EXHIBIT F

AXIS DESIGNGROUP
ARCHITECTURE & ENGINEERING, INC.

PROJECT MANUAL

CLACKAMAS COMMUNITY COLLEGE

BARLOW HALL

AUTO TECH RENOVATION

September 28, 2018
Outline Specification

PREPARED FOR:

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SECTION 00 01 07

SEALS PAGE

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SECTION 00 01 10

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SECTION 00 21 13
INSTRUCTIONS TO BIDDERS

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1.02 RELATED DOCUMENTS

A. Document 01 10 00 - Summary.

B. Document 00 41 00 - Bid Form.

C. Document 00 43 23 - Alternates Form.

D. Document 00 43 25 - Substitution Request Form - During Procurement

E. Document 00 52 00 - Agreement Form:
   1. Performance assurance and insurance requirements.

F. Document 00 73 00 - Supplementary Conditions:

INVITATION

2.01 BID SUBMISSION

A. Bids signed and under seal, executed, and dated will be received at the office of the Owner at _____ before _____ a.m. local standard time on the ____ day of _____.

B. Offers submitted after the above time shall be returned to the bidder unopened.

C. Submit required Supplements To Bid Forms within 24 hours after closing time for receiving bids.

D. Offers will be opened publicly immediately after the time for receipt of bids.

E. Amendments to the submitted offer will be permitted if received in writing prior to bid closing and if endorsed by the same party or parties who signed and sealed the offer.

2.02 INTENT

A. The intent of this Bid request is to obtain an offer to perform work to complete a _____ located at _____ for a Stipulated Sum contract, in accordance with the Contract Documents.

2.03 WORK IDENTIFIED IN THE CONTRACT DOCUMENTS

A. Work of this proposed Contract comprises building construction, including general construction Work.

2.04 CONTRACT TIME

A. Identify Contract Time in the Bid Form. The completion date in the Agreement shall be the Contract Time added to the commencement date.

BID DOCUMENTS AND CONTRACT DOCUMENTS

3.01 DEFINITIONS

A. Bid Documents: Contract Documents supplemented with Invitation To Bid, Instructions to Bidders, Information Available to Bidders, Bid Form Supplements To Bid Forms and Appendices identified.

B. Contract Documents: Defined in _____ including issued Addenda.

C. Bid, Offer, or Bidding: Act of submitting an offer under seal.

D. Bid Amount: Monetary sum identified by the Bidder in the Bid Form.

3.02 CONTRACT DOCUMENTS IDENTIFICATION

A. The Contract Documents are identified as Project Number ____, as prepared by Architect who is located at _____, and with contents as identified in the Table of Contents.

3.03 AVAILABILITY

A. Bid Documents (PDF) will be issued by the Owner.

B. Bid documents may be obtained at _____.

C. Bid Documents are made available only for the purpose of obtaining offers for this project. Their use does not grant a license for other purposes.

3.04 EXAMINATION

A. Bid Documents are on display at the offices of the following construction plan rooms:
1. _____.

B. Upon receipt of Bid Documents verify that documents are complete. Notify Architect should the documents be incomplete.

C. Immediately notify Architect upon finding discrepancies or omissions in the Bid Documents.

3.05 INQUIRIES/ADDENDA

A. Direct questions to _____, email; _____.

B. Addenda may be issued during the bidding period. All Addenda become part of the Contract Documents. Include resultant costs in the Bid Amount.

C. Verbal answers are not binding on any party.

D. Clarifications requested by bidders must be in writing not less than 7 days before date set for receipt of bids. The reply will be in the form of an Addendum, a copy of which will be forwarded to known recipients and _____.

3.06 PRODUCT/ASSEMBLY/SYSTEM SUBSTITUTIONS

A. Submit substitution requests by completing the form in Section 00 43 25 - Substitution Request Form - During Procurement; see this section for additional information and instructions. Use only this form; other forms of submission are unacceptable.

