NEMA.
 4. NEC.
- V. Protective Features: The VFD shall be designed to meet the following specifications and operate within the following parameters:
1. AC Input Fuses: The VFDs power circuit shall be fused and isolated internally with respect to ground. Fuses shall provide a minimum of 100,000 A interrupting capacity.
 2. Logic Common: The power unit's logic common shall be at ground potential.
 3. Phase Loss Protection: Phase loss protection shall be provided to prevent single phasing.
 4. Phase Loss Ride-Through: The VFD shall be capable of continued operation during an intermittent loss of power for 0.1 seconds (6 cycles). Opening the VFDs input and/or output line switches while operating shall not result in damage to the power circuit components.
 5. Short Circuit and Ground Fault Protection: The VFD shall have an instantaneous electronic trip circuit to protect the VFD from output line-to-line and line-to-ground short circuits. The VFD must be capable of withstanding short circuits at 480V plus 10 percent (528V). The VFD supplier must demonstrate ground fault and short circuit protection at time of start up or plant witness test. The VFD shall be capable of providing 110 percent motor current intermittently. The VFD shall include an instantaneous overcurrent trip and shall not restart after electronic overcurrent trip until reset through the run/stop circuit, or unless the auto restart function has been enabled.
 6. Transient and Surge Voltage Protection: Transient and surge voltage protection shall be provided through the use of Metal Oxide Varistors (MOVs). The VFD shall withstand a 6,000volt, 80 joule surge voltage when tested in accordance with ANSI/IEEE C62.41-1980 with the test circuit adjusted for a 2,100 amp peak 8x20 microseconds short circuit discharge current pulse.
 7. Rotating Motor Start: The VFD shall be able to start into a motor rotating in either direction and at any speed, and accelerate to set speed without any time delay, tripping or component loss.
 8. Load Side Disconnects: A disconnect switch may be used on the load side of the VFD near the motor for ease of service and safety. Operating the switch with the VFD running shall not cause any component failure. In dual motor applications, VFD shall be able to operate either motor with the other motor disconnected without requiring jumpers, parameter modifications, or other adjustments. As part of start-up, VFD supplier shall certify all load side disconnects can be opened or closed with drive running at full speed without damage to the drive.
- W. Reliability: A complete description of supplier's Quality Assurance and Testing program shall be provided.
1. Component Testing. All power semiconductors and integrated circuits shall be 100 percent tested.
 2. Computerized ATE Testing: Computerized Automated Testing Equipment (ATE) testing shall be used to evaluate functional performance of printed circuit boards. Printed circuit boards shall receive a thermal stress test where temperatures are

cycled between 0 degrees C and 65 degrees C and receive electrical power-on and power-off cycle tests.

3. Burn In: All VFDs shall be tested/run in the equivalent of a NEMA 1 enclosure and burned in at rated ambient (40°C) with a fully loaded motor.

X. Maintainability:

1. All control circuit voltages (12VAC, 24VDC, 160VDC and 120VAC) shall be physically and electrically isolated from power circuit voltages (200 to 600VAC, 600VDC) to ensure safety to maintenance personnel.
2. The VFD shall be furnished with an alphanumeric diagnostic display with fault indications to include the following: bus overvoltage, bus undervoltage, overcurrent, overtemperature, ground fault, and timed overload.
3. All printed circuit boards shall utilize quick disconnect plugs and/or pull apart terminal blocks to facilitate maintenance by providing quick change-out without disconnecting terminal strip connections thereby reducing wiring errors.
4. VFD shall be capable of starting and operating without a motor connected for ease of service.
5. All setup and operating parameters shall be stored in nonvolatile memory. The static memory module shall to be removed and installed in replacement logic boards with all setup and operating parameters intact requiring no adjustment of replacement boards.

Y. Additional Features:

1. Operator Panel: A door-mounted Softtouch Operator Panel shall be included with the following features:
 - a. Shall digitally display motor speed, load, amps, and output volts (and controller set point and system pressure when set point controller is included).
 - b. Shall have keypad display for indicating drive run, drive ready, drive fault, plus operator function / status indication such as auto speed reference, and auto restart.
 - c. Shall provide selection for Hand/Off/Auto control. In Hand mode, the VFD shall be started and stopped from the operators panel. In the Auto mode, the VFD shall be started and stopped by remote contact closure. In the Off mode, the VFD shall be locked out.
 - d. Shall provide selection for Manual/Auto Speed Reference. In the Manual Reference mode, the VFD speed reference shall be set from the operators panel. In the Auto Reference mode, the VFD speed reference shall be set by the external source instrument signal. Selecting between Manual and Auto speed reference shall have no bearing on the Hand/Off/Auto start/stop selector, or vice versa.
 - e. Shall name all parameters in English, not codes or numbers.
 - f. Keypad shall include electronic lock-out feature to prevent unauthorized personnel from parameter access.
 - g. Shall store up to ten (10) drive faults in a history batch file in the order they occur to simply trouble-shooting. This file will automatically be updated should new faults occur.
2. Automatic Bypass Control Circuitry: Bypass control circuitry shall be mounted integrally to the VFD enclosure. The bypass shall utilize an input switch to feed the VFD and isolate the VFD for trouble shooting. An output contractor which is electrically and mechanically interlocked with the bypass starter shall be utilized on the VFD to provide a positive disconnect between the VFD and the motor. Separate Hand/Off/Auto and Inverter/Bypass switches shall be included to allow manual or automatic transfer to across-the-line operation. If the VFD trips on a fault, power will automatically transfer across the line to run the motor at full speed. If the VFD auto

- restart function has been enabled, the drive will first attempt to restart itself after a fault. If it is unable to do so within the number of times programmed, power will then automatically transfer across the line. Auxiliary contacts, and overload relay with adjustable heater settings shall also be included. Any protective shutdown circuits shall function in all modes (hand, auto, or bypass).
3. A120V. control transformer fused on both the primary and the secondary. Disconnect Switch: The operating mechanism shall be designed so that the door can be padlocked in the "OFF" position. The switch shall have an interrupting capacity of 65,000 symmetrical amperes.
 4. Communications Port: A communications port for RS 232C or RS 422 communications with selectable baud rates for 300, 1200, or 2400 baud shall be provided.
 5. Provide factory start up, adjustment, and initialization.
 6. NEMA 4X enclosure for exterior installations.
 7. Elapsed time meter to indicate how long the drive has been running.
 8. On-site owner training of at least 4 hours shall be provided, and must include a complete description on Theory of Operation, Operating Procedures, Functional and Operating Characteristics of Specific Logic Boards, Troubleshooting, Repair, and Preventative Maintenance. A simulated failure shall be diagnosed. All costs for instructor's time, travel, meals, lodging, etc. shall be included.

PART 3 EXECUTION

EXAMINATION

The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the architect/engineer for resolution before rough-in work is started.

The contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the engineer for resolution before rough-in work is started.

The contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the contractor's work and the plans and the work of others—the contractor shall report these discrepancies to the engineer and shall obtain written instructions for any changes necessary to accommodate the contractor's work with the work of others.

INSTALLATION

Provide all relays, switches, sources of emergency and UPS battery back-up electricity and all other auxiliaries, accessories and connections necessary to make a complete operable system in accordance with the sequences specified. All field wiring shall be by this contractor.

Install controls so that adjustments and calibrations can be readily made. Controls are to be installed by the control equipment manufacturer.

Mount surface-mounted control devices on brackets to clear the final finished surface on insulation.

Install equipment level and plumb.

Install control valves horizontally with the power unit up.

Unless otherwise noted, install wall mounted thermostats and humidistat 48" above the floor measured to the center line of the instrument, or as otherwise directed by the Architect.

Install averaging elements in ducts and plenums in horizontal crossing or zigzag pattern.

Install outdoor sensors in perforated tube and sunshield.

Install damper motors on outside of duct in protected areas, not in locations exposed to outdoor temperatures.

Install labels and nameplates on each control panel listing the name of the panel referenced in the graphics and a list of equipment numbers served by that panel.

Furnish hydronic instrument wells, valves, and other accessories to the mechanical contractor for installation.

Furnish automatic dampers to mechanical contractor for installation.

Install guards on thermostats in the following locations:

- A. Entrances.
- B. Public areas.
- C. Where indicated.

ELECTRICAL WIRING

This contractor shall be responsible for power that is not shown on the electrical drawings, to controls furnished by this contractor. If power circuits are shown on the electrical drawings, this contractor shall continue the power run to the control device. If power circuits are not shown, this contractor shall coordinate with the electrical contractor to provide breakers at distribution panels for power to controls. This contractor is then responsible for power from the distribution panel.

- A. Coordinate panel locations. If enclosures for panels are shown on the electrical drawings, furnish the enclosures according to the electrician's installation schedule.

This contractor shall not be responsible for power to control panels and control devices that are furnished by others, unless it is part of the control interlock wiring.

Refer to Coordination section for what devices this contractor is responsible to mount and which are turned over to others to mount.

This contractor shall be responsible for wiring of any control device that is furnished as part of this section of specification.

Wiring for controls furnished by others:

- A. Provide control wiring for HVAC controls furnished by others. Wiring may include, but not limited to, the following items:
 - 1. Thermostats
 - 2. Condensers
 - 3. Chiller control devices shipped loose
 - 4. Leak detectors

5. Humidifier controls
6. Refrigerant leak monitoring systems
7. Exhaust or Purge fans
8. Manual switches for HVAC equipment (not shown on electrical drawings)
9. Emergency ventilation switches (not shown on electrical drawings)
10. Emergency shutdown switches (not shown on electrical drawings)

Provide network wiring for equipment that is called to be integrated to the BAS.

ELECTRICAL WIRING AND CONNECTION INSTALLATION

All low voltage control wiring shall be class 2. Control wiring that is not class 2 shall be run in separate conduits from class 2 wiring.

Floor level network wiring between terminal units can be combined with thermostat and other low voltage wiring in the same conduit. All other network wiring shall be in dedicated conduits.

Install raceways, boxes, and cabinets according to Division 26 Section "Raceways and Boxes."

Install building wire and cable according to Division 26 Section "Conductors and Cables."

Installation shall meet the following requirements:

- A. Conceal cable and conduit, except in mechanical rooms and areas where other conduit and piping are exposed.
- B. Install exposed cable in raceway or conduit.
- C. Install concealed cable using plenum rated cable.
- D. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.
- E. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
- F. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
- G. All wiring in lab areas shall be in conduit.
- H. All unsupported risers shall be rigid steel conduit. Supported risers shall be EMT.

Raceway located outdoors shall be in rigid conduit shall be steel, hot dip galvanized, threaded with couplings, ¾ inch minimum size, manufactured in accordance with ANSI C-80-1. Electrical metallic tubing (EMT) with compression fittings or intermediate metallic conduit (IMC) may be used as conduit or raceway where permitted by the NEC.

Concealed control conduit and wiring shall be provided in all spaces except in the Mechanical Equipment Rooms and in unfinished spaces. Install in parallel banks with all changes in directions made at 90 degree angles.

Install conduit adjacent to machine to allow service and maintenance.

Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

Ground equipment.

COMMUNICATION WIRING

Network cable jacket color must meet owner cable standards. All cabling shall be installed in a neat and workmanlike manner. Follow manufacturer's installation recommendations for all communication cabling.

Do not install communication wiring in raceway and enclosures containing Class 1 wiring.

Maximum pulling, tension, and bend radius for cable installation, as specified by the cable manufacturer, shall not be exceeded during installation.

Contractor shall verify the integrity of the entire network following the cable installation. Use appropriate test measures for each particular cable.

Cable bundling:

- A. Cabling run open air in accessible areas can be bundled with other class 2 low voltage cabling.
- B. Cabling run between terminal units in conduits above ceilings or under floors or in inaccessible areas can be bundled with other class 2 low voltage cabling.
- C. Cabling run between floors shall be in a communication only conduit.
- D. Conduit run long distances between utility rooms or between buildings shall be in a communication only conduit.
- E. Ethernet cabling shall be in a communication only conduit.
- F. Fiber optics can be run with Ethernet and RS485/ TP/FT-10 cabling as long as the conduit is bent to fiber optic standards and junction boxes are sized for fiber optic use.

RS485 Cabling:

- A. RS485 shall use plenum rated low capacitance, 20-24 gauge, twisted shield-ed pair.
- B. The shields shall be tied together at each device.
- C. The shield shall be grounded at one end only and capped at the other end.
- D. Provide end of line (EOL) termination devices at each end of the RS485 network or subnetwork run, to match the impedance of the cable, 100 to 120ohm.

TP/FT-10 channel type Cabling:

- A. Uses transceivers that conform to the ISO/IEC 14908-2 Free-Topology Twisted Pair Channel Specification

Ethernet Cabling:

- A. Ethernet shall not be run with any Class 1 or low voltage Class 2 wiring.
- B. CAT5e or CAT6, unshielded twisted pair (UTP) cable shall be used for BAS Ethernet.
- C. Solid wire shall be used for long runs, between mechanical rooms and be-tween floors. Stranded cable can be used for patch cables and between pan-els in the same mechanical room up to 50 feet away.
- D. When the BAS Ethernet connects to an Owner's network switch, document the port number on the BAS As-builts.

When a cable enters or exits a building, a lightning arrestor must be installed be-tween the lines and ground. The lighting arrestor shall be installed according to the manufacturer's instructions.

All runs of communication wiring shall be unspliced length when that length is commercially available.

All communication wiring shall be labeled to indicate origination and destination data. All communication wiring must have a purple jacket.

Grounding of coaxial cable shall be in accordance with NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

IDENTIFICATION

Control Equipment and Device labeling:

- A. Labels and tags shall match the unique identifiers shown on the as-built drawings.
- B. All Enclosures shall be labeled to match the as-built drawing by either control panel name or the names of the DDC controllers inside.
- C. All sensors and actuators shall be labeled.
- D. Airflow measurement arrays shall be tagged to show flow rate range for signal output range, duct size, and pitot tube AFMS flow coefficient.
- E. Duct static pressure taps shall be tagged at the location of the pressure tap.
- F. Each device inside enclosures shall be tagged.
- G. Terminal equipment need only have a tag for the unique terminal number, not for each device. Match the unique number on:
 - a. First, the design drawings, or
 - b. Second, the control as-builts, or
 - c. Third, the DDC addressing scheme
- H. Tags on the terminal units shall be displayed on the Operator Workstation Graphics.

Tags shall be mechanically printed on permanent adhesive backed labeling strips, 12 point height minimum.

Manufacturers' nameplates and UL or CSA labels are to be visible and legible after equipment is installed.

Identification of Wires:

- A. Tag each wire with a common identifier on each end of the wire, such as in the control panel and at the device termination. Use shrink wrap labels.
- B. Tag each network wire with a common identifier on each end. Network cabling must be in purple jackets.
- C. Tag each 120V power source with the panel and breaker number it is fed by.

Identification of Conduits:

- A. Identify the low voltage conduit runs as BAS conduit, power feeds not included.
- B. Identify each electric box, junction box, utility box and wiring tray with a blue paint mark or blue permanent adhesive sticker.
- C. For conduit runs that run more than 8 ft between junction boxes in 1 room, place a blue identifier at least every 8 feet.
- D. Place a blue identifier on each side of where a conduit passed through a wall or other inaccessible path.
- E. Identify all BAS communication conduits the same as above.

FIELD QUALITY CONTROL

Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

- A. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
- B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
- C. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

Replace damaged or malfunctioning controls and equipment.

- A. Start, test, and adjust control systems.
- B. Demonstrate compliance with requirements, including calibration and testing, and control sequences. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

DDC TEMPERATURE CONTROLS CONTRACTOR (TCC) BALANCER COORDINATION

First Day: The TCC shall have a technical representative present with the Balancer on the first day of balancing for a minimum of 4 hours of active balancing - temperature controls coordination.

Remainder of Balancing: The TCC shall either:

- A. Have a technical representative continuously present at each step of the continuation of the balancing or
- B. Furnish the Balancer with the latest DDC software any required interface device for the duration of the balancing process. This option includes instructing the Balancer in the use of the software until the Balancer is proficient in the use of the software. Software and interface device shall be returned to TCC when balance report has been accepted. There shall be no charge to the owner or to the Balancer for the use of the software, OR
- C. Furnish the Balancer with the latest DDC software and any required interface device, and a portable computer for the duration of the balancing process. This option includes instructing the Balancer in the use of the portable computer and the software until the Balancer is proficient in the use of the software. Portable computer, interface device, and software shall be returned to the TCC when balance report has been accepted. There shall be no charge to the Owner or to the Balancer for the use of the software or portable computer.

SYSTEM CHECKOUT AND STARTUP

Inspect each termination in the control panels and devices to make sure all wires are connected according to the wiring diagrams and all termination are tight.

After the controls devices and panels are installed and power is available to the controls, perform a static checkout of all the points, including the following. Submit a Point-To-Point report to the engineer including BAS values, measured values, successful function and issues found:

- A. Inspect the setup and reading on each temperature sensor against a thermometer to verify its accuracy.

- B. Inspect the setup and reading on each humidity sensor against a hygrometer to verify its accuracy.
- C. Inspect the reading on each CO2 sensor using a calibration kit to verify the sensor range accuracy matches the DDC setup.
- D. Inspect the reading of each status switch to verify the DDC reads the open and close correctly.
- E. Command each relay to open and close to verify its operation.
- F. Command each 2-position damper actuator to open and close to verify operation.
- G. Command each 2-position valve to open and close to verify operation.
- H. Ramp each modulating actuator to 0%, 25%, 50%, 75% and 100% to verify its operation.
- I. Ramp each modulating output signal, such as a VFD speed, to verify its operation.
- J. Test each safety device with a real-life simulation, for instance check freezestats with ice water, water detectors with water, etc.

Document that each point was verified and operating correctly. Correct each failed point before proceeding to the dynamic startup.

Verify that each DDC controller communicates on its respective network correctly.

- A. After all of the points are verified, and power is available to the mechanical system, coordinate a startup of each system with the mechanical contractor. Include the following tests:
- B. Start systems from DDC.
- C. Verify that each setpoint can be met by the system.
- D. Change setpoints and verify system response.
- E. Change sensor readings to verify system response.
- F. Test safety shutdowns.
- G. Verify time delays.
- H. Verify mode changes.
- I. Adjust filter switches and current switches for proper reactions.
- J. Adjust proportional bands and integration times to stabilize control loops.

Perform all program changes and debugging of the system for a fully operational system.

Verify that all graphics at the operator workstations correspond to the systems as installed. Verify that the points on the screens appear and react properly. Verify that all adjustable setpoints and manual commands operate from the operator workstations.

Setup and test alarms described in the sequence of operation and points summary.

After the sequence of operation is verified, setup the trends that are listed in the sequence of operations and points summary for logging and archiving.

SYSTEM COMMISSIONING, DEMONSTRATION AND TURNOVER

Functional Testing: The BAS Contractor shall demonstrate functional aspects for the owner engineer testing all aspects of controls operation including modes, control loops, alarm functions, trending and time of day scheduling. This process will occur until engineer and owner acceptance has been obtained.

Control System Commissioning: If specified, the BAS contractor shall conduct functional testing in accordance with commissioning specifications

- A. 019100 General commissioning Requirements
- B. 230800 Commissioning of Mechanical System

The BAS contractor shall fix punch list items within 30 days of acceptance.

When the system performance is deemed satisfactory in whole or in part by these observers, the system parts will be accepted for beneficial use and placed under warranty.