B. See Section 01 60 00 - Product Requirements for additional requirements.

SITE ASSESSMENT

4.01 SITE EXAMINATION

A. Examine the project site before submitting a bid.

B. A visit to the project site has been arranged for bidders as follows: _____

4.02 PREBID CONFERENCE

A. A bidders conference has been scheduled for _____ a.m. on the _____ day of _____ at the location of _____.

B. ONLY Pre-qualified bidders are invited.

C. Representatives of Architect will be in attendance.

D. Information relevant to the Bid Documents will be recorded in an Addendum, issued to Bid Document recipients.

QUALIFICATIONS

5.01 EVIDENCE OF QUALIFICATIONS

A. To demonstrate qualification for performing the Work of this Contract, bidders may be requested to submit written evidence of financial position, license to perform work in the State and _____.

5.02 SUBCONTRACTORS/SUPPLIERS/OTHERS

A. Owner reserves the right to reject a proposed subcontractor for reasonable cause.

B. Refer to General Conditions.

BID SUBMISSION

6.01 SUBMISSION PROCEDURE

A. Bidders shall be solely responsible for the delivery of their bids in the manner and time prescribed.

B. Submit one copy of the executed offer on the Bid Forms provided, signed and sealed with the required security in a closed opaque envelope, clearly identified with bidder's name, project name and Owner's name on the outside.

C. Improperly completed information, irregularities in security deposit, may be cause not to open the Bid Form envelope and declare the bid invalid or informal.

D. An abstract summary of submitted bids will be made available to all bidders following bid opening.

6.02 BID INELIGIBILITY

A. Bids that are unsigned, improperly signed or sealed, conditional, illegible, obscure, contain arithmetical errors, erasures, alterations, or irregularities of any kind, may at the discretion of the Owner, be declared unacceptable.

B. Bid Forms, Appendices, and enclosures that are improperly prepared may, at the discretion of Owner, be declared unacceptable.

C. Failure to provide security deposit, bonding or insurance requirements may, at the discretion of Owner, be waived.

D. Bids are by invitation, only from selected bidders. Bids from unsolicited bidders may be returned.

BID ENCLOSURES/REQUIREMENTS

7.01 PERFORMANCE ASSURANCE

A. Accepted Bidder: Provide a Performance bond as described in 00 73 00 - Supplementary Conditions.

B. Include the cost of performance assurance bonds in the Bid Amount.

7.02 INSURANCE

A. Provide an executed "Undertaking of Insurance" on the form provided stating their intention to provide insurance to the bidder in accordance with the insurance requirements of the Contract Documents.
   1. See Section 00 52 00 - Agreement Form: A sample Agreement and General Conditions to be executed.

7.03 BID FORM REQUIREMENTS

A. Complete all requested information in the Bid Form and Appendices.

7.04 FEES FOR CHANGES IN THE WORK

A. Include the fees for overhead and profit on own Work and Work by subcontractors, identified in Document 00 73 00 - Supplementary Conditions .

B. Include in the Bid Form, the overhead and profit fees on own Work and Work by subcontractors, applicable for Changes in the Work, whether additions to or deductions from the Work on which the Bid Amount is based.

C. Include in the Bid Form, the fees proposed for subcontract work for changes (both additions and deductions) in the Work. Contractor shall apply fees as noted, to the subcontractor's gross (net plus fee) costs on additional work.

7.05 BID FORM SIGNATURE

A. The Bid Form shall be signed by the bidder, as follows:
   1. Sole Proprietorship: Signature of sole proprietor in the presence of a witness who will also sign. Insert the words "Sole Proprietor" under the signature. Affix seal.
   2. Partnership: Signature of all partners in the presence of a witness who will also sign. Insert the word "Partner" under each signature. Affix seal to each signature.
   3. Corporation: Signature of a duly authorized signing officer(s) in their normal signatures. Insert the officer's capacity in which the signing officer acts, under each signature. Affix the corporate seal. If the bid is signed by officials other than the president and secretary of the company, or the president/secretary/treasurer of the company, a copy of the by-law resolution of their board of directors authorizing them to do so, must also be submitted with the Bid Form in the bid envelope.
   4. Joint Venture: Each party of the joint venture shall execute the Bid Form under their respective seals in a manner appropriate to such party as described above, similar to the requirements of a Partnership.