User Occupancy Meeting: The BAS contractor shall prepare documentation describing thermostat operation, thermal zoning, and user operation for owners use during user occupancy presentation.

Pre - User Occupancy Testing: Prior to user occupancy and after testing and balance activities are complete, BAS contractor shall conduct a pre-user occupancy test period that last one week. During the test period BAS contractor defines temporary trending and alarm conditions (beyond what has been specified) in an attempt to verify operation and reveal hidden functional issues. Contractor will call the project each day for 1 full week to check trending, alarms and search for issues. At the end of the week, BAS contractor shall submit to engineer for review observations made during the week and trend documentation showing issues or function.

Post user occupancy Monitoring: Temporary trending and alarms are removed and for a period of one month, the BAS contractor calls the project each morning and searches for issues such as untuned loops, poor system response, temperature, humidity or pressure that are out of range. In addition, BAS contractor optimizes system setpoints for efficiency comfort. During the user occupancy monitoring period, BAS contractor submits to the engineer, weekly reports containing observations on his activities.

PROJECT RECORD DOCUMENTS

Project Record Documents: Submit three (3) copies of record (as-built) documents upon completion of installation. Submittal shall consist of:

- A. Project Record Drawings. As-built versions of the submittal shop drawings provided as AutoCAD compatible files in electronic format and as 11 x 17 inch prints.
- B. Testing and Commissioning Reports and Checklists submitted electronically in PDF format. Completed versions of reports, checklists, and trend logs used to meet requirements in the Control System Demonstration and Acceptance section of this specification.
- C. Operation and Maintenance (O & M) Manual submitted electronically in PDF format.
 - 2. As-built versions of the submittal product data.
 - 3. Names, addresses, and 24-hour telephone numbers of installing contractors and service representatives for equipment and control systems.
 - 4. Operator's Manual with procedures for operating control systems, logging on and off, handling alarms, producing point reports, trending data, overriding computer control, and changing setpoints and variables.
 - 5. Programming manual or set of manuals with description of programming language and of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
 - 6. Engineering, installation, and maintenance manual or set of manuals that explains how to design and install new points, panels, and other hardware; how to perform preventive maintenance and calibration; how to debug hardware problems; and how to repair or replace hardware.
 - 7. Documentation of all programs created using custom programming language, including setpoints, tuning parameters, and object database.
 - 8. Graphic files, programs, and database on electronic media.

9. List of recommended spare parts with part numbers and suppliers.
10. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware, including computer equipment and sensors.
11. Complete original original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
12. Licenses, guarantees, and warranty documents for equipment and systems.

Operating manual to serve as training and reference manual for all aspects of day-to-day operation of the system submitted electronically in PDF format. As a minimum include the following:

- A. Sequence of operation for automatic and manual operating modes for all building systems. The sequences shall cross-reference the system point names.
- B. Description of manual override operation of all control points in system.
- C. BMS system manufacturers complete operating manuals.

Provide maintenance manual to serve as training and reference manual for all aspects of day-to-day maintenance and major system repairs. As a minimum include the following:

- A. Complete as-built installation drawings for each building system.
- B. Overall system electrical power supply schematic indicating source of electrical power for each system component. Indicate all battery backup provisions.
- C. Photographs and/or drawings showing installation details and locations of equipment.
- D. Routine preventive maintenance procedures, corrective diagnostics troubleshooting procedures, and calibration procedures.
- E. Parts list with manufacturer's catalog numbers and ordering information.
- F. Lists of ordinary and special tools, operating materials, supplies and test equipment recommended for operation and servicing.
- G. Manufacturer's operation, set-up, maintenance and catalog literature for each piece of equipment.
- H. Maintenance and repair instructions.
- I. Recommended spare parts.

Provide Programming Manual to serve as training and reference manual for all aspects of system programming. As a minimum include the following:

- A. Complete programming manuals, and reference guides.
- B. Details of any custom software packages and compilers supplied with system.
- C. Information and access required for independent programming of system.
- D. If owner already possess items listed above, then do not provide another copy.

TRAINING

During System commissioning and at such time as acceptable performance of the Building Automation System hardware and software has been established, the BAS contractor shall provide on-site operator instruction to the owner's operating personnel. Operator instruction during normal working hours shall be performed by a competent building automation contractor representative familiar with the Building Automation System's software, hardware and accessories.

Training Plan: Contactor shall submit for approval by owner's representative and engineer, a training agenda describing who will be conducting training, documentation used, and training topics. Training may not proceed until agenda has been approved by owner's representative and

engineer.

At a time mutually agreed upon, during System commissioning as stated above, the BAS contractor shall give 16-hours (or approved lesser amount of hours) of onsite training on the operation of all BAS equipment. Describe its intended use with respect to the programmed functions specified. Operator orientation of the automation system shall include, but not be limited to:

- A. Explanation of drawings and operator's maintenance manuals.
- B. Walk through of the job to locate all control components.
- C. Operator workstation and peripherals.
- D. BLC Controller and ASC operation/sequence.
- E. Operator control functions including scheduling, alarming, and trending.
- F. Explanation of adjustment, calibration and replacement procedures.

Additional 8-hours of training shall be given after the 30 day power user occupancy period.

END OF SECTION

23 21 13 HYDRONIC PIPING

PART 1 GENERAL**RELATED DOCUMENTS**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specifications, apply to this Section.

SUMMARY

This Section includes piping, special-duty valves, and hydronic specialties for hot-water heating, chilled-water cooling and condenser water systems; makeup water for these systems; blowdown drain lines; and condensate drain piping.

Related Section include the following:

- A. Division 23 Section "Basic Mechanical Materials and Methods" for general piping materials and installation requirements.
- B. Division 23 Section "Hangers and Supports" for pipe supports, product descriptions and installation requirements. Hanger and support spacing is specified in this Section.
- C. Division 23 Section "Valves" for general-duty gate, globe, ball, butterfly and check valves.
- D. Division 23 Section "Meters and Gages" for thermometers, flow meters and pressure gages.
- E. Division 23 Section "Mechanical Identification" for labeling and identifying hydronic piping.
- F. Division 23 Section "HVAC Instrumentation and Controls" for temperature-control valves and sensors.

SUBMITTALS:

Product Data: For each type of special-duty valve indicated. Include flow and pressure drop curves based on manufacturer's testing for diverting fittings, calibrated balancing valves, and automatic flow-control valves.

Shop Drawings: Detail fabrication of pipe anchors, hangersn special pipe support assemblies, alignment guides, expansion joints and loops, and their attachment to the building structure. Detail locatin of anchors, alignment guides and expansion joints and loops.

Grooved Joint Couplings and Fittings: Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.

Welding Certificate: Copies of certificates for welding procedures and personnel.

Field Test Reports: Written reports of tests specified in Part 3 of this Section. Include the following:

- A. Test procedures used.
- B. Test results that comply with requirements.
- C. Failed test results and corrective action taken to achieve requirements.

Maintenance Data: For hydronic specialties and special-duty valves to include in maintenance manuals specified in Division 1.

QUALITY ASSURANCE

Welding: Qualify processes and operators according to the ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

Grooved Joint Couplings and Fittings: All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

- A. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

COORDINATION

Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression system components, and partition assemblies.

Coordinate pipe sleeve installation for foundation wall penetrations.

Coordinate piping installation with roof curbs, equipment supports and roof penetrations.

Coordinate pipe pressure classes with products specified in related Sections.

Coordinate size and location of concrete bases. Cast anchor bolt inserts into base.

PART 2 PRODUCTS

MANUFACTURERS:

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- A. Grooved Mechanical-Joint Fittings and Couplings:
 - 1. Central Sprinkler Company; Central Grooved Piping Products.
 - 2. Grinnell Corporation.
 - 3. Victaulic Company of America.
- B. Calibrated Balancing Valves:
 - 1. Armstrong Pumps, Inc.
 - 2. Flow Design, Inc.
 - 3. ITT Bell & Gossett.
 - 4. Taco, Inc.
 - 5. Victaulic / TA Hydronics.

PIPING MATERIALS:

General: Refer to Part 3 "Piping Applications" Article for applications of pipe and fitting materials.

COPPER TUBE AND FITTINGS:

Drawn-Tempered Copper Tubing: ASTM B 88, Type L.

Wrought-Copper Fittings and Unions: ASME B16.22.

Solder Filler Metals: ASTM B 32, 95-5 tin antimony.

Brazing Filler Metals: AWS A5.8, Classification Bag-1 (silver).

STEEL PIPE AND FITTINGS:

Steel Pipe, NPS 2" and smaller: ASTM A 53, Type S (seamless), Grade A, Schedule 40, black steel, plain or grooved ends.

Steel Pipe, NPS 2-1/2" through NPS 12: ASTM A 53, Type E (electric-resistance welded, ERW), Grade A, Schedule 40, black steel, plain or grooved ends.

Steel Pipe Nipples: ASTM A 733, made of ASTM A 53, Schedule 40, black steel; seamless for NPS 2" and smaller and ERW for NPS 2-1/2" and larger.

Cast-Iron Threaded Fittings: ASME B16.4, Classes 125 and 250.

Malleable-Iron Threaded Fittings: ASME B16.3, Classes 125 and 250.

Malleable-Iron Unions: ASME B16.39, Classes 150, 250 and 300.

Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125 and 250; raised ground face and bolt holes spot faced.

Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts and gaskets for the following material group, end connections and facings:

- A. Material Group: 1.1.
- B. End Connections: Butt welding.
- C. Facings: Raised face.

Grooved Mechanical-Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 53, Type E or S, Grade B factory-fabricated steel; or ASTM A 234, Grade WPB wrought steel fittings with grooves or shoulders designed to accept grooved end couplings.

Grooved Mechanical-Joint Couplings: Two ductile iron housings and synthetic rubber gasket of central cavity pressure-responsive design; with nuts and bolts to secure grooved end fittings and valves.

- A. Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
 - 1. 2" through 8": Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to +250 deg F. Victaulic Style 107H.
 - 2. Victaulic Zero-Flex Style 07.

- B. Flexible Type: For use in locations where vibration attenuation and stress relief are required. Three flexible couplings may be used in lieu of a flexible connector. Victaulic Installation-Ready Style 177 or Style 77.
- C. 14" through 24": Victaulic AGS series with lead-in chamfer on housing key and wide width FlushSeal® gasket.
 - 1. Rigid Type: Housing key shall fill the wedge shaped AGS groove and provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9. Victaulic Style W07.
 - 2. Flexible Type: Housing key shall fit into the wedge shaped AGS groove and allow for linear and angular pipe movement. Victaulic Style W77.
- D. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 150 flanged components. Victaulic Style 741 / W741.

Flexible Connectors (up to NPS 4"): Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150 psig minimum working pressure and 250 deg. F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4" misalignment.

Flexible Connector, Grooved Joint Couplings (NPS 2" and larger): Three Victaulic flexible couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief. The couplings shall be placed in close proximity to the source of the vibration.

Welding Materials: Comply with Section II, Part C, of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

Gasket Material: Thickness, material and type suitable for fluid to be handled; and design temperatures and pressures.

Grooved Joint Lubricants: Lubricate gaskets in accordance with the manufacturer's recommendations with lubricant supplied by the coupling manufacturer that is suitable for the gasket elastomer and system media. Basis of Design: Victaulic 'Vic-Lube'.

VALVES:

Globe, check, ball and butterfly valves are specified in Division 23 Section "Valves."

Refer to Part 3 "Valve Applications" Article for applications of each valve.

Calibrated Balancing Valves, NPS 2" and smaller: Bronze body, ball or globe type, 250 psig working pressure, 230 deg. F maximum operating temperature and having threaded ends. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals, and be equipped with a memory stop to retain set position.

Calibrated Balancing Valves, NPS 2-1/2" and Larger: Cast-iron, ductile-iron, copper-alloy, or steel body, globe or ball type, 300 psig working pressure, 230 deg. F operating temperature and having flanged or grooved connections. Valves shall have calibrated orifice or venturi, connections for portable differential pressure meter with integral seals and be equipped with a memory stop to retain set position.

HYDRONIC SPECIALTIES:

Manual Air Vents: Bronze body and nonferrous internal parts, 150 psig working pressure, 225 deg. F operating temperature, manually operated with screwdriver or thumbscrew with NPS 1/8 discharge connection and NPS 1/2 inlet connection.

Automatic Air Vent: Designed to vent automatically with float principle, bronze body and nonferrous internal parts, 150 psig operating pressure, 240 deg. F operating temperature, with NPS 1/4 discharge connection and NPS 1/2 inlet connection.

Y-Pattern Strainers: 300 psig working pressure, ductile-iron body (ASTM A536 Grade 65-45-12) with grooved ends, or cast-iron body (ASTM A 126, Class B), flanged ends for NPS 2-1/2" and larger, threaded connections for NPS 2" and smaller, bolted cover, perforated stainless-steel basket and bottom drain connection.

Flexible Connectors (up to NPS 4"): Stainless steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket; 150 psig minimum working pressure and 250 deg. F maximum operating temperature. Connectors shall have flanged or threaded-end connections to match equipment connected and shall be capable of 3/4" misalignment.

Flexible Connector, Grooved Joint Couplings (NPS 2" and larger): Three Victaulic flexible couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief. The couplings shall be placed in close proximity to the source of the vibration.

PART 3 EXECUTION

PIPING APPLICATIONS:

Hot and Chilled Water, NPS 2" and Smaller: Aboveground, use Type L drawn-temper copper tubing with soldered joints, Schedule 40 steel pipe with threaded joints, or Schedule 5S stainless steel pipe with Vic-Press joints. Below ground or within slabs, use Type K annealed-tempered copper tubing with soldered joints. Joints below ground or within slabs is not permitted.

Hot and Chilled Water, NPS 2-1/2" and Larger: Schedule 40 steel pipe with welded or grooved joints.

Condenser Water: Schedule 40 steel pipe with welded or grooved joints or Schedule 80 CPVC with solvent welded joints.

Condensate Drain Lines: Type L drawn-tempered copper tubing with soldered joints.

VALVE APPLICATIONS:

General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:

- A. Shutoff Duty: Ball and butterfly.
- B. Throttling Duty: Globe, ball and butterfly.

Install shutoff duty valves at each branch connection to supply mains and at supply and return connections to each piece of equipment.

Install calibrated balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

Install check valves at each pump discharge and elsewhere as required to control flow direction.

Install safety valves at each pump discharge and elsewhere as require by the ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping, without valves, to floor drain. Comply with the ASME Boiler and Pressure Vessel Code, Section VIII, Division 1, for installation requirements.

Install pressure-reducing valves on hot-water generators and elsewhere as required to regulate system pressure.

PIPING INSTALLATIONS:

Refer to Division 23 Section "Basic Mechanical Materials and Methods" for basic piping installation requirements.

Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

Install drains, consisting of a tee fitting, NPS 3/4" ball valve and short NPS 3/4" threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.

Install piping at a uniform grade of 0.2 percent upward in direction of flow.

Reduce pipe sizes using eccentric reducer fitting installed with level side up.

Unless otherwise indicated, install branch connections to mains using tee fittings in main pipe, with the takeoff coming off the top of the main pipe at a 45 degree angle. For up-feed risers, install the takeoff coming out the top of the main pipe.

Install strainers on supply side of each control valve, pressure-reducing valve, solenoid valve, in-line pump and elsewhere as indicated. Install NPS 3/4" nipple and ball valve in blowdown connection of strainers NPS 2" and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2".

HANGERS AND SUPPORTS:

Hanger, support and anchor devices are specified in Division 23 Section "Hangers and Supports." Comply with requirements below for maximum spacing of supports.

Install the following pipe attachments:

- A. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.

Install hangers for copper tubing, steel, and ductile iron with the following maximum spacing:

- A. 1-1/2" NPS (DN40) and Smaller: Maximum horizontal spacing, 60 inches (1500 mm); maximum vertical spacing, 10 feet (3 m).
- B. 2" through 2-1/2" NPS (DN50 to DN65): Maximum horizontal spacing, 72 inches (1800 mm); maximum vertical spacing, 10 feet (3 m).
- C. 3" NPS (DN80) and Larger: Maximum horizontal spacing, 10 feet (3 m); maximum vertical spacing, 10 feet (3 m).

Minimum rod size to be according to manufacturer's written instructions for service conditions base on maximum hanger spacing.

Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

PIPE JOINT CONSTRUCTION:

Refer to Division 23 Section "Basic Materials and Methods" for joint construction requirements for soldered and brazed joints in copper tubing; threaded, welded and flanged joints in steel piping.

Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

Install Vic-Press 304™ in accordance with Victaulic recommendations. Pipe shall be certified for use with the Vic-Press 304™ system, square cut (+/-0.030"), properly deburred, and cleaned. Pipe ends shall be marked with a gauge supplied by Victaulic. Use a Victaulic 'PFT' series tool with the proper sized jaw for pressing.

HYDRONIC SPECIALTIES INSTALLATION:

Install manual air vents at high points in piping, at heat transfer coils and elsewhere as required for system air venting.

Install automatic air vents at air separator and elsewhere as indicated with drain to floor drain.

Install flexible connectors at equipment in locations where vibration attenuation and stress relief are required.

TERMINAL EQUIPMENT CONNECTIONS:

Size for supply and return piping connections shall be same as for equipment connections.

Install control valves in accessible locations close to connected equipment.

Install ports for pressure and temperature gages at coil inlet and outlet connections.

FIELD QUALITY CONTROL:

Prepare hydronic piping according to ASME B31.9 and as follows:

- A. Leave joints, including welds, uninsulated and exposed for examination during test.
- B. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
- C. Flush system with clean water. Clean strainers after each flush.
 - . Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
- E. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

Perform the following tests on hydronic piping:

- A. Use ambient temperature water as a testing medium unless there is a risk of freezing. Another liquid that is safe for workers and compatible with piping may be used.
- B. While filling system, use vents installed at high points of system to release trapped air. Use drains installed at low points for complete draining of liquid.
- C. Check expansion tanks to determine that they are not air bound and that the system is full of water.
- D. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the design pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve or other component i system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed either 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A of ASME B31.9, "Building Services Piping."
- E. After hydrostatic test pressure has been applied for at least 12 hours, examine piping, joints, and connections for leakage. Eliminate leaks and repeat test until there are no leaks.
- F. Prepare written report of testing.

ADJUSTING:

Mark calibrated nameplates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

Perform these adjustments before operating the system:

- A. Open valves to fully open position.
- B. Check air vents at high points of system and determine if all are installed and operation freely (automatic type), or bleed air completely (manual type).
- E. Set temperature controls so all coils are calling for full flow.
- F. Check and set operating temperatures of boilers, chillers and cooling towers to design requirements.
- H. Lubricate motors and bearings.

CLEANING:

Flush hydronic piping systems with clean water. Remove and clean or replace strainer screens. After cleaning and flushing hydronic piping system, but before balancing, remove disposable fine-mesh strainers in pump suction diffusers.

END OF SECTION

23 25 00 HVAC WATER TREATMENT

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY

This Section includes water-treatment systems for the following:

- A. Chilled-water piping (closed-loop system).
- B. Heating-water piping (closed-loop system).

CHEMICAL FEED SYSTEM DESCRIPTION

Closed-Loop System: One injection piping connection on each system with isolating and drain valves downstream from circulating pumps, unless otherwise indicated.

PERFORMANCE REQUIREMENTS

Maintain water quality for HVAC systems that controls corrosion and build-up of scale and biological growth for maximum efficiency of installed equipment without posing a hazard to operating personnel or the environment.