7.06 ADDITIONAL BID INFORMATION

A. All bidders must comply with current Prevailing Wage Law in ORS 279C.365. The successful bidder Contract will submit monthly applications for payment and necessary certified payroll reports required by BOLI.

B. Submit the following Supplements concurrent with bid submission:
   1. Document 00 43 23 - Alternates Form: Include the cost variation to the Bid Amount applicable to the Work described in Section _____.

7.07 SELECTION AND AWARD OF ALTERNATES

A. Indicate variation of bid price for Alternates listed on the Bid Form. Unless otherwise indicated, indicate _____ as a difference in bid price by adding to or deducting from the base bid price.

B. Bids will be evaluated on the total of the base bid price and all of the Alternates. After determination of the successful bidder, consideration will be given to which Alternates will be included in the Work.

OFFER ACCEPTANCE/REJECTION

8.01 DURATION OF OFFER

A. Bids shall remain open to acceptance and shall be irrevocable for a period of thirty (30) days after the bid closing date.

8.02 ACCEPTANCE OF OFFER

A. Owner reserves the right to accept or reject any or all offers.

B. After acceptance by Owner, Architect on behalf of Owner, will issue to the successful bidder, a written Bid Acceptance.

END OF SECTION

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SECTION 00 41 00

BID FORM

THE PROJECT AND THE PARTIES

1.01 TO:

A. Owner

_____

1.02 FOR:

A. _____

1.03 DATE: _____ (BIDDER TO ENTER DATE)

1.04 SUBMITTED BY: (BIDDER TO ENTER NAME AND ADDRESS)

A. Bidder's Full Name _____
   1. Address _____
   2. City, State, Zip_____

1.05 OFFER

A. Having examined the Place of The Work and all matters referred to in the Instructions to Bidders and the Bid Documents prepared by _____ for the above mentioned project, we, the undersigned, hereby offer to enter into a Contract to perform the Work for the Sum of:

B. _____
_____ dollars
($_____), in lawful money of the United States of America.

C. We have included the required security deposit as required by the Instruction to Bidders.

D. We have included the required performance assurance bonds in the Bid Amount as required by the Instructions to Bidders.
   1. The cost of the required performance assurance bonds is _ _____ _dollars ($_____), in lawful money of the United States of America.

E. All applicable federal taxes are included and State of _____ taxes are included in the Bid Sum.

1.06 ACCEPTANCE

A. This offer shall be open to acceptance and is irrevocable for thirty days from the bid closing date.

B. If this bid is accepted by Owner within the time period stated above, we will:
   1. Execute the Agreement within seven days of receipt of Notice of Award.
   2. Furnish the required bonds within seven days of receipt of Notice of Award.
   3. Commence work within seven days after written Notice to Proceed of this bid.

1.07 CONTRACT TIME

A. If this Bid is accepted, we will:

B. Complete the Work in _____ calendar days from _____.
   1. Desired Final Completion Date: Not later than Month XX, 2019.

1.08 CHANGES TO THE WORK

A. When Architect establishes that the method of valuation for Changes in the Work will be net cost plus a percentage fee in accordance with General Conditions, our percentage fee will be:
   1. _____ percent overhead and profit on the net cost of our own Work;
   2. _____ percent on the cost of work done by any Subcontractor.

B. On work deleted from the Contract, our credit to Owner shall be Architect-approved net cost plus _____ of the overhead and profit percentage noted above.

1.09 ADDENDA

A. The following Addenda have been received. The modifications to the Bid Documents noted below have been considered and all costs are included in the Bid Sum.
   1. Addendum # _____ Dated _____.
   2. Addendum # _____ Dated _____.

1.10 BID FORM SUPPLEMENTS

A. The following Supplements are attached to this Bid Form and are considered an integral part of this Bid Form:
   1. Document 00 43 23 - Alternates Form: Include the cost variations to the Bid Sum applicable to the Work as described in Section _____.

1.11 BID FORM SIGNATURE(S)

A. The Corporate Seal of

B. _____

C. (Bidder - print the full name of your firm)

D. was hereunto affixed in the presence of:

E. _____

F. (Authorized signing officer, Title)

G. (Seal)

H. _____

I. (Authorized signing officer, Title)

1.12 IF THE BID IS A JOINT VENTURE OR PARTNERSHIP, ADD ADDITIONAL FORMS OF EXECUTION FOR EACH MEMBER OF THE JOINT VENTURE IN THE APPROPRIATE FORM OR FORMS AS ABOVE.

END OF SECTION

SECTION 00 43 23

ALTERNATES FORM

PARTICULARS

1.01 THE FOLLOWING IS THE LIST OF ALTERNATES REFERENCED IN THE BID SUBMITTED BY:

1.02 (BIDDER) _____

1.03 TO (OWNER): _____

1.04 DATED _____ AND WHICH IS AN INTEGRAL PART OF THE BID FORM.

ALTERNATES LIST

2.01 THE FOLLOWING AMOUNTS SHALL BE ADDED TO OR DEDUCTED FROM THE BID AMOUNT. REFER TO SECTION 01 23 00 - ALTERNATES.

ALTERNATE # 1: ADD / (DEDUCT) $ _____

ALTERNATE # 2: ADD / (DEDUCT) $ _____

ALTERNATE # 3: ADD / (DEDUCT) $ _____

ALTERNATE # 4: ADD / (DEDUCT) $ _____

ALTERNATE # 5: ADD / (DEDUCT) $ _____

ALTERNATE # 6: ADD / (DEDUCT) $ _____

ALTERNATE # 7: ADD / (DEDUCT) $ _____

ALTERNATE # 8: ADD / (DEDUCT) $ _____

END OF SECTION

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SECTION 00 43 25

SUBSTITUTION REQUEST FORM - DURING PROCUREMENT

PART 1 GENERAL

1.01 THE REQUEST FORM SHOULD BE LIKE THE ATTACHED SAMPLE FOLLOWING THIS PAGE.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 00 50 00

CONTRACTING FORMS AND SUPPLEMENTS

PART 1 GENERAL

1.01 FORMS

A. Use the following forms for the specified purposes unless otherwise indicated elsewhere in the Contract Documents.

B. Post-Award Certificates and Other Forms:
   1. Submittal Transmittal Letter Form: to be based on AIA G810: Contractor furnished form.
   2. Schedule of Values Form: to be based on AIA G703: Contractor furnished form.
   3. Application for Payment Form: to be based on AIA G702 with AIA G703 (for Contractors): Contractor furnished form.

C. Clarification and Modification Forms:
   1. Request for Information (RFI) Form: Contractor furnished form.
   2. Substitution Request Form: CSI/CSC Form 13.1A (After the Bidding/Negotiating Stage): Contractor furnished form.
   3. Change Order Request (COR) Form: Contractor furnished form.
   4. Change Order Form: to be based on AIA G701: Contractor furnished form.

D. Closeout Forms:
   1. Certificate of Substantial Completion Form: AIA G704.
   2. Warranty Form: Contractor furnished form.

1.02 REFERENCE STANDARDS

A. AIA G701 - Change Order; 2017.

B. AIA G702 - Application and Certificate for Payment; 1992.

C. AIA G703 - Continuation Sheet; 1992.

D. AIA G704 - Certificate of Substantial Completion; 2017.

E. CSI/CSC Form 13.1A - Substitution Request (After the Bidding/Negotiating Phase); Current Edition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 00 52 00