Base chemical treatment performance requirements on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

Closed System: Maintain system essentially free of scale, corrosion, and fouling.

SUBMITTALS

Product Data: Include rated capacities; water-pressure drops; shipping, installed, and operating weights; and furnished products listed below:

- A. Chemicals.

Shop Drawings: Detail equipment assemblies indicating dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

Wiring Diagrams: Detail power and control wiring and differentiate between manufacturer-installed and field-installed wiring.

Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

QUALITY ASSURANCE

Installer Qualifications: An experienced installer who is an authorized representative of the chemical treatment manufacturer for both installation and maintenance of chemical treatment equipment required for this Project.

MAINTENANCE

Scope of Service: Provide chemicals and service program for maintaining optimum conditions in the circulating water for inhibiting corrosion, scale, and organic growths in the cooling, chilled-water piping and heating, hot-water piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, including the following:

- A. Initial water analysis and recommendations.
- B. Startup assistance.
- C. Periodic field service and consultation.
- D. Customer report charts and log sheets.
- E. Laboratory technical assistance.
- F. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

EXTRA MATERIALS

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

Chemicals: Furnish quantity for one year of operation from the date of Substantial Completion.

PART 2 PRODUCTS**MANUFACTURERS**

Manufacturers: Subject to compliance with requirements, provide products by one of the following:

HVAC Water-Treatment Products:
Swander.

CHEMICALS

Furnish chemicals recommended by water-treatment system manufacturer that are compatible with piping system components and connected equipment.

System Cleaner: Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products.

Biocide: Chlorine release agents or microbiocides.

Closed-Loop, Water Piping Chemicals: Sequestering agent to reduce deposits and adjust pH, corrosion inhibitors, and conductivity enhancers.

PART 3 EXECUTION

WATER ANALYSIS

Perform an analysis of supply water to determine the type and quantities of chemical treatment needed to maintain the water quality as specified in "Performance Requirements" Article.

INSTALLATION

Install treatment equipment level and plumb.

Add cleaning chemicals as recommended by manufacturer.

END OF SECTION

23 31 13 METAL DUCTS

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes rectangular, round, and flat-oval metal ducts and plenums for heating, ventilating, and air-conditioning systems in pressure classes from **minus 2- to plus 10-inch wg (minus 500 to plus 2490 Pa)**.

Related Sections include the following:

- A. Division 23 Section "Mechanical Insulation" for duct insulation.
- B. Division 23 Section "Duct Accessories" for dampers, sound-control devices, duct-mounted access doors and panels, turning vanes, and flexible ducts.
- C. Division 23 Section "Air Terminals" for constant-volume and variable-air-volume control boxes, and reheat boxes.
- D. Division 23 Section "Control Systems Equipment" for automatic volume-control dampers and operators.
- E. Division 23 Section "Testing, Adjusting, and Balancing" for air balancing and final adjusting of manual-volume dampers.

DEFINITIONS:

Thermal Conductivity and Apparent Thermal Conductivity (k-Value): As defined in ASTM C 168. In this Section, these values are the result of the formula $\text{Btu} \times \text{in.}/\text{h} \times \text{sq. ft.} \times \text{deg F}$ or $\text{W}/\text{m} \times \text{K}$ at the temperature differences specified. Values are expressed as Btu or W.

- A. Example: Apparent Thermal Conductivity (k-Value): 0.26 or 0.037.

SYSTEM DESCRIPTION:

Duct system design, as indicated, has been used to select and size air-moving and -distribution equipment and other components of air system. Not all fittings and offsets are indicated on the plans and it is assumed that the Contractor is to include these to accommodate minor changes required for coordination and installation of duct system. Significant changes to layout or configuration of duct system must be specifically approved in writing by Engineer/Architect. Accompany requests for layout modifications with calculations showing that proposed layout will provide original design results without increasing system total pressure.

SUBMITTALS:

Product Data: For duct liner and sealing materials.

Shop Drawings: Show details of the following:

- A. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.

- B. Duct layout indicating pressure classifications and sizes on plans.
- C. Fittings.
- D. Reinforcement and spacing.
- E. Seam and joint construction.
- F. Penetrations through fire-rated and other partitions.
- G. Terminal unit, coil, and humidifier installations.
- H. Hangers and supports, including methods for building attachment, vibration isolation, seismic restraints, and duct attachment.

Record Drawings: Indicate actual routing, fitting details, reinforcement, support, and installed accessories and devices.

QUALITY ASSURANCE:

Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," unless otherwise indicated.

Comply with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems," unless otherwise indicated.

DELIVERY, STORAGE, AND HANDLING:

Deliver sealant and firestopping materials to site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, pot life, curing time, and mixing instructions for multicomponent materials.

Store and handle sealant and firestopping materials according to manufacturer's written recommendations.

Deliver and store stainless-steel sheets with mill-applied adhesive protective paper maintained through fabrication and installation.

PART 2 PRODUCTS

SHEET METAL MATERIALS:

Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for 36-inch (900-mm) length or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

DUCT LINER:

General: Comply with NFPA 90A or NFPA 90B and NAIMA's "Fibrous Glass Duct Liner Standard."

Materials: ASTM C 1071 with coated surface exposed to airstream to prevent erosion of glass fibers.

- A. Thickness: 1 inch (25 mm) on all supply and return ductwork.
- B. Thermal Conductivity (k-Value): 0.26 at 75 deg F (0.037 at 24 deg C) mean temperature.
- C. Fire-Hazard Classification: Maximum flame-spread rating of 25 and smoke-developed rating of 50, when tested according to ASTM C 411.
- D. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916.
- E. Mechanical Fasteners: Galvanized steel, suitable for adhesive attachment, mechanical attachment, or welding attachment to duct without damaging liner when applied as recommended by manufacturer and without causing leakage in duct.
 - 1. Tensile Strength: Indefinitely sustain a 50-lb- (23-kg-) tensile, dead-load test perpendicular to duct wall.
 - 2. Fastener Pin Length: As required for thickness of insulation and without projecting more than 1/8 inch (3 mm) into airstream.
 - 3. Adhesive for Attaching Mechanical Fasteners: Comply with fire-hazard classification of duct liner system.
- H. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Certainteed (ToughGard R)
 - 2. Manson (Akousti-Liner)
 - 3. Manville (Line Acoustic)

SEALANT MATERIALS:

Joint and Seam Sealants, General: The term "sealant" is not limited to materials of adhesive or mastic nature but includes tapes and combinations of open-weave fabric strips and mastics.

- A. Joint and Seam Tape: 2 inches (50 mm) wide; glass-fiber fabric reinforced.
- B. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with tape to form a hard, durable, airtight seal.
- C. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant, formulated with a minimum of 75 percent solids.
- D. Flanged Joint Mastics: One-part, acid-curing, silicone, elastomeric joint sealants, complying with ASTM C 920, Type S, Grade NS, Class 25, Use O.

HANGERS AND SUPPORTS:

Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for building materials.

- A. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
 - 1. Exception: Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

Hanger Materials: Galvanized, sheet steel or round, threaded steel rod.

- A. Hangers Installed in Corrosive Atmospheres: Electrogalvanized, all-thread rod or galvanized rods with threads painted after installation.
- B. Straps and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for sheet steel width and thickness and for steel rod diameters.

Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

Trapeze and Riser Supports: Steel shapes complying with ASTM A 36/A 36M.

- A. Supports for Galvanized-Steel Ducts: Galvanized steel shapes and plates.

RECTANGULAR DUCT FABRICATION:

General: Fabricate ducts, elbows, transitions, offsets, branch connections, and other construction with galvanized, sheet steel, according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible." Comply with requirements for metal thickness, reinforcing types and intervals, tie-rod applications, and joint types and intervals.

- A. Lengths: Fabricate rectangular ducts in lengths appropriate to reinforcement and rigidity class required for pressure classification.
- B. Materials: Free from visual imperfections such as pitting, seam marks, roller marks, stains, and discolorations.

Static-Pressure Classifications: Unless otherwise indicated, construct ducts to the following:

- A. Supply Ducts: 3-inch wg (750 Pa).
- B. Return Ducts: 2-inch wg (500 Pa), negative pressure.
- C. Exhaust Ducts: 2-inch wg (500 Pa), negative pressure.

Cross Breaking or Cross Beading: Cross break or cross bead duct sides 19 inches (480 mm) and larger and 0.0359 inch (0.9 mm) thick or less, with more than 10 sq. ft. (0.93 sq. m) of unbraced panel area, unless ducts are lined.

SHOP APPLICATION OF LINER IN RECTANGULAR DUCTS:

Adhere a single layer of indicated thickness of duct liner with 90 percent coverage of adhesive at liner contact surface area. Multiple layers of insulation to achieve indicated thickness are prohibited.

Apply adhesive to liner facing in direction of airflow not receiving metal nosing.

Butt transverse joints without gaps and coat joint with adhesive.

Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

Do not apply liners in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and standard liner product dimensions make longitudinal joints necessary.

Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).

Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely around perimeter; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profile or are integrally formed from duct wall. Fabricate edge facings at the following locations:

- A. Fan discharge.
- B. Intervals of lined duct preceding unlined duct.
- C. Upstream edges of transverse joints in ducts.

Secure insulation liner with perforated sheet metal liner of same metal thickness as specified for duct, secured to ducts with mechanical fasteners that maintain metal liner distance from duct without compressing insulation.

- A. Sheet Metal Liner Perforations: **3/32-inch (2.4-mm)** diameter, with an overall open area of 23 percent.

Terminate liner with duct buildouts installed in ducts to attach dampers, turning vane assemblies, and other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct wall with bolts, screws, rivets, or welds. Terminate liner at fire dampers at connection to fire-damper sleeve.

ROUND AND FLAT-OVAL DUCT FABRICATION:

General: Diameter as applied to flat-oval ducts in this Article is the diameter of the size of round duct that has a circumference equal to perimeter of a given size of flat-oval duct.

Round Ducts: Fabricate supply ducts of galvanized steel according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

Flat-Oval Ducts: Fabricate supply ducts with standard spiral lock seams or with butt-welded longitudinal seams according to SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

Double-Wall (Insulated) Ducts: Fabricate double-wall (insulated) ducts with an outer shell and an inner liner. Dimensions indicated on internally insulated ducts are inside dimensions.

- A. Thermal Conductivity (k-Value): **0.26 at 75 deg F (0.037 at 24 deg C)** mean temperature.
- B. Outer Shell: Base outer-shell metal thickness on actual outer-shell dimensions. Fabricate outer-shell lengths **2 inches (50 mm)** longer than inner shell and insulation, and in metal thickness specified for single-wall duct.
- C. Insulation: **1-inch- (25-mm-)** thick fibrous-glass insulation, unless otherwise indicated. Terminate insulation where internally insulated duct connects to single-wall duct or uninsulated components. Terminate insulation and reduce outer duct diameter to inner liner diameter.
- D. Solid Inner Liner: Fabricate round and flat-oval inner liners with solid sheet metal of thickness listed below:
- E. Perforated Inner Liner: Fabricate round and flat-oval inner liners with sheet metal having **3/32-inch- (2.4-mm-)** diameter perforations, with an overall open area of 23 percent. Use the following sheet metal thicknesses and seam construction:
 - 2. Ducts **3 to 8 Inches (75 to 200 mm)** in Diameter: **0.019 inch (0.5 mm)** with standard spiral seam construction.
 - 3. Ducts **9 to 42 Inches (225 to 1070 mm)** in Diameter: **0.019 inch (0.5 mm)** with single-rib spiral seam construction.
- F. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

ROUND AND FLAT-OVAL SUPPLY AND EXHAUST FITTING FABRICATION:

90-Degree Tees and Laterals and Conical Tees: Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," with metal thicknesses specified for longitudinal seam straight duct.

Diverging-Flow Fittings: Fabricate with a reduced entrance to branch taps with no excess material projecting from body onto branch tap entrance.

Elbows: Fabricate in die-formed, gored, pleated, or mitered construction. Fabricate bend radius of die-formed, gored, and pleated elbows one and one-half times elbow diameter. Unless elbow construction type is indicated, fabricate elbows as follows:

- A. Mitered-Elbow Radius and Number of Pieces: Welded construction complying with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible," unless otherwise indicated.
- B. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from **minus 2- to plus 2-inch wg (minus 500 to plus 500 Pa)**:
 1. Ducts **3 to 26 Inches (75 to 660 mm)** in Diameter: **0.028 inch (0.7 mm)**.
 2. Ducts **27 to 36 Inches (685 to 915 mm)** in Diameter: **0.034 inch (0.85 mm)**.
- C. Round Mitered Elbows: Welded construction with the following metal thickness for pressure classes from **2- to 10-inch wg (500 to 2490 Pa)**:
 1. Ducts **3 to 14 Inches (75 to 355 mm)** in Diameter: **0.028 inch (0.7 mm)**.
 2. Ducts **15 to 26 Inches (380 to 660 mm)** in Diameter: **0.034 inch (0.85 mm)**.
 3. Ducts **27 to 50 Inches (685 to 1270 mm)** in Diameter: **0.040 inch (1.0 mm)**.
- B. Flat-Oval Mitered Elbows: Welded construction with same metal thickness as longitudinal seam flat-oval duct.
- C. 90-Degree, Two-Piece, Mitered Elbows: Use only for supply systems, or exhaust systems for material-handling classes A and B; and only where space restrictions do not permit using 1.5 bend radius elbows. Fabricate with single-thickness turning vanes.
- D. Round Elbows, **8 Inches (200 mm)** and Smaller: Fabricate die-formed elbows for 45- and 90-degree elbows and pleated elbows for 30, 45, 60, and 90 degrees only. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with gored construction.
- E. Round Elbows, **9 through 14 Inches (225 through 355 mm)**: Fabricate gored or pleated elbows for 30, 45, 60, and 90 degrees, unless space restrictions require a mitered elbow. Fabricate nonstandard bend-angle configuration or nonstandard diameter elbows with gored construction.
- F. Round Elbows, Larger Than **14 Inches (355 mm)**, and All Flat-Oval Elbows: Fabricate gored elbows, unless space restrictions require a mitered elbow.
- G. Die-Formed Elbows for Sizes through **8 Inches (200 mm)** and All Pressures: **0.040 inch (1.0 mm)** thick with two-piece welded construction.
- H. Round Gored-Elbow Metal Thickness: Same as non-elbow fittings specified above.
- I. Flat-Oval Elbow Metal Thickness: Same as longitudinal seam flat-oval duct specified above.
- J. Pleated Elbows for Sizes through **14 Inches (355 mm)** and Pressures through **10-Inch wg (2490 Pa)**: **0.022 inch (0.55 mm)**.

Double-Wall (Insulated) Fittings: Fabricate double-wall (insulated) fittings with an outer shell and an inner liner. Dimensions indicated on internally insulated ducts are inside dimensions.

- A. Thermal Conductivity (k-Value): **0.26 at 75 deg F (0.037 at 24 deg C)** mean

temperature.

- B. Outer Shell: Base outer-shell metal thickness on actual outer-shell dimensions. Fabricate outer-shell lengths **2 inches (50 mm)** longer than inner shell and insulation. Use the same metal thicknesses for outer duct as for uninsulated fittings.
- C. Insulation: **1-inch- (25-mm-)** thick fibrous-glass insulation, unless otherwise indicated. Terminate insulation where internally insulated duct connects to single-wall duct or uninsulated components. Terminate insulation and reduce outer duct diameter to nominal single-wall size.
- D. Solid Inner Liner: Fabricate round and flat-oval inner liners with solid sheet metal of thickness listed below:
- E. Perforated Inner Liner: Fabricate round and flat-oval inner liners with sheet metal having **3/32-inch- (2.4-mm-)** diameter perforations, with an overall open area of 23 percent. Use the following sheet metal thicknesses:
 - 2. Ducts **3 to 34 Inches (75 to 865 mm)** in Diameter: **0.028 inch (0.7 mm)**.
 - 3. Ducts **35 to 58 Inches (890 to 1475 mm)** in Diameter: **0.034 inch (0.85 mm)**.
- F. Maintain concentricity of liner to outer shell by mechanical means. Retain insulation from dislocation by mechanical means.

PART 3 EXECUTION

DUCT INSTALLATION, GENERAL:

Duct installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts, fittings, and accessories.

Construct and install each duct system for the specific duct pressure classification indicated.

Install round and flat-oval ducts in lengths not less than **12 feet (3.7 m)**, unless interrupted by fittings.

Install ducts with fewest possible joints.

Install fabricated fittings for changes in directions, changes in size and shape, and connections.

Install couplings tight to duct wall surface with a minimum of projections into duct.

Install ducts, unless otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs.

Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

Install ducts with a clearance of **1 inch (25 mm)**, plus allowance for insulation thickness.

Conceal ducts from view in finished spaces. Do not encase horizontal runs in solid partitions, unless specifically indicated.

Coordinate layout with suspended ceiling, fire- and smoke-control dampers, lighting layouts, and similar finished work.

Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

Non-Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same metal thickness as duct. Overlap opening on four sides by at least **1-1/2 inches (38 mm)**.

Fire-Rated Partition Penetrations: Where ducts pass through interior partitions and exterior walls, install appropriately rated fire damper, sleeve, and firestopping sealant. Fire and smoke dampers are specified in Division 15 Section "Duct Accessories." Firestopping materials and installation methods are specified in Division 7 Section "Firestopping."

INSULATION:

Provide duct liner on all rectangular supply and return ductwork. All dimensions of ductwork shown on the plans are the required clear interior dimensions unless noted otherwise.

SEAM AND JOINT SEALING:

General: Seal duct seams and joints according to the duct pressure class indicated and as described in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

Pressure Classification Less Than **2-Inch wg (500 Pa)**: Transverse joints.

Seal externally insulated ducts before insulation installation.

HANGING AND SUPPORTING:

Install rigid round, rectangular, and flat-oval metal duct with support systems indicated in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

Support horizontal ducts within **24 inches (600 mm)** of each elbow and within **48 inches (1200 mm)** of each branch intersection.

Support vertical ducts at a maximum interval of **16 feet (5 m)** and at each floor.

Install upper attachments to structures with an allowable load not exceeding one-fourth of failure (proof-test) load.

Install concrete inserts before placing concrete.

Install powder-actuated concrete fasteners after concrete is placed and completely cured.

CONNECTIONS:

Connect equipment with flexible connectors according to Division 23 Section "Duct Accessories."

For branch, outlet and inlet, and terminal unit connections, comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

ADJUSTING:

Adjust volume-control dampers in ducts, outlets, and inlets to achieve design airflow.

Refer to Division 23 Section "Testing, Adjusting, and Balancing" for detailed procedures.

CLEANING:

After completing system installation, including outlet fittings and devices, inspect the system. Vacuum ducts before final acceptance to remove dust and debris.

END OF SECTION

23 33 00 DUCT ACCESSORIES

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes the following:

- A. Manual-volume dampers.
- B. Turning vanes.
- C. Duct-mounted access doors and panels.
- D. Flexible connectors.
- E. Duct accessory hardware.

Related Sections include the following:

- A. Division 23 Section "Air Terminals" for constant-volume and variable-air-volume control boxes, and reheat boxes.
- B. Division 23 Section "Control Systems Equipment" for electric and pneumatic damper actuators.

SUBMITTALS:

Product Data: For the following:

- A. Manual-volume dampers.
- B. Duct-mounted access doors and panels.

QUALITY ASSURANCE:

NFPA Compliance: Comply with the following NFPA standards:

- A. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
- B. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

PART 2 PRODUCTS**SHEET METAL MATERIALS:**

Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.

Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for 36-inch (900-mm) length or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

Low Pressure Supply Ductwork: 2-inch static pressure classification (i.e., after FPVAV's, SAV's and on low pressure AHU's). Medium pressure supply ductwork to have a 4-inch static pressure classification (i.e., VAV systems).

MANUAL-VOLUME DAMPERS:

General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.

- A. Pressure Classifications of 3-Inch wg (750 Pa) or Higher: End oilite bearings for ducts with 3/8" axles full length of damper blades and bearings at both ends of operating shaft. Extended quadrant locks with 3/8" dial regulators and end extended bearing plates for externally insulated ductwork. Rectangular ducts 20" and wider same as above with 16 Ga. blades, 1/2" axles and dial regulators. (Equal to Ruskin MD25/MDRS25)

Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, and suitable for horizontal or vertical applications.

- A. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
- B. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized, sheet steel.
- C. Blade Axles: Galvanized steel.
- D. Tie Bars and Brackets: Galvanized steel.

Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, and suitable for horizontal or vertical applications.

- A. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
- B. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized, sheet steel.
- C. Blade Seals: Neoprene.
- D. Blade Axles: Galvanized steel.
- E. Tie Bars and Brackets: Galvanized steel.

Jackshaft: 1-inch- (25-mm-) diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.

- A. Length and Number of Mountings: Appropriate to connect linkage of each damper of a multiple-damper assembly.

Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

TURNING VANES:

Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."

Manufactured Turning Vanes: Fabricate of 1-1/2-inch- (38-mm-) wide, curved blades set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set

into side strips suitable for mounting in ducts.

DUCT-MOUNTED ACCESS DOORS AND PANELS:

General: Fabricate doors and panels airtight and suitable for duct pressure class.

Frame: Galvanized, sheet steel, with bend-over tabs and foam gaskets.

Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel. Include 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.

Size: Size door to be 2-inches smaller than side of duct installed on, with a maximum size of 24- by-24-inch.

Seal around frame attachment to duct and door to frame with neoprene or foam rubber.

Insulation: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

FLEXIBLE CONNECTORS:

General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.

Transverse Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to two strips of 4-3/8-inch- (111-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.

Conventional, Indoor System Flexible Connector Fabric: Glass fabric double coated with polychloroprene.

- A. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
- B. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp, and 360 lbf/inch (63 N/mm) in the filling.

ACCESSORY HARDWARE:

Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness.

Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches (75 to 450 mm) to suit duct size.

Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

INSTALLATION:

Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal.

Install volume dampers in lined duct; avoid damage to and erosion of duct liner.

Manual volume dampers are to be provided in duct runouts for all diffusers, grilles, and registers. Damper to be located at the main duct take-off. Locations where grilles and registers are mounted directly on the main duct an opposed blade damper (OBD) is to be provided.

Provide test holes at fan inlet and outlet and elsewhere as indicated.

Install duct access panels for access to both sides of duct coils. Install duct access panels downstream from volume dampers, fire dampers, turning vanes, and equipment.

- A. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining accessories and terminal units.
- B. Install access panels on side of duct where adequate clearance is available.

Label access doors according to Division 23 Section "Mechanical Identification."

ADJUSTING:

Adjust duct accessories for proper settings.

Final positioning of manual-volume dampers is specified in Division 23 Section "Testing, Adjusting, and Balancing."

END OF SECTION

23 36 13 AIRFLOW CONTROL TERMINALS

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes the following:

- A. Venturi air terminals.

Related Sections include the following:

- A. Division 23 Section "Duct Insulation" for external insulation of air terminals.
- B. Division 23 Section "Control Systems Equipment" for control devices installed on air terminals.

SUBMITTALS:

Product Data: Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories for each model indicated. Include a schedule showing drawing designation, room location, number furnished, model number, size, and accessories furnished.

Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

- A. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

Maintenance Data: List of parts for each type of air terminal and troubleshooting maintenance guide to include in the maintenance manuals specified in Division 1.

QUALITY ASSURANCE:

Product Options: Drawings and schedules indicate requirements of air terminals and are based on specific systems indicated. Other manufacturers' systems with equal performance characteristics may be considered. Refer to Division 1 Section "Substitutions."

Listing and Labeling: Provide electrically operated air terminals specified in this Section that are listed and labeled.

- A. The Terms "Listed" and "Labeled": As defined in NFPA 70, Article 100.
- B. Listing and Labeling Agency Qualifications: A "Nationally Recognized Testing Laboratory" as defined in OSHA Regulation 1910.7.

NFPA Compliance: Install air terminals according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

Comply with NFPA 70 for electrical components and installation.

PART 2 PRODUCTS

MANUFACTURERS:

Manufacturers: Subject to compliance with requirements, provide air terminals by one of the following:

- A. CRC.
- B. Triatek.

AIRFLOW CONTROL SYSTEM:

General:

The Airflow Control System will control the Primary and Secondary Room containment zones. The system is to maintain volumetric offset to achieve room pressurization in relation to adjacent spaces. The system is to provide temperature, humidity, and environmental control while maintaining minimum ventilation rates as per design schedule.

- A. Devices to include an integrated room controller. Each user interface shall communicate clear, unambiguous indication of the current room condition and mode in plain language via full color touch screen.
- B. All room level control shall be hardwired inputs and outputs. Systems utilizing network communication or proprietary communication languages shall not be accepted. Controllers shall be configurable through local touch screen display(s) and not require additional proprietary software for setup or commissioning.
- C. Each area shall have a dedicated system to operate stand-alone from the building automation system. System shall not use or rely on information from controllers in other areas to control functions within its space.

Control Strategies:

Airflow control shall be volumetric offset to maintain secondary containment and pressurization.

- A. The system shall continuously measure the sum of all exhaust air valves and the sum of all supply air valves and maintain a constant offset based on measured airflows.
- B. Volumetric offset tracking shall ensure supply air set point is determined from measured total exhaust airflow. Systems utilizing independent set points not based on measured values shall not be acceptable.
- C. The system shall maintain proper room pressurization regardless of any change in room/system conditions or changes in duct static pressure. Systems achieving room pressurization control by means of direct pressure control are unacceptable.

Temperature control shall utilize dual loop and variable ventilation rates to maintain temperature.

- A. The system shall use dual loop temperature control on all rooms serving critical spaces to maintain consistent room temperatures regardless of air volume changes.
- B. The system shall continuously measure both room temperature and supply air duct temperature. The system shall continuously modulate reheat valve based on difference in calculated supply air duct temperature set point and the measured room temperature.

- C. The system shall modulate the reheat valve closed on a call for cooling and then modulate the general exhaust air valve from minimum to maximum ventilation set point until the room temperature set point is met.
- D. The system shall modulate the reheat valve open on a call for heating after modulating the general exhaust air valve to minimum ventilation set point until the room temperature set point is met.
- E. The system shall maintain the reheat valve position last commanded to achieve proper heat load in the space.
- F. The system shall maintain the ventilation set point last commanded to achieve proper cooling load in the space.

Equipment:

Room shall consist of one controller for room level control. Each air valve shall not require a controller for the system to operate.

- A. Controller shall utilize analog signals (scaled voltage) to control air valves. Room level networks shall not be acceptable.
- B. Controller shall be BACnet native, BTL Listed, and utilize BACnet MS/TP communication protocol for integration.
- C. Controller shall be application specific for volumetric offset control and not require logic-based programming.
- D. Controller shall be configurable through local environmental condition display (password protection optional).
- E. Controller shall serve as power source for all sensors within the system.
- F. Controller shall support up to five modes that each have customizable parameters, alarms, set points, etc.

Environmental Condition Display:

- A. The display shall be wall mounted and capable to be mounted up to 200' from controller.
- B. Each display shall be a 5-inch resistive touch screen display capable of sensing touch with a gloved hand.
- C. The controller shall support multiple display formats for environmental condition with information in an icon or pill-based display. Refer to project plans for display types.
- D. Pressure Monitor view with full color background and icon for room condition. Points of information accessible from slider bar at bottom of display.
- E. User Defined Modes:
 - 1. 15-character customizable name text.
 - 2. Background color customizable, including, but not limited to; green, blue, red, yellow, grey, etc.
 - 3. Monitor icon customizable, including, but not limited to; patient bed, surgeon mask, beaker, stop hand, caution triangle, mop, etc.
 - 4. Customizable set points per mode
 - 5. Modes shall be able to be changed locally from display, through the building automation system or through hardware signal.
- F. Displayed Information
 - 1. The room pressure monitor shall have the ability to display 28 points of information.
 - 2. Each point shall be fully customizable from the display
 - 3. Each point shall include:
 - i) 15-character customizable point name
 - ii) Engineering unit customizable: including, but not limited to, CFM, "WC, ACH, %, °, etc.

- iii) Resolution selection of 0 to 0.0000
 - iv) Ability to hide, show or adjust set points
 - v) Customizable alarm parameters
4. Displayed information shall be configurable from (14) analog inputs and/or writable through the building automation system.

Alarm and Security:

The monitor shall include audible and visual alarming customizable for each point of information, including, but not limited to; low pressure, high pressure, emergency condition, temperature, humidity, ACH, etc.

Each point of information within the room pressure monitor shall have ability to enable or disable alarming for each user defined mode.

Each point of information within the room pressure monitor shall have user defined alarm delay.

- A. During alarm delay the display shall have visual indication of point outside alarm parameters.

The display and/or through the BAS, shall have the ability to mute alarms while maintaining visual alarm state.

The display shall have the ability to alarm individual point or entire display screen; with the screen alarm being a pulsated visual.

Each display shall utilize four levels of password-protected access. Different levels of secure access shall include: administrative, mode change, more information, and set point.

Each display shall include up to three unique user passwords and each user be configurable for level of access.

Building Automation System (BAS) Interface:

The environmental condition display shall allow BAS to write points of information to be displayed.

The environmental condition display shall allow settings adjustments over the building network, including, but not limited to; set point, alarm parameters, modes, etc.

The BMS shall use either analog inputs, digital inputs, or utilize BACnet network protocol to view points or status of the room being measured. The use of BACnet protocol shall be native to the device and shall not require the use of an external gateway.

The display shall include the ability to change MAC address, device instance ID, and baud rate (9600, 19200, 38400, 76800, 115200) without the use of rotary dial or dip switches.

Controller shall modulate exhaust airflow between minimum and maximum airflow rates scheduled in Air Valve Device Schedules.

The controller shall share the measured CFM through scaled voltage (0-10VDC) hardwire and not rely on network communication to room level device.

The controller shall utilize field characterization of the venturi air valve to ensure speed of response.

During In Use operation, display will have a green background and display current mode, current face velocity (FPM) or air volume (CFM), sash opening, alarms, operating conditions and indication of status. If the fume hood is not maintaining proper operation, the FHC will have red background, indicate loss of flow and audible alarm. When in alarm, monitor will prompt user to close sash.

Venturi Air Valves

Valve type shall be closed loop precision feedback venturi anemometer through manifolded venturi sensing.

Direct pressure measurement by means of dead ended silicon imbedded glass sensing device. Thermal based pressure measurement devices are not acceptable.

Flow sensing that bisects and/or obstructs the duct shall not be acceptable.

The valve shall be pressure independent over a static pressure range of minimum of .005" to 5" W.C.

Shall not be limited by air velocity and will produce an airflow signal throughout full open to full shutoff.

Shall not be limited by minimum duct air velocities for flow signal.

No inlet or outlet duct diameters shall be required for accuracy and/or pressure independence.

Suppliers of airflow devices requiring minimum duct diameters will provide revised duct layouts showing the straight duct runs upstream and downstream of these devices. In addition, suppliers shall include static pressure loss calculations as part of their submittals. All costs to modify the ductwork, increase fan sizes and horsepower and all associated electrical changes shall be the responsibility of the system supplier.

Valve shall have no axis of orientation mounting requirement for accuracy and/or pressure independence.

Air valve shall be capable of a turndown of 10:1 maintaining an accuracy of $\pm 5\%$ of measured flow.

Airflow measuring devices that require a minimum velocity for flow feedback shall provide a secondary flow measurement device for velocities below published manufactures minimum.

Valves shall be capable of being mounted in any position and orientation.

Based on application the air valve shall be manufactured as follows:

- A. Non-corrosive (Supply, Return and General Exhaust): The valve shall be constructed from 16-gauge aluminum or Galvanized body. The valve shall have 316 stainless steel single blade elliptical damper mounted on a solid stainless-steel shaft with corrosive resistant shaft bearings.
- B. The venturi airflow device shall be capable of shutoff with leakage $< 0.05\%$ of maximum designed air valve flow at 6" W.C.

- C. The valve response signal shall be < 25 milliseconds.
- D. The venturi airflow valve shall achieve 90% of desired set point in < 1 second.
- E. Airflow valves shall be low pressure designed to operate at maximum static pressure drop of 0.3" W.C.
- F. Airflow valves shall be configured for FAIL-SAFE operation where required.
- G. Electric modulating actuator shall be factory mounted. Valve shall have fast acting actuators, FAIL-SAFE as required by the system.
- H. Floating point actuators are not acceptable.

Room Pressure Monitoring:

The room pressure sensor shall hardwire to the system and not require additional controller and/or display within the space.

The room pressure sensor shall continuously monitor bi-directional room pressure between the associated referenced space.

The room pressure sensor shall be capable to be mounted up to 250 feet from pressure pickup plates.

The room pressure sensor shall utilize industrial quality differential pressure transducer technology.

Pressure sensing technology shall be direct pressure measurement by means of dead ended silicon imbedded glass sensing device to measure differential.

Implied pressure measurement systems utilizing thermal hot wire, thermal mass air velocity measurement, metallic diaphragm or non-dead ended are not acceptable.

Pressure sensor shall not be integral to room pressure monitor.

The pressure sensor shall be capable of replacement without removing room pressure monitor.

Room pressure monitor suppliers with pressure sensing integral to monitor shall include one (1) monitor/sensor for every five (5) monitors required for project.

The room pressure sensor shall be factory calibrated with NIST traceable standards.

The room pressure sensor shall be individually calibrated for installed and scheduled range.

The room pressure sensors that catalogue accuracy based on larger transducer ranges will not be accepted.

Sensing accuracy statement shall include the effects of non-linearity, non repeatability, hysteresis, zero offset and span setting errors.

Accuracy statements and claims that use the (RSS) root sum squares of non-linearity (BFSL), non-repeatability and hysteresis or exclude zero offset and span setting errors are not acceptable.

The room pressure sensor shall be dead ended to protect from the effects of dust, dirt and lint. Sensors with elements exposed to the airstream are not acceptable.

PART 3 EXECUTION**INSTALLATION:**

Install airflow control terminals level and plumb, according to manufacturer's written instructions, rough-in drawings, original design, and referenced standards; and maintain sufficient clearance for normal service and maintenance.

Connect ductwork to air terminals according to Division 23 ductwork Sections.

CONNECTIONS:

Electrical: Comply with applicable requirements in Division 16 Sections.

Ground equipment.

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. Where manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

FIELD QUALITY CONTROL:

Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

CLEANING:

After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes.

COMMISSIONING:

Verify that installation of each air terminal is according to the Contract Documents.

Check that inlet duct connections are as recommended by air terminal manufacturer to achieve proper performance.

Check that controls and control enclosure are accessible.

Verify that control connections are complete.

Check that nameplate and identification tag are visible.

Verify that controls respond to inputs as specified.

DEMONSTRATION:

Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in the maintenance manuals. Refer to Division 1 Section "Contract Closeout."

- C. Review data in the maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
- D. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

END OF SECTION

15 854 CENTRAL STATION AIR HANDLERS

PART 1 GENERAL**RELATED DOCUMENTS:**

Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

SUMMARY:

This Section includes central station air handling units with coils for indoor and outdoor installations.

Related Sections: The following Sections contain requirements that relate to this Section:

- A. Division 23 Section "Mechanical Insulation" for field-applied equipment insulation.

SUBMITTALS:

General: Submit each item in this Article according to the Conditions of the Contract and Division 1 Specification Sections.

Product Data for each central-station air-handling unit specified, including the following:

- A. Certified coil-performance ratings with system operating conditions indicated.

Shop Drawings from manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

It is the responsibility of the Contractor to verify available space to install and service the equipment. Equipment larger than the area allocated for the equipment and servicing will not be accepted.

Maintenance data for central station air handling units to include in the operation and maintenance manual specified in Division 1 Sections and Division 23 Section "Basic Mechanical Requirements."

DELIVERY, STORAGE, AND HANDLING:

Deliver air-handling unit as a factory-assembled module with protective crating and covering.

Lift and support units with manufacturer's designated lifting or supporting points.

SEQUENCING AND SCHEDULING:

Coordinate size and location of concrete housekeeping bases. Cast anchor-bolt inserts into base.

Coordinate size and location of structural-steel support members.

EXTRA MATERIALS:

Filters: Furnish 2 sets for each central-station air-handling unit with filter section modifications.

PART 2 PRODUCTS

MANUFACTURED UNITS:

General Description: Factory assembled, consisting of fans, motor and drive assembly, coils, damper, plenums, filters, drip pans, and mixing dampers.

CABINET:

Materials: All sections to be double-wall solid construction except the fan section which is to be double-wall perforated formed and reinforced G90 galvanized steel panels with a complete frame, fabricated to allow removal for access to internal parts and components, with joints between sections sealed. Removal of side panels must not affect the structural integrity of the unit.

6" Base Rail: Minimum 10 gauge galvanized steel support channel shall be provided for the entire length of unit. Match base rail on existing units.

Insulation: Coated, glass-fiber insulation, complying with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," for insulation.

- A. Thickness: 1-1/2 lb./sq.ft.
- B. Location and Application: Factory applied with adhesive and mechanical fasteners to the internal surface of section panels downstream from and including the cooling coil section.

COILS:

Coil Sections: Common or individual, insulated, galvanized steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to assure full airflow through coils. Maximum coil size to be 4'-0" x 11'-6" face area. The Mechanical Contractor is responsible to connect to all coils that are part of a coil section with proper balancing and isolation valves per each coil.

- A. Fins: Aluminum, mechanically bonded to tubes.
- B. Tubes: Seamless copper with minimum 0.025" wall thickness.
- C. Coil Casing: Galvanized steel.
- D. Headers for Steam and Water Coils: Steel, cast iron, or copper with connections for drain valve and air vent, and threaded piping connections.

Water Coils: Drainable with threaded plugs, serpentine with return bends in smaller sizes and with return headers in larger sizes.

Coil-Performance Tests: Factory-test cooling and heating coils, except sprayed surface coils for rating according to ARI 410, "Forced Circulation Air Cooling and Air Heating Coils."

FILTER SECTION:

Filters: Comply with NFPA 90A.

Filter Section: Provide filter media holding frames arranged for angular orientation, with access doors on both sides of unit.

PART 3 EXECUTION

EXAMINATION:

Examine areas and conditions to receive equipment, for compliance with installation tolerances and other conditions affecting performance of central station air handling units.

Do not proceed with installation until unsatisfactory conditions have been corrected.

INSTALLATION:

Install central station air handling units level and plumb, according to manufacturer's written instructions.

- A. Floor-Mounted Units: Support on concrete housekeeping bases using housed-spring isolators. Secure units to anchor bolts installed in concrete housekeeping base.

HOUSEKEEPING BASES:

Coordinate size of housekeeping bases with actual unit sizes provided. Construct base 4 inches (100 mm) larger in both directions than overall dimensions of supported unit.

Install reinforcing bars, tied to frame, and place anchor bolts and sleeves to facilitate securing units.

Place concrete and allow to cure before installing units. Use portland cement conforming to ASTM C 150, 4000-psi (27.6-MPa) compressive strength, and normal-weight aggregate.

Clean exposed steel form according to SSPC-SP 2 or SSPC-SP 3 and apply 2 coats of rust-preventive metal primer.

CONNECTIONS:

Connect condensate drain pans using Type M copper tubing. Size per Manufacturers recommendations or Code, whichever is most stringent. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

Hot and Chilled Water Piping: Conform to applicable requirements of Division 15 Section "Hydronic Piping." Connect to supply and return coil tapings with shutoff valve and union or flange at each connection.

ADJUSTING:

Adjust damper linkages for proper damper operation.

CLEANING:

After completing installation, inspect exposed finish. Remove burrs, dirt, and construction debris, and repair damaged finishes including chips, scratches, and abrasions.

Vacuum clean fan wheels, cabinets, and coils entering air face.

END OF SECTION

SECTION 26 00 00 - BASIC ELECTRICAL REQUIREMENTS**PART 1 - GENERAL****1.1 RELATED DOCUMENTS**

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to all Sections of Division 26, 27, and 28. All of the electrical related work required for this project (unless noted otherwise) is a part of the electrical contract price and is not necessarily specified under Division 26, 27, 28 or shown on the electrical drawings. Therefore, all divisions of this specification and all drawings shall be consulted. The more stringent requirement of this specification (or drawings) shall be followed; regardless of what division or section the more stringent requirement resides.

1.2 SUMMARY

- A. This Section includes the following:
- a. Related Documents.
 - b. Summary.
 - c. References.
 - d. General.
 - e. Submittal Information.
 - f. Quality Assurance, Regulations, and Codes.
 - g. Coordination.
 - h. Permits and Fees.
 - i. Electrical demolition.
 - j. Renovation and Remodel.
 - k. Cutting and patching for electrical construction.
 - l. Painting.
 - m. Aligning, Adjusting and Testing.
 - n. Substitution of Equipment.
 - o. Materials Approved as Equal.
 - p. As-built Drawings.
 - q. Operating Instructions, Brochures, and Manuals.
 - r. Punch-list and Final Inspection.
 - s. Guarantee.

1.3 REFERENCES

- A. The latest edition of the following standards and codes, standard publications of professional organizations, and the local authorities having jurisdiction are the minimum requirements for this work.
- a. American National Standards Institute (ANSI).
 - b. American Society for Testing and Materials (ASTM).
 - c. Association of Edison Illuminating Companies (AEIC).
 - d. Code of Federal Regulations (CFR).
 - e. Insulated Cable Engineer's Association (ICEA).
 - f. Institute of Electrical and Electronic Engineers (IEEE).
 - g. National Electrical Manufacturer's Association (NEMA).
 - h. National Fire Protection Association (NFPA).

- i. NFPA 70, the National Electrical Code (NEC).
- j. Underwriters' Laboratories, Inc. (UL).
- k. State, City, and Local Authorities.

1.4 GENERAL

- A. The Electrical Contractor shall furnish all labor; materials, tools, transportation, equipment, services and facilities, required for the complete and proper installation of all electrical work specified within the contract documents. The electrical installation shall include all materials, devices, apparatus, and equipment as specified herein, as shown on the drawings, AND as required for a complete and operational system.
- B. Experienced, qualified, licensed electricians shall install the entire electrical system in a first class, workmanlike manner. The electrical system shall be left completely connected and ready to give continuous, trouble-free service.
 - a. TO ENSURE THAT ONLY QUALIFIED AND RESPONSIBLE BIDS ARE CONSIDERED, SUBMIT THE FOLLOWING INFORMATION ATTACHED TO THE BID FORM:
 - b. List the date of your company's incorporation, and the state of which the company is incorporated. List the number of years in business under current corporate name.
 - c. List your company's President, Vice-President(s), Treasurer's, and Secretary's names.
 - d. List jurisdictions and trade categories in which your organization is legally qualified to do business, and indicate registration or license numbers of company and all personnel who plan to work on this project.
 - e. List the category of work your organization normally performs with its own forces.
 - f. Claims & Suits: List any judgments, claims, arbitration proceedings, suits, or disputes (previous or ongoing) against your organization or its officers. List any arbitration proceedings or suits (previous or ongoing) that your organization has filed with regard to construction contracts within the last five years.
 - g. List, within the last five years, any officers of your organization that were officers of another organization that failed to complete a construction contract.
 - h. List the name of the job foreman that will be assigned to this project and include his/her work history with the company and with any previous companies. List this persons construction experience and present commitments of other projects. List any other key individuals of your organization who will be assigned to this project.
 - i. List a minimum of Five (5) previous projects of similar size and characteristics to this project, which were completed by your organization and the foreman listed above. Provide the name of each project, owner, architect, contract amount, project location, and the date project was completed.
 - j. List all major construction projects that your organization has in progress, giving the name of project, owner, architect, contract amount, percent complete and scheduled completion date.
 - k. State the total amount of work in progress and under contract by your company at time of submitting bid for this project.
 - l. State average annual amount of construction work performed during the past five years.
 - m. References: Provide a minimum of Three (3) Trade References.
- C. The electrical drawings are shown in a schematic form (unless specifically dimensioned) and are intended to show only the approximate locations of devices, and equipment. This does not grant the contractor permission to locate devices and equipment as he sees fit.

- a. Exact equipment locations, device placement, and conduit routings are not specified on the drawings (unless dimensioned) and shall be governed by structural conditions, ceiling/wall panel spacing, base cabinets, permanent furniture and other obstructions.
 - b. Full coordination of all work and consultation of all drawings shall be required to avoid possible interference with other trades. The architectural plans shall be consulted to determine space availability for electrical equipment prior to rough in.
 - c. The Architect reserves the right to make any reasonable change in the location of apparatus, outlets and equipment up to the time of rough in, without any additional expense to the Owner. Relocating a receptacle outlet 6ft. in any direction is considered a reasonable change.
- D. Any damage to the building or elements of the building including other trades work (accidental or intentional) caused by or originating from the Contractor shall be repaired at the cost of the Contractor.
- E. All electrical components shall be installed per the respective manufacturer's installation instructions.

1.5 SUBMITTAL INFORMATION

- A. The Electrical Contractor shall submit electronic submittals in PDF format which shall include the following information:
- a. On front cover provide the name and address of the Project, the Architect, the Engineer, and the Contractor. List the name and telephone number for the Electrical Contractor assigned to the project.
 - b. Adequate description(s) of product submitted – Manufacturer's name, catalog number, technical data, shop drawings, pictures, etc. Include wiring diagrams, photometries, and test reports as required.
 - c. Instructions for the operation and maintenance of the equipment prepared by the manufacturer.
 - d. Complete parts list for each equipment item.
 - e. Clearly marked catalog logic indicating mounting, finishes, capacities, sizes, options, etc.
 - f. Identification mark or nomenclature relating each submitted item to the drawings (when applicable). For example, Panel "A", Light Fixture Type "B", or Special Outlet No. 1.
- B. The submittal review performed by the Architect-Engineer shall not include verification or approval of quantities indicated on the submittal. All submittal approvals relate to the product's conformance with the contract documents only.
- C. All submittals must be reviewed, verified, and approved by the ELECTRICAL contractor before the Architect or Engineer will review same. Submittals reviewed and stamped by the General Contractor only, will be returned. The ELECTRICAL contractor's stamp and signature on each submittal shall indicate the Contractors review. The Contractor shall return all submittals, which do not meet the specifications, to the supplier for correction before submitting to the Engineer or Architect. Only those materials specified, approved, or otherwise indicated by the contract documents will be permitted on this project.
- D. The Architect-Engineer's submittal approval will not relieve the Contractor from his responsibilities to full-fill the contract documents. All deviations from the contract documents associated with submittals must be called to the Engineer's attention at time of submission and must also be approved by the Owner or his representative.

- E. Shop drawings shall be submitted on wiring devices, conduit, boxes, wire, light fixtures (includes LED drivers, ballasts & lamps), light poles, switchgear (includes distribution and branch circuit panelboards, starters and disconnects), and all special systems (fire alarm, intercom, clocks, sound, security, telephone, data, etc.). Refer to each respective division 26 section for additional submittal requirements.
- F. Electronic Autocad files (.dwg) may be made available to the successful contractor for the sole purpose of creating submittal drawings related to this project. The Contractor shall execute a Cad Release agreement and submit a fee equal to \$100 per drawing sheet, prior to receiving the files.

1.6 QUALITY ASSURANCE, REGULATIONS, & CODES

- A. All Electrical Components, Devices, Equipment, and Accessories installed under this contract shall be listed and labeled by Underwriters Laboratories, Inc. (UL). Materials, which are not covered by UL shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use. The Architect/Engineer must specifically approve materials that do not carry the UL label.
- B. All Electrical Components, Devices, Equipment, and Accessories installed under this contract shall be of the brand(s) specified herein, or approved as an equal by the Architect/Engineer within the contract documents. All materials and equipment furnished shall be new, free from defects, and of current production. Materials and equipment, which are no longer being produced, will not be acceptable.
- C. Each class of materials or equipment shall be of a single manufacturer. Do not intermix manufacturers of the same class of equipment. Manufacturers of all equipment shall have a permanent service organization, which will respond with service via telephone within 2 hours of request and in person (if necessary) within 24 hours of request.
- D. All electrical equipment and materials shall be received and stored by the Electrical Contractor in a manner which will protect the equipment and materials against physical damage, dirt, moisture, grease, etc. Conduit shall be kept closed and free of foreign objects.
- E. All electrical work shall comply with the latest rules and regulations of the National Electrical Code (NFPA 70), the Americans with Disabilities Act (ADA), the local ordinances (City, County, and State), the local utility companies and all other Boards, Codes, and Departments having jurisdiction. The electrical installation shall be performed in accordance with the latest Rules and Regulations of the Occupational Safety and Health Act (OSHA).
- F. All electrical work and material shown on the drawings or specified herein, which is determined to be in direct conflict with a code requirement or local ordinance, shall be provided and installed to meet the code or local ordinance. However, all electrical work indicated in the contract documents, which is determined to be in excess of code requirements or local ordinances, shall be performed as specified in the contract documents. Any deviations made from the plans and specifications in order to conform to codes, ordinances, laws, rules, or regulations shall be approved by the Architect and be made with no cost increase to the Owner. In cases where two or more codes have different levels of requirements (regarding the same topic), the more stringent code shall apply.

1.7 COORDINATION

- A. The electrical contractor shall visit the site and examine all existing conditions, which may affect work under his contract prior to bidding. Failure to visit the site and determine existing conditions is not a basis for additional compensation.
- B. Coordinate chases, slots, inserts, sleeves, and openings with general construction work and arrange in building structure during progress of construction to facilitate the electrical installations that follow.

- a. Set inserts and sleeves in poured-in-place concrete, masonry work, and other structural components as they are constructed.
- C. Sequence, coordinate, and integrate the installation of electrical materials and equipment for efficient flow of work among all other trades. Perform work in such an order that there will be no unnecessary delays or interference with other trade installations. Coordinate the installation of large electrical equipment requiring positioning before closing in the building. Coordinate closely with the Mechanical Contractor to allow for a clean and neat installation of conduit, cable tray, light fixtures, devices, plumbing, mechanical equipment, mechanical duct work, etc. above ceilings and in other concealed locations.
- D. Coordinate service connections to components and systems furnished by utility companies.
 - a. Coordinate installation and connection of exterior underground and overhead utilities and services, including provision for electricity-metering components with the utility company.
 - b. All electrical service entrance equipment and work shall comply with requirements of authorities having jurisdiction and of utility company providing electrical power.
 - c. The electrical contractor shall bear all expenses for the installation of the temporary and permanent electrical service to the building. These expenses include concrete filled guard posts around transformers and the installation of pedestals (when required by local utility company). The Electrical Contractor shall also pay for all deposits and reimbursements required for the service to the building.
 - d. The electrical contractor shall coordinate and bear all expenses involved in the complete telephone, internet, cable TV service conduit installations (include pull wire) per respective utility company requirements.
- E. Coordinate location of access panels and doors for electrical items that are concealed by finished surfaces. Access doors and panels are specified in Division 8 Section "Access Doors."
- F. Where electrical identification devices are applied to field-finished surfaces, coordinate installation of identification devices with completion of finished surface.
- G. Where acoustical ceilings and similar finishes will conceal electrical identification markings and devices, coordinate installation of these items before ceiling installation.

1.8 PERMITS AND FEES

- A. The Electrical Contractor shall pull all permits required for this project. He shall pay for all fees related to the certificates, permits, licenses, and inspections.
 - a. These items must be submitted to the Architect before final acceptance of the project is granted.

1.9 ELECTRICAL DEMOLITION

- A. Demolish (disconnect and remove) all electrical items as noted or shown on the drawings back to source. Sequence work with other trade demolition.
- B. The Electrical Contractor shall be responsible for all electrical demolition associated with architectural, structural, and mechanical demolition of this project. Refer to the architectural, structural and mechanical plans and specifications for areas/items required to be demolished. Verify all questionable electrical items with the General Contractor prior to demolition.
 - a. Remove all existing electrical equipment, devices, conduit, conductors, etc. associated with areas/items of demolition back to source.
 - b. Cut and cap abandoned raceways, which can not be entirely removed due to concrete encasement or other inaccessibility. Provide blank plates as required and/or patch to match existing adjacent surface(s).

- C. Remove all demolished electrical material from the site periodically to prevent damage to new equipment or injury to personnel.
- D. The Owner shall reserve the right to salvage any and all electrical components, which are removed by the Electrical Contractor during the demolition phase (unless specifically noted otherwise).
 - a. Coordinate with the Owner or his authorized representative prior to commencing with the demolition phase and verify which items are to be salvaged and returned to the Owner.

1.10 RENOVATION AND REMODEL

- A. The Electrical Contractor shall fully familiarize himself with the existing systems (electrical power, fire alarm, intercom, security, telephone, computer networking, sound, clocks, bells, etc.) of the building to be renovated or remodeled.
 - a. Consult existing system manufacturers for ALL interconnection requirements between new devices and existing systems. Verify all required parts, prior to bidding the job and notify the Architect/Engineer of all conflicts such as capacity, availability, or obsolescence.
 - b. The Electrical Contractor shall be responsible for providing and installing ALL components necessary to interconnect new devices to existing systems even though not specifically shown on the drawings or called out in the specifications.
- B. The Electrical Contractor shall be responsible for properly supporting (per N.E.C.) ALL existing conduit and cable encountered during the renovation process.
- C. Relocate all existing electrical items as shown on the drawings or as required by the Architect to facilitate work by other trades.
 - a. Relocate switches, fixtures, outlets, boxes, conduit, panelboards, and all other electrical components in order to meet the intent of the architectural plans (for example, relocate items where new doors are installed in existing walls).
 - b. Consult system manufacturers for specific requirements when applicable.
 - c. Provide and install all components required for the relocation of all electrical items (wire, cable, conduit, boxes, coverplates, fasteners, etc.).
 - d. Relocate all "special systems" components as required. For example, if a reception or office area is being relocated, all of the special systems associated with that area shall be relocated to the new reception or office.

1.11 CUTTING & PATCHING

- A. The Contractor shall be responsible for cutting and/or patching any building material necessary to complete the installation of the electrical system.
 - a. Use a "Concrete Termite" drill or "core" drill when drilling through concrete. Do not use a "hammer drill", "air hammer" or "star drill".
 - b. Use "link-seal" products by Thunderline Corporation after drilling through exterior basement or foundation walls.
- B. Qualified workmen of the trade involved shall do all cutting and patching.
- C. The Electrical Contractor shall pay for cutting and patching due to Electrical Contractors failure to coordinate at the time of rough in.

1.12 PAINTING

- A. All electrical raceways and equipment installed in finished areas (defined by the Architect) shall be painted in accordance with division 9 "painting" section (unless directed otherwise by the Architect).
- B. All electrical equipment requiring touch-up painting due to shipping and handling abuse or any other reason shall be painted to match the adjacent surface (color and quality).

1.13 ADJUSTING, ALIGNING AND TESTING

- A. The Electrical Contractor shall keep a calibrated voltmeter, ammeter, ground test meter, infrared scanner, and megohm meter on site and available at all times during construction hours.
Provide test readings as required by these specifications and as requested by the Engineer.
 - a. The electrical load shall be distributed equally across all phases from the service entrance equipment down to the smallest branch circuit panelboard. Keep a record of all adjustments and submit final voltage and amperage readings (each phase) to the Architect.
 - b. After the project is substantially completed, perform dielectric testing in accordance with the requirements of the National Electrical Code. The entire system shall test out to be free from short circuits and open circuits.
- B. Check, align, and adjust all components of the electrical system for optimum performance. Perform all tests required by these specifications – refer to each division 26 section for specific test requirements
- C. The Owner reserves the right to conduct independent Acceptance Tests on the electrical system as he sees fit. These tests, if performed, will be used to determine compliance of these specifications and will be conducted in the presence of the Architect/Engineer and Contractor. Notification of these independent tests will be given a minimum of five (5) working days prior to execution. The contractor shall correct all deficiencies in materials and workmanship revealed by the Acceptance Tests.

1.14 SUBSTITUTION OF EQUIPMENT

- A. After execution of the contract, substitutions of equipment manufacturers and/or material manufacturers shall be permitted only when the equipment and/or material specified cannot be delivered to the job in time to complete the work in proper sequence.
 - a. Any delay must originate beyond the control of the contractor; otherwise the substitution will not be approved.
 - b. The Electrical Contractor must make substitution requests in writing. Written requests shall be accompanied with documentation from the specified manufacturer and from the proposed manufacturer indicating equality, differences in price, and differences in delivery dates.
 - c. The Owner shall receive all credits associated with the approved substitution via change order.

1.15 MATERIALS APPROVED AS EQUAL

- A. All materials used for this project shall be provided as specified (manufacturer's name and model number) unless changes to the contract documents are formally made by written addendum prior to the opening of bids.

1.16 AS-BUILT DRAWINGS

- A. Prepare two (2) sets of blue-line or black-line electrical drawings showing in red ink ALL changes or deviations made from the original plan design. These changes marked in red ink shall also include all addendum items, change orders, etc.
 - a. These drawings shall be clean, neat and without tears or stains. Do not use the field set of drawings as these required As-Built drawings.
 - b. These drawings are to be submitted to the Engineer for review and will be forwarded to the Owner for his future reference.

1.17 OPERATING INSTRUCTIONS, BROCHURES, AND MANUALS

- A. The Electrical Contractor shall submit ALL operating instructions, brochures, instruction sheets, and manuals, which are provided with (or available with) new equipment to the Architect for transmittal to the Owner. Provide this information in a neat, organized format and present the information in a 3-ring binder. Label the front cover with the follow information:
 - a. "Electrical Operating Instructions, Brochures, and Manuals for Facility Systems"
 - b. Project Name and Address
 - c. Name and Address of Architect
 - d. Name and Address of Engineer
 - e. Name and Address of Contractor
 - f. Contractor's Telephone Number (including emergency number).
- B. Save all adjusting tools, wrenches, keys, etc. which may be provided with new equipment, and submit to the Architect for transmittal to the Owner.
- C. The Electrical Contractor and/or special systems sub-contractor shall also provide full explanation (as well as any written material) to the Owner regarding the operation, maintenance, and care of each special system. Special systems include Fire Alarm, Intercom, Clock, Sound, Intrusion Detection, Cable TV, and Voice/Data.