AGREEMENT FORM

PART 1 GENERAL

1.01 FORM OF AGREEMENT

1.02 THE AGREEMENT TO BE EXECUTED IS ATTACHED FOLLOWING THIS PAGE.

1.03 RELATED REQUIREMENTS

A. Section 00 72 00 - General Conditions.

B. Section 00 73 00 - Supplementary Conditions.

C. Section 01 42 16 - Definitions.

PART 2 PRODUCTS (NOT USED)

PART 3 EXECUTION (NOT USED)

END OF SECTION

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SECTION 00 72 00

GENERAL CONDITIONS

FORM OF GENERAL CONDITIONS

1.01 THE GENERAL CONDITIONS APPLICABLE TO THIS CONTRACT IS ATTACHED FOLLOWING THIS PAGE.

RELATED REQUIREMENTS

2.01 SECTION 01 42 16 - DEFINITIONS.

END OF SECTION

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SECTION 01 10 00

SUMMARY

PART 1 GENERAL

1.01 PROJECT

A. Project Name: _____.

B. Owner's Name: _____.

C. Architect's Name: _____.

D. The Project consists of the construction of _____.

1.02 CONTRACT DESCRIPTION

A. Contract Type: A single prime contract based on a Stipulated Price as described in Document 00 52 00 - Agreement Form.

1.03 DESCRIPTION OF ALTERATIONS WORK

A. Scope of demolition and removal work is indicated on drawings and specified in Section 02 41 00.

B. Scope of alterations work is indicated on drawings.

C. Plumbing: Alter existing system and add new construction, keeping existing in operation.

D. HVAC: Alter existing system and add new construction, keeping existing in operation.

E. Electrical Power and Lighting: Alter existing system and add new construction, keeping existing in operation.

F. Fire Suppression Sprinklers: Alter existing system and add new construction, keeping existing in operation.

G. Fire Alarm: Alter existing system and add new construction, keeping existing in operation.

H. Telephone: Alter existing system and add new construction, keeping existing in operation.

I. Security System: Alter existing system and add new construction, keeping existing in operation.

1.04 WORK BY OWNER

A. Owner has awarded a contract for supply and installation of _____ which commenced _____.

B. Items noted NIC (Not in Contract) will be supplied and installed by Owner before Substantial Completion. Some items include:
   1. Technology.
   2. Furniture / Fixtures / Equipment.
   3. HVAC, DDC Mechanical controlls.

1.05 OWNER OCCUPANCY

A. Owner intends to continue to occupy adjacent portions of the existing building during the entire construction period.

B. Owner intends to occupy the Project upon Substantial Completion.

C. Cooperate with Owner to minimize conflict and to facilitate Owner's operations.

D. Schedule the Work to accommodate Owner occupancy.

1.06 CONTRACTOR USE OF SITE AND PREMISES

A.

B. Construction Operations: Limited to areas noted on Drawings.

C. Arrange use of site and premises to allow:
   1. Owner occupancy.
   2. Work by Owner.

D. 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. Do not obstruct roadways, sidewalks, or other public ways without permit.

E. Existing building spaces may not be used for storage.

F. Existing building spaces MAY BE USED for storage. Coordinate with Owner.

G. Utility Outages and Shutdown:
1. Limit disruption of utility services to hours the building is unoccupied.
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.

1.07 WORK SEQUENCE

A. Coordinate construction schedule and operations with Owner.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 20 00

PRICE AND PAYMENT PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Procedures for preparation and submittal of applications for progress payments.

B. Procedures for preparation and submittal of application for final payment.

1.02 RELATED REQUIREMENTS

A. Section 00 50 00 - Contracting Forms and Supplements: Forms to be used.

B. Section 01 78 00 - Closeout Submittals: Project record documents.

1.03 SCHEDULE OF VALUES

A. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit draft to Architect for approval.

B. Forms filled out by hand will not be accepted.

1.04 APPLICATIONS FOR PROGRESS PAYMENTS

A. Payment Period: Submit at intervals stipulated in the Agreement.

B. Electronic media printout including equivalent information will be considered in lieu of standard form specified; submit sample to Architect for approval.