1.18 PUNCH-LIST AND FINAL INSPECTION

- A. An initial inspection will be performed upon written notification from the Contractor indicating that the job is complete. The Engineer will generate a punch-list after the initial inspection. This punch list will be transmitted to the contractor for execution.
 - a. The Electrical Contractor shall be present for the initial inspection and shall provide all tools, ladders, meters, instruments, etc. required for a complete and thorough inspection (removal of coverplates, panelboard covers, ceiling tiles, etc.).
- B. A Final Inspection by the Engineer will be performed after the contractor has executed all punch-list items.
 - a. The intent of the Final Inspection is for the Contractor and Architect-Engineer to verify that the completed project is in conformance with the contract documents.
 - b. The Electrical Contractor shall be present for the Final Inspection and shall again provide all tools, ladders, meters, instruments, etc. required for a complete and thorough inspection (removal of coverplates, panelboard covers, ceiling tiles, etc.).
 - c. Additional inspections by the Architect-Engineer due to incomplete or incorrect work will be charged to the Contractor at an hourly rate of \$120.00 per man-hour.

1.19 GUARANTEE

- A. This Contractor shall guarantee the entire electrical installation for a period of one (1) year. The one-year period will start on the date of final completion and acceptance (by the Architect).

- a. Should defective or faulty parts, components, equipment, etc. become evident within this one-year period, the Electrical Contractor shall correct and/or replace the defective component without cost to the Owner.
- b. In addition to defective components, the Electrical Contractor shall also guarantee the installation of the electrical system. The electrical work associated with this project is guaranteed by the Electrical Contractor to be first-class, executed by experienced workmen, and installed to comply with the contract documents. The Electrical Contractor shall correct all areas of the building showing poor workmanship or incomplete installations (such as loose joints & connections involving the raceways & conductors).

PART 2 - PRODUCTS (not applicable)

PART 3 - EXECUTION (not applicable)

END OF SECTION

SECTION 26 05 19 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES**PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes the following:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS**2.1 CONDUCTORS AND CABLES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Southwire Company
 - 2. General Cable Technologies Corporation
 - 3. Cerrowire LLC
 - 4. Encore Wire Corporation
 - 5. AFC Cable Systems
- B. Use Copper Conductors Only: UL-Listed, comply with NEMA WC 70. All conductor sizes are based on the use of copper materials and are code required minimum sizes. Conductor sizes exceeding ampacity requirements of the circuit are sized for voltage drop and shall be installed as indicated.
- C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN-2.
- D. Minimum Size: Wire smaller than No. 12 AWG shall not be used unless specifically indicated herein or on the drawings
 - 1. No. 14 AWG (or larger) copper, solid or stranded, 90° C. wire shall be permitted for control wiring applications. Where stranded conductors are used, provide with spade type insulated copper terminals.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hubbell Power Systems, Inc.
 - 2. O-Z/Gedney; EGS Electrical Group LLC.
 - 3. 3M; Electrical Products Division.
 - 4. Ideal Industries, Inc.
 - 5. ILSCO
- B. Description: UL-Listed, Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.
- C. Conductors smaller than or equal to No. 8 AWG are permitted to be spliced or tapped with spring pressure, screw-on, pre-insulated connectors rated for the circuit involved.
- D. Conductors larger than No. 8 AWG shall be spliced with compression connectors (fully insulated).

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders & Branch Circuits: **Copper**. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION, APPLICATIONS AND WIRING METHODS

- A. Service Entrance and all other underground circuits: Type THWN-2, single conductors in raceway.
- B. Feeders & Branch Circuits: Type THHN/THWN-2, single conductors in raceway.
- C. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainlesssteel, wire-mesh, strain relief device at terminations to suit application.
- D. Class 1 Control Circuits: Type THHN-THWN, in raceway.
- E. Class 2 Control Circuits: Type THHN-THWN, in raceway.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Install wires and cables as indicated, according to manufacturer's written instructions and NECA's "Standard of Installation."
- B. Conceal conductors & cables in finished walls, ceilings, and floors, unless otherwise indicated via raceway.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed conductors & cables (in raceway) parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- G. Identify and Color-code conductors and cables according to Section 260553 "Identification for Electrical Systems." Note: All conductors shall have fully colored, factory applied insulation.
- H. Seal around cables/raceways penetrating fire-rated elements according to Section 078413 to restore original fire-resistance rating of assembly. Seal cable and wire (between conduit and conductor) entering a building from underground where the conductor(s) exit the conduit, with a non-hardening compound listed for such use.
- I. Neatly form and tie all wires inside panelboards, cabinets, wireways, switches, equipment enclosures, etc.
- J. Install cable supports (split wedge type) inside raceways for all vertical feeder runs in accordance with the NFPA 70.
- K. Where quantities of conductors in a raceway system are not shown / missing on the drawings, provide the number as required to maintain function, control and number of circuits indicated.
- L. Do not share the neutral conductor across phases. Provide dedicated neutral conductor per phase conductor.
- M. Maximum of (3) 20A-1P branch circuits per raceway.
- N. Do not route branch circuits from one panelboard through another panelboard (can). All branch circuits shall exit the source panelboard via "homerun" raceway(s).

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.
- B. Electrical Connections: Connect outlets and components to wiring and to ground as indicated and instructed by manufacturer and per NFPA 70 Article 110.14. See receptacle wiring detail on drawings.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 8 **inches** of slack.
- D. All wires shall be routed within conduit, shall be of the same insulation type and shall be continuous between outlets and boxes (no splices or taps in conduit).
- E. Keep all splicing to a minimum. Splicing will not be allowed in panelboards, switchboards or other enclosures where the conductor(s) are to be terminated.
 - 1. Make splices and taps that are compatible with conductor material (copper) and that possess equivalent or better mechanical strength and insulation ratings than un-spliced conductors. All conductor splices larger than #6AWG shall be spliced using compression method insulated with a heavy wall shrink tubing.
 - 2. Unsatisfactory splices or terminations shall be re-worked as directed by the Engineer at no additional cost to the Owner.

3.6 FIELD QUALITY CONTROL

- A. Perform tests and inspections and prepare test reports.
- B. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test conductors for compliance with requirements.
 - 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Test electrical insulation using megger testing. Certify compliance with test parameters.
 - 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- C. Test Reports: Prepare a written report to record the following:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.
- D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY**

- A. This Section includes grounding of electrical systems and equipment. Grounding requirements specified in this Section may be supplemented by special requirements of systems described in other Sections.

1.2 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 and NFPA 70, Article 250 for grounding and bonding methods, materials and equipment.

PART 2 - PRODUCTS**2.1 CONDUCTORS**

- A. Insulated Conductors: Use only **Copper** wire or cable insulated for 600 V. Comply with Section 260519 Low Voltage Electrical Power Conductors and Cables.
 - 1. Equipment Grounding Conductors: Insulated with green-colored insulation.
 - 2. Isolated Ground Conductors: Insulated with green-colored insulation with yellow stripe. On feeders with isolated ground, use factory colored green w/yellow stripe, continuous over length of conductor.
- B. Grounding Electrode Conductors: #6 solid, larger sizes to be stranded cable
- C. Underground Conductors (exposed): Bare, tinned, stranded, unless otherwise indicated.
- D. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Tinned Conductors: ASTM B 33.
 - 4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
 - 5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.
 - 6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
 - 7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.
- E. Grounding Bus: Predrilled rectangular bars of annealed copper, **1/4 by 4 inches** in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

2.2 CONNECTORS

- A. Comply with IEEE 837 and UL 467; Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, pressure type with at least two bolts.
 - 1. Pipe Connectors: Clamp type, sized for pipe.

- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-bar Connectors: Mechanical type, cast silicon bronze, solderless **compression** type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.3 GROUNDING ELECTRODES

- A. Ground Rods: **Copper-clad steel; sectional type ¾"dia. by 10 feet (19 mm by 3 m).**

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: Install solid conductor for No. **8** AWG and smaller, and stranded conductors for No. **6** AWG and larger unless otherwise indicated.
- B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe.
- C. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors.
 - 3. Connections to Ground Rods: Welded connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING INSTALLATION

- A. General: At the service entrance equipment, bond the service entrance ground bus, the service entrance neutral bus, the secondary service neutral conductor, the service entrance grounding electrode conductor(s) and the service entrance enclosure together at the point of service disconnect per NFPA 70 Article 250. This will establish the Grounding Electrode System (GES). For remodel projects and building additions, the existing GES shall be verified to be installed per these specifications. Otherwise, provide & install additional grounding to meet specifications.
 - 1. Comply with NFPA 70, Article 250, for types, sizes, and quantities of equipment grounding conductors, unless specific types, larger sizes, or more conductors than required by NFPA 70 are indicated.
 - 2. Install equipment-grounding conductors in all feeder and branch circuit raceways.
 - 3. 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.
 - 4. 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.
- B. Ground Rods: Install at least two rods spaced at 10 feet apart.
 - 1. Drive ground rods until tops are 2 inches above finished floor or final grade, unless otherwise indicated.
 - 2. Interconnect ground rods with grounding electrode conductor and connect to the main service disconnect ground bus.
 - 3. Make all connections to the rods using exothermic welds, without exposing steel or damaging copper coating.

- C. Metal Water Service Pipe (supplemental ground): Provide #3/0 insulated copper grounding conductor, in conduit, from building's main service disconnect ground bus, to main metal water service entrance(s) to building using 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.
- D. Building Steel: Provide #3/0 insulated copper grounding conductor, in conduit, from building's main service disconnect ground bus, to the building steel.
- E. Building Foundation - Ufer: Provide a 20 ft. #3/0 bare copper grounding conductor, incased in the building footing and connected to the reinforcing rebar in at least four locations, from building's main service disconnect ground bus, to the building footing.
- F. All raceway bodies (conduit, nipples, wireways, troughs, gutters, etc.) housing phase conductors shall be provided with a full-length "green" insulated grounding/bonding conductor sized according to the respective phase conductors – per the latest edition of the National Electrical Code.
- G. Isolated Grounding Receptacle Circuits: Install an insulated equipment grounding conductor (green w/yellow stripe) connected to the receptacle grounding terminal. Isolate grounding conductor from raceway and from normal ground bus in panelboard grounding terminals. Terminate on isolated ground bus as indicated on plans. In addition to the isolated grounding conductor, install an equipment grounding conductor and bond to receptacle/outlet box.
- H. Signal and Communication Systems: In addition to grounding and bonding required by NFPA 70, provide a separate grounding system complying with requirements in TIA/ATIS JSTD-607-A. For telephone, alarm, voice and data, and other communication systems, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.
 - 1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4" x 2" x 12" grounding bus. Install on insulated spacers 2 inches minimum from wall, coordinate exact mounting heights and other requirements with communication system contractor.
 - 2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.
- I. Metal Poles Supporting Outdoor Lighting Fixtures: Provide a grounding electrode (rod) in addition to installing a separate equipment grounding conductor routed with supply branchcircuit conductors. Use exothermic welded connections for all ground rods. See pole base detail on plans.

3.3 LABELING

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems" for instruction signs. The label or its text shall be green.
- B. Install labels at the telecommunications bonding conductor and grounding equalizer and at the grounding electrode conductor where exposed.
 - 1. Label Text: "If this connector or cable is loose or if it must be removed for any reason, notify the facility manager."

3.4 CONNECTIONS

- A. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible.
 - 1. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - 2. Make connections with clean, bare metal at points of contact.
 - 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 at all ground rods: Comply with manufacturer's written instructions. Welds that are puffed up or that show convex surfaces indicating improper cleaning are not acceptable.
- C. Equipment Grounding Conductor Terminations: For No. 8 AWG and larger, use pressure-type grounding lugs. No. 10 AWG and smaller grounding conductors may be terminated with winged pressure-type connectors.
- D. Noncontact Metal Raceway Terminations: If metallic raceways terminate at metal housings without mechanical and electrical connection to housing, terminate each conduit with a grounding bushing. Connect grounding bushings with a bare grounding conductor to grounding bus or terminal in housing. Bond electrically noncontinuous conduits at entrances and exits with grounding bushings and bare grounding conductors, unless otherwise indicated. Typical application occurs where service entrance feeders stub up through slab with GRS raceways.
- E. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A.
- F. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
- G. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.

3.5 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections and prepare test reports:
1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected. Perform tests by using clamp-on ground resistance meter.
- B. Report measured ground resistances that exceed the following values:
1. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: **10** ohms.
 2. Power and Lighting Equipment or System with Capacity of 500 to 1000 kVA: **5** ohms.
 3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: **3** ohms.
- C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.
- D. Provide drawings locating each ground rod and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results.

END OF SECTION

SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section includes:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.3 QUALITY ASSURANCE

- A. Comply with NFPA 70.

PART 2 - PRODUCTS**2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS**

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Allied Tube & Conduit.
 - b. Cooper B-Line, Inc.; a division of Cooper Industries.
 - c. ERICO International Corporation.
 - d. GS Metals Corp.
 - e. Thomas & Betts Corporation.
 - f. Unistrut; Tyco International, Ltd.
 - g. Wesanco, Inc.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA4.
 - 5. Channel Dimensions: Selected for applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser

conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Hilti Inc.
 - 2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
 - 3) MKT Fastening, LLC.
 - 4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
 - 2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Cooper B-Line, Inc.; a division of Cooper Industries.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti Inc.
 - 4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc. 5) MKT Fastening, LLC.
 - 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 - 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 - 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 - 6. Toggle Bolts: All-steel springhead type.
 - 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing: All raceways shall have supports at a maximum spacing of 10-feet and within 3-feet of a box, fitting, elbow, or enclosure. Attach each raceway to each trapeze hanger using fasteners designed for the application.

- C. Minimum Hanger Rod Size for Raceway: Provide 3/8" dia. (minimum) threaded steel rods where required. Use galvanized steel materials on installations exposed to weather. Do not use chain, perforated plumbers strap, or wire for supporting raceways.
- D. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 - 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- E. Spring-steel clamps designed for supporting single conduits with bolts may be used for 1 inch and smaller raceways serving branch circuits and communication systems above suspended ceilings.
- F. Conduit "bat-wing clips" may only be used for supporting flexible lighting whips to rod/wire.
- G. Junction boxes, pull boxes, fixtures, suspended ceilings, etc. are not approved supporting methods. All raceways shall be supported independently of all aforementioned items.
- H. Combination electrical box and conduit hanger/support products shall not be used (commonly known as "barely legal").

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Raceway Support Methods: In addition to methods described in NECA 1, EMT may be supported by openings through structure members, as permitted in NFPA 70 and by the Structural Engineer.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
 - 6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.
- F. Support wall boxes to studs using a horizontal, adjustable mounting bracket spanned between and attached to both studs.
- G. Raceways, outlet boxes, panelboards, etc. shall not utilize plastic anchors for attachment to building elements. Plastic anchors will not be permitted for use at any location.
- H. When using straps, use two hole straps when supporting raceways. Do not use one hole straps.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Surface raceways.
 - 5. Boxes, enclosures, and cabinets.
 - 6. Handholes and boxes for exterior underground cabling.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. FMC: Flexible metal conduit.
- C. IMC: Intermediate metal conduit.
- D. LFMC: Liquidtight flexible metal conduit.
- E. RMC: Rigid metal conduit.
- F. RNC: Rigid nonmetallic conduit (Schedule 40 or 80 PVC).

1.3 COORDINATION

- A. Coordinate layout and installation of raceways and boxes with other construction elements to ensure adequate headroom, working clearance, and access.

PART 2 - PRODUCTS**2.1 METAL CONDUITS, TUBING, AND FITTINGS**

- A. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RMC: Comply with ANSI C80.1 and UL 6.
- C. IMC: Comply with ANSI C80.6 and UL 1242.
- D. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch, minimum.
- E. EMT: Comply with ANSI C80.3 and UL 797.
 - 1. Use factory painted (RED) raceways for all fire alarm work.
- F. FMC: Comply with UL 1; zinc-coated steel.
- G. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
 - 2. Fittings for EMT:
 - a. Material: **Steel** only. Do not use die-cast fittings.
 - b. Type: **Set-screw or compression**.
 - c. All EMT connectors shall have **insulated throats**.
 - 3. Expansion Fittings: Steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.

4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.

- I. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. RNC: Schedule **40 or 80 PVC**, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. LFNC: Comply with UL 1660.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Fittings for LFNC: Comply with UL 514B.
- F. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal, complying with UL 870 and NEMA 250, **Type 1 or Type 3R** unless otherwise indicated, and sized according to NFPA 70.
 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- C. Finish: Manufacturer's standard enamel finish.
- D. Wireway Covers: Screw type.

2.4 SURFACE RACEWAYS

- A. Listing and Labeling: Surface raceways and tele-power poles shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Surface Metal Raceways: Galvanized steel with snap-on covers complying with UL 5. Types, sizes, and channels as indicated and required for each application, with fittings that match and mate with raceways. C. Tele-Power Poles:
 1. Material: Galvanized steel with ivory baked-enamel finish or Aluminum with clear anodized finish.
 2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Metal Floor Boxes:
 - 1. Material: Cast metal or sheet metal.
 - 2. Type: **Fully adjustable**.
 - 3. Shape: Rectangular.
 - 4. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- E. Nonmetallic Floor Boxes: Nonadjustable, round or rectangular.
 - 1. Listing and Labeling: Nonmetallic floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- G. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb.
 - 1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- H. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- I. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- J. Device Box Dimensions: **4 inches square by 2-1/8 inches deep**. Gangable boxes are prohibited.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, **Type 1 or Type 3R** with continuous-hinge cover with flush, lockable latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- L. Cabinets:
 - 1. NEMA 250, **Type 1 or Type 3R** galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.
 - 6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. General Requirements for Handholes and Boxes:
 - 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 - 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two. Equal to Hubbell Quazite.
 - 1. Standard: Comply with SCTE 77.
 - 2. Configuration: Designed for flush burial with **open** bottom unless otherwise indicated.

3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering..
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 1. Exposed Conduit: **RMC** (galvanized rigid steel).
 2. Concealed Conduit, Aboveground: Rigid steel, IMC or as noted on plans.
 3. Underground Conduit: RNC, (schedule 40 or 80 PVC).
 4. Connection to Vibrating Equipment: **LFMC**.
 5. Boxes and Enclosures, Aboveground: NEMA 250, **Type 3R**.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated.
 1. Exposed, finished areas: Wiremold.
 2. Exposed, non-finished areas: **EMT**.
 3. Exposed and Subject to Severe Physical Damage: **GRC**.
 4. Concealed in Ceilings and Interior Walls and Partitions: **EMT**.
 5. Connection to Vibrating Equipment: FMC, except use LFMC in damp or wet locations.
 6. Damp or Wet Locations: **RMC**.
 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 **stainless steel** in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Raceway Size:
 1. Interior: 1/2-inch trade size for metallic. 3/4-inch trade size for homerun raceways leaving panelboard.
 2. Exterior: 3/4-inch trade size for nonmetallic.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use **setscrew or compression, steel** fittings. Comply with NEMA FB 2.10.
 - a. Use "raintight" compression fittings for exterior applications.
 4. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface, exposed raceways only where indicated on Drawings or where impossible to conceal.
- G. Do not install nonmetallic conduit inside the building.

3.2 RACEWAY INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Install raceways level and square and at proper elevations. Provide adequate headroom.
- E. Raceways shall not be used as a supporting means for materials other than their contents.
- F. Complete raceway installation before starting conductor installation.
- G. Use temporary closures to prevent foreign matter from entering raceways.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of four 90-degree bends in any conduit run. Make bends and offsets so ID is not reduced – use standard bending machines. Bending methods which will crease or flatten raceway shall not be used. Keep legs of bends in the same plane and straight legs of offsets parallel, unless otherwise indicated. Support within 12 inches of changes in direction.
- J. Run concealed raceways, with a minimum of bends, in the shortest practical distance considering the type of building construction and obstructions, unless otherwise indicated.
- K. Install raceways parallel to or at right angles to nearby surfaces or structural members, and follow the surface contours as much as practical.
 - 1. Run parallel or banked raceways together, on common supports where practical.
 - 2. Make bends in parallel or banked runs from same centerline to make bends parallel. Use factory elbows only where elbows can be installed parallel; otherwise, provide field bends for parallel raceways.
 - 3. Run tight to structure wherever possible.
- L. Join raceways with fittings designed and approved for the purpose and make joints tight.
 - 1. Make raceway terminations tight. Use bonding bushings, locknuts or wedges at connections subject to vibration. Use bonding jumpers where joints cannot be made tight.
 - 2. Use insulating bushings and set-screw connectors to protect conductors.
 - 3. Tighten set screws of threadless, steel fittings with suitable tools.
- M. Conceal raceways within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- N. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of **1 inch** of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete.
 - 5. Change from ENT to **GRC** before rising above floor.
- O. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- P. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

- Q. Coat field-cut threads on PVC-coated raceway with a corrosion-preventing conductive compound prior to assembly.
- R. Where stubbing out of concrete, wrap conduit with **0.010-inch-** thick, pipe-wrapping plastic tape applied with a 50 percent overlap to prevent corrosion. S. Raceway Terminations:
1. Where raceways are terminated with locknuts and bushings, align raceways to enter squarely and install locknuts with dished part against the box. Where terminations are not secure with 1 locknut, use 2 locknuts: 1 inside and 1 outside the box. Use insulated throat metal bushings to protect conductors.
 2. Where raceways are terminated with threaded hubs, screw raceways or fittings tightly into the hub so the end bears against the wire protection shoulder. Where chase nipples are used, align raceways so the coupling is square to the box and tighten the chase nipple so no threads are exposed.
- T. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use. U. Surface Raceways:
1. Install surface raceway with a minimum 2-inch radius control at bend points.
 2. Secure surface raceway with screws or other anchor-type devices at intervals not exceeding 48 inches and with no less than two supports per straight raceway section. Support surface raceway according to manufacturer's written instructions. Tape and glue are not acceptable support methods.
- V. Provide a ¾" (minimum) empty EMT raceway from each voice, data, TV, and fire alarm outlet to nearest accessible ceiling cavity. Terminate (bend) parallel with ceiling and provide insulated bushing for protection of low voltage wiring when entering/exiting raceway.
- W. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service raceway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- X. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for **recessed and semi-recessed luminaires**, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
1. Use LFMC in damp or wet locations.
- Y. Raceways shall not be installed (routed horizontally) on roofs without written approval from the engineer.
- 3.3 BOX INSTALLATION: Install boxes, as indicated below, and according to manufacturer's written instructions.
- A. All outlets for receptacles and lighting fixtures, and low voltage (voice, data, TV, intercom, etc.) shall be 4-inch square, code gauge steel galvanized knockout boxes (depth as required for service and device used).
1. Concrete installations: Boxes shall be installed in forms of exact dimensions from bench marks, columns, walls or floors.
 2. Masonry installations: Boxes shall be roughed in to general location before installation of walls and furring. Set to exact dimensions at time of wall installation.

- B. Mount boxes at heights indicated. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to **bottom** of box unless otherwise indicated or required by ADA.
 - 1. Mount all light fixture boxes over mirrors in restrooms to allow for a 2-inch separation between fixture and mirror.
 - 2. Standard switch mounting heights are 4'-0" A.F.F.
 - 3. Standard receptacle mounting heights are 1'-4" A.F.F.
 - 4. Install counter-top receptacles at 8" above the counter, measured to the bottom of the box. Where this dimension interferes with back-splash or upper cabinets, consult the Architect for exact placement.
 - 5. All mounting height requirement shall be maintained within a 1/4" tolerance. Refer to the drawings for all other outlet elevations.
- C. Install boxes (covers) flush in finished walls and ceilings when connecting to concealed raceways.
 - 1. Provide plaster rings for boxes to suit adjacent construction and device to be installed. Install boxes not more than 1/8" back from finished walls.
 - 2. Boxes that are installed crooked, more than 1/8" back from wall, or sticking out beyond surface of wall shall be reworked at the discretion of the engineer without additional cost.
 - 3. Above ceiling surface boxes that are installed "floating" off of the wall due to improper conduit rough-in methods shall be reworked at the discretion of the engineer without additional cost.
- D. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel. Rated walls require back to back outlets to be spaced a minimum of 24" apart horizontally.
- E. Locate boxes so that cover or plate will not span different building finishes.
- F. Install wall boxes to studs using a horizontal, adjustable mounting bracket spanned between and attached to both studs.
- G. Install all light switch boxes on the latch side of door. Verify door swings prior to rough in.
- H. Locate boxes in columns to be "off center" to allow for future furniture partitioning, such as open office settings.
- I. Install boxes level and plumb and true to finish lines in a secure and substantial manner.
- J. Install additional pull boxes and junction boxes where needed to prevent damage to wires and cables during pulling. All pull boxes and junction boxes shall be accessible.
- K. Provide blank plates for all junction boxes, pull boxes, and outlet boxes (not being used).
- L. Only remove the knockout(s) associated with the raceway(s) entering and exiting the box. Plug all unused knockout openings with appropriate plug to match box construction.
- M. Install outlets for water coolers to be concealed but accessible. Coordinate with water cooler manufacturer and/or the Mechanical Contractor.
- N. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.
- O. Set metal floor boxes level and flush with finished floor surface.
- P. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- Q. Provide 1" minimum empty raceway (for low voltage) stubbed to accessible ceiling cavity for all multi-service floor boxes, unless noted otherwise to have larger raceway.
- R. All coverplates shall be installed parallel and perpendicular to finish lines and shall completely cover openings separating finished and unfinished areas. The Electrical Contractor shall notify the General Contractor of all locations where faulty work by other trades will not allow coverplates to cover (gaps, holes or spaces).

3.4 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
5. Underground feeders and service entrance raceways: Install manufactured rigid steel or fiberglass 90's and sweeps when using PVC underground.
6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.5 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.
- C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.
- D. Install handholes with bottom below frost line, below grade.

3.6 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.7 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.8 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

3.9 CLEANING

- A. On completion of installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finish, including chips, scratches, and abrasions.

END OF SECTION

SECTION 26 05 44 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
 - 2. Sleeve-seal systems.
 - 3. Sleeve-seal fittings.
 - 4. Grout.
 - 5. Silicone sealants.
- B. Related Requirements:
 - 1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fireresistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

PART 2 - PRODUCTS**2.1 SLEEVES**

- A. Wall Sleeves:
 - 1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
 - 2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; **0.0239-inch** minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board. C. Sleeves for Rectangular Openings:
 - 1. Material: Galvanized sheet steel.
 - 2. Minimum Metal Thickness:
 - a. For sleeve cross-section rectangle perimeter less than **50 inches** and with no side larger than **16 inches**, thickness shall be **0.052 inch**.
 - b. For sleeve cross-section rectangle perimeter **50 inches** or more and one or more sides larger than **16 inches**, thickness shall be **0.138 inch**.

2.2 SLEEVE-SEAL SYSTEMS

- A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
 - 1. **Basis-of-Design Product:** Subject to compliance with requirements, provide **product indicated on Drawings** or comparable product by one of the following:
 - a. GPT, Enpro Industries
 - b. Advance Products & Systems, Inc.
 - c. CALPICO, Inc.
 - d. Metraflex Company (The).
 - e. Proco Products, Inc.
 - 2. Sealing Elements: **EPDM** rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.

3. Pressure Plates: **Stainless steel**.
4. Connecting Bolts and Nuts: **Stainless steel** of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

1. Manufacturers: Subject to compliance with requirements, **available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:**
2. Basis-of-Design Product: Subject to compliance with requirements, provide **product indicated on Drawings** or comparable product by one of the following:
 - a. Presealed Systems.

2.4 GROUT

- A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
- B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- C. Design Mix: **5000-psi**, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

- A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.
 1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
- B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Comply with NECA 1.
- B. Comply with NEMA VE 2 for cable tray and cable penetrations.
- C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:
 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 3. Size pipe sleeves to provide **1/4-inch** annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
 4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:
1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.
- E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using **steel** pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for **1-inch** annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- G. Underground, Exterior-Wall and Floor Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for **1-inch** annular clear space between raceway or cable and sleeve for installing sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall. C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION

SECTION 26 05 53 - IDENTIFICATION FOR ELECTRICAL SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

PART 2 - PRODUCTS**2.1 POWER RACEWAY IDENTIFICATION MATERIALS**

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductors: Color shall be factory applied over the entire length of conductor. This includes all conductor sizes.
- B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

2.3 FLOOR MARKING TAPE

- A. 2-inch- (50-mm-) wide, 5-mil (0.125-mm) pressure-sensitive vinyl tape, with black and white stripes and clear vinyl overlay.

2.4 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils. B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.
2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.
3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

2.5 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.
- C. Metal-Backed, Butyrate Warning Signs:
 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application.
 2. 1/4-inch (6.4-mm) grommets in corners for mounting.
 3. Nominal size, 10 by 14 inches (250 by 360 mm).
- D. Warning label and sign shall include, but are not limited to, the following legends:
 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.6 NAMEPLATES AND INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. inches (129 sq. cm) and 1/8 inch (3.2 mm) thick for larger sizes. Lettering shall be "machine engraved". Home-made engraved nameplates will not be accepted.
 1. Normal Power: Engraved legend with black letters on white face.
 2. Emergency Power: Engraved legend with white letters on red face.
 3. Punched or drilled for mechanical fasteners.
 4. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Nameplates and Signs: Rivets or stainless-steel machine screws with nuts and flat lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- B. Apply identification devices to surfaces that require finish after completing finish work.

- C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device. Do not use self-adhesive identification for equipment labeling.
- D. Attach signs and nameplates with mechanical fasteners appropriate to the location and substrate.
- E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas. Apply the following colors to the systems listed below:
 - 1. Fire Alarm System: Red
 - 2. Security System: Yellow
 - 3. Telecommunication System: Blue
- F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches (400 mm) overall. Install underground-line warning tape for both directburied cables and cables in raceway.
- G. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application. Paint all Fire Alarm junction boxes red.
- H. Lettering, Colors, and Graphics: Coordinate names, abbreviations, colors, and other designations with corresponding designations in the Contract Documents or with those required by codes and standards. Use consistent designations throughout Project.

3.2 IDENTIFICATION SCHEDULE

- A. Circuit Identification Labels on Boxes: Install labels externally. Includes all receptacle coverplates/boxes.
 - 1. Exposed Boxes/coverplates: Pressure-sensitive, self-adhesive vinyl label on cover (1/8" black letters on clear tape).
 - 2. Concealed Boxes: Permanent black marker.
 - 3. Labeling Legend: Permanent, waterproof listing of panel and circuit number.
- B. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than **30 A**, and **120 V** to ground: Install labels at **30-foot (9-m)** maximum intervals.
 - 1. Label shall Include voltage, amperage and panel I.D.
- C. Power-Circuit Conductor Identification, 600 V or Less:
 - 1. Color-code throughout the electrical system. Color-Coding for Phase and Voltage Level Identification, Use colors listed below; Color shall be factory applied over the entire length of conductor.
 - a. Colors for 208/120-V Circuits:
 - Phase A: Black.
 - Phase B: Red.
 - Phase C: Blue.
 - Neutral: White.
 - Ground: Green.
 - Isolated Ground: Green with yellow stripe.
 - b. Colors for 480/277-V Circuits:
 - Phase A: Brown.
 - Phase B: Orange.
 - Phase C: Yellow.

Neutral: White with a colored stripe or gray. Ground:
Green.

- D. Install instructional sign including the color-code for grounded and ungrounded conductors using engraved plastic-laminated labels.
- E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 - 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Selfadhesive warning labels.
 - 1. Comply with 29 CFR 1910.145.
 - 2. Identify system voltage with black letters on an orange background.
 - 3. Apply to exterior of door, cover, or other access.
- I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer or power disconnect.
- K. Equipment Identification Labels (Nameplates): Engraved plastic laminate. Install on each unit of equipment, including central or master unit of each system. This includes power, lighting, communication, signal, and alarm systems, unless units are specified with their own selfexplanatory identification. Apply nameplates for each unit of the following categories of equipment using mechanical fasteners (adhesive labels for equipment identification is not acceptable). All nameplates shall adequately describe the function or use of the particular equipment involved.
 - 1. Panelboards, switchgear, switchboards and enclosures; Include panel designation, amperage, voltage, phase, color coding of phases, and A.I.C. rating. See detail on plans.
 - 2. Access doors and panels for concealed electrical items. Motor-control centers.
 - 3. Disconnect switches; Include size & type of fuse used if fusible.
 - 4. Enclosed circuit breakers.
 - 5. Motor starters.
 - 6. Push-button stations.
 - 7. Power transfer equipment.
 - 8. Contactors.
 - 9. Transformers.

END OF SECTION

SECTION 26 27 26 - WIRING DEVICES**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
1. Receptacles.
 2. Wall switches
 3. Wall-box dimmers.
 4. Wall plates.
 5. Fustats

1.2 DEFINITIONS

- A. GFCI: Ground-fault circuit interrupter.
 B. IG: Isolated Ground
 C. TVSS: Transient voltage surge suppressor.
 D. AF: Arc Fault
 E. USB: USB charging receptacle
 F. TR: Tamper Resistant

PART 2 - PRODUCTS**2.1 MANUFACTURERS**

- A. Receptacles:

	P & S	Hubbell	Leviton	Arrow-Hart
Duplex:	5352	5352AB	5362	5362
Single:	5361	HBL5361	5361	5361
GFCI:	2097	GFRST20	G5362-0T	SGF20
IG:	IG6300	IG5352	5862-IG	IG5362
TVSS w/IG:	IG5362-SP	IG5362SA	5380-IG	IG5362S
Tamper Res.:	TR5352	BR20TR	5362-SG	TRSGF20
USB Charging:	TR5362USB	USB20A5	M58AA	TR7756
ARC Fault:	AF20DFW	AFR20TR	AFTR2	TRAFCI20
USB w/ GFCI:	2097TRUSB			

- B. Switches:

	P & S	Hubbell	Leviton	Arrow-Hart
Toggle 1-pole:	CSB120	CS1221	CSB1-20	CSB120
Toggle 3-Way:	CSB320	CS1223	CSB3-20	CSB320
Toggle 4-Way:	CSB420	CS1224	CSB4-20	CSB420
Key 1-pole:	20AC1-L	HBL1221L	1221-2L	AH1221L
Toggle Pilot 1P:	20AC1-RPL	HBL1221PL	1221-PLR	AH1221PL

- C. Shunt Trip Switches:

1. Pushbutton, mushroom head, 2-position switch. **Square D #9001KR9RH13.**
2. Enclosure. **Square D #9001KY1.**
3. Locking mechanism. **Square D #9001K62.**

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.
- B. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. All receptacles listed above shall be grounded, with back & side wired terminations, and rated at 20A-125V. All receptacles shall be constructed using a High-Impact Thermoplastic material and shall carry the Federal Specification mark. Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, UL 943 Class A and FS W-C-596.
- D. All receptacles shown on the drawings with a weather-proof indication "WP" are to be GFCI devices mounted under a raintight coverplate. Use heavy duty, cast aluminum, single-gang, vertical mount, for "while in use" protection. All exterior GFCI receptacles shall bear an "outdoor/weather proof" rating.
- E. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.
- F. Refer to the drawings for special outlet configuration specifications (special outlet schedule).
- G. All switches listed above shall be 20A, back & side wired, provided with a ground terminal, quiet operating, and rated for the voltage indicated on the drawings. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- H. Provide all pilot light switches with a red illuminated toggle in the on position.
- I. Provide all key switches keyed alike for master key operation.
- J. Refer to the drawings for special switch/control applications.
- K. Comply with NFPA 70.
- L. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.
 - 1. Compatibility:
 - a. Dimming control components shall be compatible with lighting fixtures, drivers, and transformers.
 - b. Coordinate with actual lighting submittals to ensure compatible dimmers are utilized.
- M. Control: Continuously adjustable slider; with single-pole or three-way switching as required. Comply with UL 1472.
- N. LED Lamp Dimmer Switches: Verify with LED lighting manufacturer for list of compatible dimmers.

2.3 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material: 0.035-inch- thick, satin-finished, Type 302 stainless steel.
 - 3. Material for Damp Locations: Thermoplastic with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weatherresistant, **die-cast aluminum** with lockable cover.

2.4 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: Almond, Black, Brown, Gray, Ivory, or White **as selected by Architect** unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
 - 3. TVSS Devices: Blue.

- B. Wall Plate Color: For plastic covers, match device color.

2.5 FUSTATS

- A. Provide fustat devices for motor protection (local disconnect and over-current) as follows:
 - 1. ½ HP-120V or less: Bussmann “SSY”.
 - 2. ¾ HP-120V: Bussmann “SOY”
- B. Mount fustat(s) inside, on, or adjacent to housing of equipment served. Size fuses at 125% of motor F.L.A. or as recommended by the manufacturer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1.
- B. Verify all locations on the job prior to rough in. Locations (not quantities) may be altered by the Architect prior to rough in without additional cost to the Owner. C. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install counter-top receptacles at 8” above the counter, measured to the bottom of the box. Where this dimension interferes with back-splash or upper cabinets, consult the Architect for exact placement.
 - 5. Install wiring devices after all wall preparation, including painting, is complete.
- D. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Do not share neutral conductors on any device branch circuit. (separate neutral conductor for each phase conductor).
- E. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Connect wiring device grounding terminal to branch-circuit equipment grounding conductor and to box.

7. Isolated-Ground Receptacles: Connect wiring device grounding terminal to isolated ground conductor routed to designated isolated equipment ground terminal of electrical system.
8. Use a torque screwdriver when a torque is recommended or required by manufacturer.
9. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
10. Tighten unused terminal screws on the device.
11. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.
12. Install devices and assemblies plumb and secure.
13. Install non-feed-through-type GFCI receptacles. Do not use one GFCI device to downstream protect another device (feed-through method).

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

G. Device Types:

1. Use tamper resistant receptacles in all areas required by the National Electrical Code.
2. Use hospital grade receptacles in all areas required by the National Electrical Code.
3. Use GFCI receptacles in all areas required by the National Electrical Code. Note: use GFCI circuit breaker in lieu of GFCI receptacle where receptacle is not readily accessible.
4. Use AFCI receptacles in all areas required by the National Electrical Code.

H. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

I. Dimmers:

1. Install dimmers within terms of their listing.
2. Install wall dimmers to achieve indicated rating after derating for ganging as instructed by manufacturer.
3. Verify that dimmers used are listed for the load application.
4. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

J. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

K. Adjust locations of floor service outlets and telephone/power service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Switches: Where three or more switches are ganged, and elsewhere as indicated, identify each switch with approved legend engraved on wall plate.