C. Forms filled out by hand will not be accepted.

D. For each item, provide a column for listing each of the following:
   1. Item Number.
   2. Description of work.
   3. Scheduled Values.
   4. Previous Applications.
   5. Work in Place and Stored Materials under this Application.
   6. Authorized Change Orders.
   7. Total Completed and Stored to Date of Application.
   8. Percentage of Completion.
   9. Balance to Finish.
   10. Retainage.

E. Execute certification by signature of authorized officer.

F. Use data from approved Schedule of Values. Provide dollar value in each column for each line item for portion of work performed and for stored products.

G. List each authorized Change Order as a separate line item, listing Change Order number and dollar amount as for an original item of work.

H. Submit PDF copies of each Application for Payment.

I. Include the following with the application:
   1. Partial release of liens from major subcontractors and vendors.

1.05 MODIFICATION PROCEDURES

A. Refer to the General Conditions for Modification Procedures.

1.06 APPLICATION FOR FINAL PAYMENT

A. Prepare Application for Final Payment as specified for progress payments, identifying total adjusted Contract Sum, previous payments, and sum remaining due.

B. Application for Final Payment will not be considered until the following have been accomplished:
   1. All closeout procedures specified in Section 01 70 00.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 22 00
UNIT PRICES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. List of unit prices, for use in preparing Bids.

B. Measurement and payment criteria applicable to Work performed under a unit price payment method.

C. Defect assessment and non-payment for rejected work.

1.02 RELATED REQUIREMENTS

A. Document 00 21 13 - Instructions to Bidders: Instructions for preparation of pricing for Unit Prices.

B. Document 00 43 22 - Unit Prices Form: List of Unit Prices as supplement to Bid Form

C. Section 01 20 00 - Price and Payment Procedures: Additional payment and modification procedures.

1.03 COSTS INCLUDED

A. Unit Prices included on the Bid Form shall include full compensation for all required labor, products, tools, equipment, plant, transportation, services and incidentals; erection, application or installation of an item of the Work; overhead and profit.
   1. Prices will be added or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

B. Assume scope shown in the documents for inclusion in base bid as described in the section Base Bid Allocations, below. Also include a schedule of unit prices, for items listed below.

C. Adjustments, based on actual quantities and unit prices, for items listed below, will be handled in the form of a Change Order.

1.04 UNIT QUANTITIES SPECIFIED

A. Quantities indicated in the Bid Form are for bidding and contract purposes only. Quantities and measurements of actual Work will determine the payment amount.

1.05 MEASUREMENT OF QUANTITIES

A. Take all measurements and compute quantities. Measurements and quantities will be verified by Architect.

B. Assist by providing necessary equipment, workers, and survey personnel as required.

C. Measurement by Area: Measured by square dimension using mean length and width or radius.

D. Linear Measurement: Measured by linear dimension, at the item centerline or mean chord.

E. Stipulated Price Measurement: Items measured by weight, volume, area, or linear means or combination, as appropriate, as a completed item or unit of the Work.

F. Perform surveys required to determine quantities, including control surveys to establish measurement reference lines. Notify Architect prior to starting work.

G. Contractor's Engineer Responsibilities: Sign surveyor's field notes or keep duplicate field notes, calculate and certify quantities for payment purposes.

1.06 PAYMENT

A. Payment for Work governed by unit prices will be made on the basis of the actual measurements and quantities of Work that is incorporated in or made necessary by the Work and accepted by the Architect, multiplied by the unit price.

B. Payment will not be made for any of the following:
   1. Products wasted or disposed of in a manner that is not acceptable.

2. Products determined as unacceptable before or after placement.
3. Products not completely unloaded from the transporting vehicle.
4. Products placed beyond the lines and levels of the required Work.
5. Products remaining on hand after completion of the Work.
6. Loading, hauling, and disposing of rejected Products.