B. Receptacles: Identify panelboard and circuit number from which served. Use machine-printed, pressure-sensitive, abrasion-resistant label tape on face of plate (black text on clear tape) and durable wire markers or tags within outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display indicators of measurement.

- B. Tests for Receptacles:
 - 1. Line Voltage: Acceptable range is 115 to 125 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Check TVSS receptacle indicating lights for normal indication.
 - 6. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 7. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- C. Wiring device will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.

PART 2 - PRODUCTS**2.1 FUSIBLE AND NONFUSIBLE SWITCHES**

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Cutler-Hammer; Siemens; Square D; GE
- B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac (as indicated), 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, quick-make and quick-break type, with clips or bolt pads to accommodate specified fuses, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position. Handle defeat feature for opening switch cover while energized by authorized personnel.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 - 4. Lugs: Suitable for number, size, and conductor material.
 - 5. Service-Rated Switches: Labeled for use as service equipment.

2.2 SHUNT TRIP SWITCHES (elevators)

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Cooper Bussmann, Inc., Ferraz Shawmut, Inc, Littlefuse Inc.
- B. General Requirements: Comply with ASME A17.1, UL 50, and UL 98, with 200-kA interrupting and short-circuit current rating when fitted with Class J fuses.
- C. Switches: Three-pole, horsepower rated, with integral shunt trip mechanism and Class J fuse block; lockable handle with capability to accept three padlocks; interlocked with cover in closed position.

- D. Control Circuit: 120-V ac; obtained from integral control power transformer, with primary and secondary fuses, of enough capacity to operate shunt trip, connected pilot, and indicating and control devices.
- E. Accessories:
 - 1. Oil tight key switch for key-to-test function.
 - 2. Oil tight ON pilot light.
 - 3. Isolated neutral lug.
 - 4. Mechanically interlocked auxiliary contacts that change state when switch is opened and closed.
 - 5. Form C alarm contacts that change state when switch is tripped.
 - 6. Three-pole, double-throw, fire-safety and alarm relay; 24-V dc coil voltage.
 - 7. Three-pole, double-throw, fire-alarm voltage monitoring relay complying with NFPA 72.

2.3 MOLDED-CASE CIRCUIT BREAKERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following: Cutler-Hammer; Siemens; Square D; GE
- B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.
- C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- D. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I^2t response.
- E. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- F. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Lugs: Suitable for number, size, trip ratings, and conductor material.
 - 3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 5. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 6. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 7. Alarm Switch: One **NO** contact that operates only when circuit breaker has tripped.

2.4 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 - 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 - 2. Outdoor Locations: NEMA 250, Type 3R.
 - 3. Kitchen Areas: NEMA 250, stainless steel.

4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

B. Manufacturer's standard prime-coat finish ready for field painting.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Examine elements and surfaces to receive enclosed switches for compliance with installation tolerances and other conditions affecting performance.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.
- B. Check for proper fuse clip provisions (clip spacing/types) prior to installing fuses. Install fuses in fusible devices.
- C. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- D. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components. E. Comply with NECA 1.

3.2 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torquetightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A and UL 486B.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Acceptance Testing Preparation:
 1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
 2. Test continuity of each line and load side circuit.
- C. Tests and Inspections:
 1. Follow NECA 90, Annex A Electrical Testing Procedures.
 2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each enclosed switch and circuit breaker. Open or remove doors or panels so connections are accessible to portable scanner.
 - a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each unit 11 months after date of Substantial Completion.
 - b. Instrument: Use an infrared scanning device designed to measure temperature and detect significant deviations from normal values. Minimum resolution 320x240,

- 45deg. field of view. Equal to Flir E8-XT or Fluke TiS60. Provide calibration record for device used. Follow instructions of test equipment used.
- c. Comply with ASTM E1934-99a. Standard guide for Examining Electrical and Mechanical equipment with Infrared Thermography.
 - d. Prepare a certified report identifying items checked and describing results of scanning. Include notation of deficiencies detected, remedial action taken, and scanning observations after remedial action.
4. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
- D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.
- F. CLEANING
- 1. On completion of installation, inspect interior and exterior of enclosures. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

END OF SECTION

SECTION 27 05 28 - PATHWAYS FOR COMMUNICATIONS SYSTEMS**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Nonmetallic conduits and fittings.
 - 3. Optical-fiber-cable pathways and fittings.
 - 4. Surface pathways.
 - 5. Boxes, enclosures, and cabinets.
 - 6. Handholes and boxes for exterior underground cabling.
- B. Related Requirements:
 - 1. Section 260533 "Raceways and Boxes for Electrical Systems" for conduits, wireways, surface raceways, boxes, enclosures, cabinets, handholes, and faceplate adapters serving electrical systems.
 - 2. Section 280528 "Pathways for Electronic Safety and Security" for conduits, surface pathways, innerduct, boxes, and faceplate adapters serving electronic safety and security.

1.2 ACTION SUBMITTALS

- A. Product Data: For surface pathways, J-hooks, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

PART 2 - PRODUCTS**2.1 METAL CONDUITS AND FITTINGS**

- A. General Requirements for Metal Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. GRC: Comply with ANSI C80.1 and UL 6.
- C. EMT: Comply with ANSI C80.3 and UL 797.
- D. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: **Steel**.
 - b. Type: **Setscrew or compression**.
 - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL-467, rated for environmental conditions where installed, and including flexible external bonding jumper.

2.2 NONMETALLIC CONDUITS AND FITTINGS

- A. General Requirements for Nonmetallic Conduits and Fittings:
 - 1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with TIA-569-B.
- B. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- C. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

2.3 OPTICAL-FIBER-CABLE PATHWAYS AND FITTINGS

- A. Description: Comply with UL 2024; flexible-type pathway, approved for **plenum** installation unless otherwise indicated.
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with TIA-569-B.

2.4 SURFACE PATHWAYS

- A. General Requirements for Surface Pathways:
1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Comply with TIA-569-B.
- B. Surface Metal Pathways: Galvanized steel with snap-on covers complying with UL 5. Manufacturer's standard enamel finish. C.
- Tele-Power Poles:
1. Material: **Galvanized steel with baked-enamel finish.**
 2. Fittings and Accessories: Dividers, end caps, covers, cutouts, wiring harnesses, devices, mounting materials, and other fittings shall match and mate with tele-power pole as required for complete system.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. General Requirements for Boxes, Enclosures, and Cabinets:
1. Comply with TIA-569-B.
 2. Boxes, enclosures and cabinets installed in wet locations shall be listed for use in wet locations.
 3. Comply with all additional SIPRNet requirements provided by DOD.
- B. Sheet-Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- D. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- E. Metal Floor Boxes:
1. Material: sheet metal.
 2. Type: Fully adjustable.
 3. Listing and Labeling: Metal floor boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- H. Ganged boxes are prohibited.
- I. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 and Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. Cabinets:
1. NEMA 250, Type 1 and Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.

2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.
6. Nonmetallic cabinets shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.6 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND CABLING

- A. General Requirements for Handholes and Boxes:
 1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
 2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 3. Comply with TIA-569-B.
- B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.
 1. Standard: Comply with SCTE 77.
 2. Configuration: Designed for flush burial with **open** bottom unless otherwise indicated.
 3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
 4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 5. Cover Legend: Molded lettering, "COMMUNICATIONS".

PART 3 - EXECUTION

3.1 PATHWAY APPLICATION

- A. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed Conduit: GRC.
 2. Concealed Conduit, Aboveground: GRC or EMT..
 3. Underground Conduit: RNC, Type EPC-40-PVC.
 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 1. Exposed, Not Subject to Physical Damage and in non-finished areas: EMT.
 2. Exposed and Subject to Severe Physical Damage: GRC.
 3. Concealed in Interior Walls and Partitions: EMT.
 4. Concealed in accessible ceilings: J-HOOKS and CABLE TRAY.
 5. Damp or Wet Locations: GRC.
 6. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway EMT.
 7. Boxes and Enclosures: NEMA 250 Type 1, except use NEMA 250 Type 4 stainless steel in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 3/4-inch trade size. Minimum size for optical-fiber cables is 1 ¼ inch.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.
 1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. EMT: Use setscrew fittings. Comply with NEMA FB 2.10.

- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings. Surface pathways will not be permitted on new walls.

3.2 INSTALLATION

- A. Comply with NECA 1, NECA 101, and TIA-569-B for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum pathways. Comply with NFPA 70 limitations for types of pathways allowed in specific occupancies and number of floors.
- B. Keep pathways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- C. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- D. Install no more than the equivalent of three 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Utilize long radius ells for all optical-fiber cables.
- E. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- F. Pathways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange pathways to keep a minimum of **1 inch** of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- G. Stub-ups to Above Recessed Ceilings:
 - 1. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- H. Route all cabling parallel and perpendicular to walls, structure and building elements. Do not route cabling diagonally across ceiling spaces.
- I. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- J. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- K. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- L. Spare Pathways: Install pull wires in empty pathways. Cap underground pathways designated as spare above grade alongside pathways in use. M. Surface Pathways:
 - 1. Install surface pathway for surface telecommunications outlet boxes only where indicated on Drawings.
- N. Pathways for Optical-Fiber and Communications Cable: Install pathways as follows:
 - 1. 3/4-Inch Trade Size and Smaller: Install pathways in maximum lengths of 50 feet.
 - 2. 1-Inch Trade Size and Larger: Install pathways in maximum lengths of 75 feet.
 - 3. Install with a maximum of two 90-degree bends or equivalent for each length of pathway unless Drawings show stricter requirements.
- O. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- P. Mount boxes at heights indicated on Drawings in accordance with ADA requirements. Install boxes with height measured to bottom of box unless otherwise indicated. All boxes shall be 4sq.
- Q. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches in nominal diameter.
 2. Install backfill as specified in Section 312000 "Earth Moving."
 3. After installing conduit, backfill and compact. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
 4. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
 5. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

- A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.
- B. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch above finished grade.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.6 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage or deterioration.

END OF SECTION

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING**PART 1 - GENERAL****1.1 SUMMARY**

- A. Section Includes:
 - 1. UTP cabling.
 - 2. Multiuser telecommunications outlet assemblies.
 - 3. Cable connecting hardware, patch panels, and cross-connects.
 - 4. Telecommunications outlet/connectors.
 - 5. Cabling system identification products.
- B. Related Requirements:
 - a. Section 271300 "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
 - b. Section 280513 "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.2 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.
- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
 - 2. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
 - 3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.
- B. Source quality-control reports.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings and Cabling Administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

1.6 STANDARDS

- A. ANSI/TIA-568-C.0: Generic Telecommunications Cabling for Customer Premises.
- B. ANSI/TIA-568-C.1: Commercial Building Telecommunications Cabling Standard.
- C. ANSI/TIA-568-C.2: Balanced Twisted-Pair Telecommunication Cabling and Components Standard.
- D. ANSI/TIA-568-C.3: Optical Fiber Cabling Components Standard.
- E. ANSI/EIA/TIA-569-A Commercial Building Standard for Telecommunications Pathways and Spaces.
- F. ANSI/EIA/TIA-606(A) Administration Standard for the Telecommunications Infrastructure of Commercial Buildings Product and Installation Specifications For Building Data Communication Cabling 5.
- G. ANSI/EIA/TIA-607(A) Commercial Building Grounding and Bonding Requirements for Telecommunications.
- H. ANSI/EIA/TIA-598: Color Coding of Fiber Optic Cables.
- I. ANSI/EIA/TIA-455: Test Procedures For Fiber Optics, Cables and Transistors.
- J. ANSI/EIA/TIA-604-3: FOCIS 3 Fiber Optic Connector Intermatability Standard.
- K. ANSI/ICEA S-83-596: Fiber Optic Premises Distribution Cable.
- L. ANSI/ICEA S-83-640: Fiber Optic Outside Plant Communications Cable.
- M. ANSI/NECA/BICSI-568: Standard for Installing Commercial Building Telecommunications Cabling.

PART 2 - PRODUCTS

2.1 GENERAL CONDITIONS

- A. This document specifies that the horizontal structured cabling system shall be a single manufacturer end-to-end solution. Recommended manufacturers include, but are not limited to, Panduit TX 6000TM System, Belden IBDN 2400 System, Commscope Gigaspeed XL, and Leviton. See appendices for examples of vendor product list and part numbers. It is recommended to consult vendors on current product offerings.

2.2 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 2. Bridged taps and splices shall not be installed in the horizontal cabling.
 3. Use same manufacturer of each new system component throughout entire project. For example: do not use both Mohawk and Bertek cable; use same cable manufacturer throughout.

2.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.

- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1. Flame-Spread Index: 25 or less.
 - 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

2.3 BACKBOARDS

- A. Backboards: Plywood, fire-retardant treated, ¾" by 48" by 96". Comply with requirements in Section 061000 "Rough Carpentry" for plywood backing panels.

2.4 FIBER

- A. **Basis-of-Design Product:** Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Belden.
 - 2. Commscope.
 - 3. Corning.
 - 4. Leviton.
 - 5. Panduit Corp.
- B. Description: Singlemode fiber between buildings, and OM3 multimode fiber between Telecommunications Rooms within a single building. The approved inter-building singlemode fiber optic backbone cables shall be 9/125um OS2 and constructed with Corning optical fiber. The approved intra-building multimode fiber optic cables shall be 50/125um OM3. Indoor cables shall be tight buffered with CMP (FT6) or CMR (FT4) where applicable. If needed, outdoor cables shall be loose tube CMR (FT4) outdoor rated fiber optic cable.
 - 1. Comply with ICEA S-83-596 for mechanical properties.
 - 2. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.5 FIBER CONNECTORS

- A. The fiber optic connectors must be field installable connectors. The connectors shall be LC style UPC for both inter-building backbone cables and intra-building backbone cables. All connectors are to meet ANSI/EIA/TIA and IEC standards for repeatability.
- B. The connector shall be capable of terminating on either 900 micron tight-buffered cable, 3.0 mm jacketed fibers or 250 micron loose tube fibers. The connector shall also have a zirconia ceramic ferrule for both multimode and singlemode connectors and must have a locking feature to the coupler.
- C. The connector shall provide a strain relief mechanism for installation on a single fiber. The fiber within the body of the connector shall be isolated mechanically from cable tension bending and twisting as per ANSI/TIA-568-C.3.

2.6 FIBER PATCH CORDS

- A. Dual fiber optic patch cords are to be singlemode 9/125um or OM3 multimode 50/125um. Connector types on ends of patch cords to be determined by Sedgwick County.

- B. Patch cords to be factory assembled and verified. Fiber patch cords shall comply with ANSI/TIA-568-C.3.
- C. The color of the singlemode patch cords will be yellow. The color of the multimode patch cords will be aqua. The length of the patch cords will be ten (10) feet or three (3) meters unless otherwise specified. Recommended manufacturers include, but are not limited to, Panduit, Belden, Commscope, Corning and Leviton.

2.7 UTP CABLE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. CommScope, Inc. Gigaspeed XL.
 - 2. Mohawk; a division of Belden Networking, Inc., IBDN 2400 System.
 - 3. Leviton.
 - 4. Panduit TX 6000TM System.
- B. Description: Solid copper conductors listed as complying with Category 6 of EIA/TIA-568-A and listed for use in air-handling spaces (plenum rated).
 - 1. Comply with ICEA S-90-661 for mechanical properties.
 - 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 - 3. Comply with TIA/EIA-568-B.2, Category 6.
 - 4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
- C. Use Category 6A for all wireless access points (WAP's).
- D. The cable shall be tested and characterized to 350 MHz and have a positive PSACR above 250 MHz. It shall also be UL listed.
- E. The jacket shall be printed with a 1000' to 0' marking system and/or 333 meter to 0 meters system.

2.8 UTP CABLE HARDWARE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:
 - 1. Belden Inc.
 - 2. Leviton Commercial Networks Division.
 - 3. Molex Premise Networks; a division of Molex, Inc.
 - 4. Panduit Corp.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.
 - 1. Number of Terminals per Field: One for each conductor in assigned cables.
- E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable plus spares and blank positions adequate to satisfy specified expansion criteria.
- F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- G. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.
 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
 2. Patch cords shall have color-coded boots for circuit identification.
- H. Verify color coding requirements with owner.

2.9 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.
- B. Workstation Outlets: Two, Three, or Four-port-connector assemblies mounted in single faceplate.
 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 2. Metal Faceplate: Stainless steel, complying with requirements in Section 262726 "Wiring Devices."
 3. For use with snap-in jacks accommodating any combination of UTP work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 4. Legend: Factory labeled by silk-screening or engraving for stainless steel faceplates.
 5. Legend: Machine printed, in the field, using adhesive-tape label.
 6. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.10 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors. B. Comply with J-STD-607-A.

2.11 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems." Faceplates, patch panels, blocks: Computer printed labels. Panduit or Equal.

2.10 SOURCE QUALITY CONTROL

- A. Factory test UTP cables on reels according to TIA/EIA-568-B.1.
- B. Factory test UTP cables according to TIA/EIA-568-B.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

Communications Horizontal
Cabling

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- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters. Conceal pathways and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
 - 2. Comply with requirements in Section 270528 "Pathways for Communications Systems."
 - 3. Comply with requirements in Section 270536 "Cable Trays for Communications Systems."
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 2. Install lacing bars and distribution spools.
 - 3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 5. Cables may not be spliced.
 - 6. Secure and support cables at intervals not exceeding 48 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals. Red Iron and/or building infrastructure is not an acceptable cabling support system.
 - 7. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
 - 10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 - 11. In the communications equipment room, install a 10-foot long service loop on each end of cable.
 - 12. At each cable drop location, install a 4-foot long service loop above ceiling prior to dropping down to outlet.
 - 13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
- C. UTP Cable Installation:
 - 1. Comply with TIA/EIA-568-B.2.
 - 2. Do not untwist UTP cables more than **1/2 inch** from the point of termination to maintain cable geometry.

- D. Open-Cable Installation:
 - 1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
 - 2. Suspend UTP cable that is not in a wireway, cable tray or pathway a minimum of **8 inches** above ceilings by cable supports not more than 48 inches apart.
 - 3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.
 - 4. Route all cabling parallel and perpendicular to walls, structure and building elements. Do not route cabling diagonally across ceiling spaces.
- E. Group connecting hardware for cables into separate logical fields.
- F. Separation from EMI Sources:
 - 1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
 - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of **5 inches**.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **12 inches**
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of **24 inches**.
 - 3. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of **3 inches**.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of **6 inches**.
 - 4. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of **48 inches**.
 - 5. Separation between Communications Cables and Fluorescent Fixtures: A minimum of **5 inches**.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.
- B. Comply with J-STD-607-A and ANSI/EIA/TIA 607(A).
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least **2-inch** clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Provide a separate cable color for each system. Suggested colors listed below shall be approved by the owner.
 - a. Data = Blue
 - b. WAP's = Green
 - c. Cameras = Yellow
- B. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Comply with requirements in Section 099123 "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.
- D. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- E. Cable and Wire Identification:
 - 1. Label each cable within **4 inches** of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding **15 feet**.
 - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
- F. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
 - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Visually inspect UTP jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 - 2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
 - 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

4. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
 - a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
 5. UTP Performance Tests:
 - a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay. 10) Delay skew.
 6. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
 - B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
 - C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
 - D. Prepare test and inspection reports.
- 3.8 DEMONSTRATION
- A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets.

END OF SECTION