1.07 DEFECT ASSESSMENT

A. Replace Work, or portions of the Work, not conforming to specified requirements.

B. If, in the opinion of Owner, it is not practical to remove and replace the Work, Owner will direct one of the following remedies:
   1. The defective Work may remain, but the unit price will be adjusted to a new unit price at the discretion of Owner.
   2. The defective Work will be partially repaired to the instructions of the Owner, and the unit price will be adjusted to a new unit price at the discretion of Owner.

C. The individual specification sections may modify these options or may identify a specific formula or percentage price reduction.

D. The authority of Owner to assess the defect and identify payment adjustment is final.

1.08 SCHEDULE OF UNIT PRICES

A. Item: No. 1 - add/deduct treating of Surface Imperfection; Section 03 35 11 - Concrete Floor Finishes.

B. Item: No. 2 - add/deduct filling Control Joints; Section 03 35 11 - Concrete Floor Finishes.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

SECTION 01 23 00

ALTERNATES

PART 1 GENERAL

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 25 00

SUBSTITUTION PROCEDURES

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

2.01 GENERAL REQUIREMENTS

A. A Substitution Request for products, assemblies, materials, and equipment constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product, equipment, assembly, or system.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Agrees to coordinate installation and make changes to other work that may be required for the work to be complete, with no additional cost to Owner.
   4. Waives claims for additional costs or time extension that may subsequently become apparent.

B. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents. Burden of proof is on proposer.

C. Content: Include information necessary for tracking the status of each Substitution Request, and information necessary to provide an actionable response.

D. Limit each request to a single proposed substitution item.

2.02 RESOLUTION

2.03 ACCEPTANCE

END OF SECTION

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SECTION 01 30 00
ADMINISTRATIVE REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. General administrative requirements.

B. Preconstruction meeting.

C. Progress meetings.

D. Construction progress schedule.

E. Submittals for review, information, and project closeout.

F. Number of copies of submittals.

G. Requests for Information (RFI) procedures.

H. Submittal procedures.

1.02 RELATED REQUIREMENTS

A. Section 01 60 00 - Product Requirements: General product requirements.

B. Section 01 70 00 - Execution and Closeout Requirements: Additional coordination requirements.

C. Section 01 78 00 - Closeout Submittals: Project record documents; operation and maintenance data; warranties and bonds.

1.03 GENERAL ADMINISTRATIVE REQUIREMENTS

A. Conform to 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 Architect:
   1. Requests for Information (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. Correction Punch List and Final Correction Punch List for Substantial Completion.
   10. Closeout submittals.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRECONSTRUCTION MEETING

A. Contractor will schedule a meeting after Notice of Award.

B. Attendance Required:
   1. Owner.
      a. By phone
   2. Contractor.
   3. Tenant.

C. Agenda:
   1. Use of premises by Contractor.
   2. Security and housekeeping procedures.
   3. Designation of personnel representing the parties to Contract, Owner and Architect.
   4. Procedures and processing of field decisions, submittals, substitutions, applications for payments, proposal request, Change Orders, and Contract closeout procedures.

5. Scheduling.
6. Site mobilization.

D. Record minutes and distribute copies within two days after meeting to participants, with PDF copies to Architect, Owner, participants, and those affected by decisions made.

3.02 PROGRESS MEETINGS

A. Contractor will make arrangements for meetings, prepare agenda with copies for participants, preside at meetings.

B. Attendance Required:
1. Contractor.
2. Owner.
   a. By phone
3. Architect.
   a. ONLY AS REQUIRED - Limited scope of work during CA phase.
4. Contractor's superintendent.
5. Tenant.

C. 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. Planned progress during succeeding work period.
6. Coordination of projected progress.
7. Effect of proposed changes on progress schedule and coordination.
8. Other business relating to work.

D. Record minutes and distribute copies within two days after meeting to participants, with two copies to Architect, Owner, participants, and those affected by decisions made.

3.03 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. Within 10 days after joint review, submit complete schedule.

C. Submit updated schedule with each Application for Payment.

3.04 REQUESTS FOR INFORMATION (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 the Contract Documents.
2. A resolution to an issue which has arisen due to field conditions and affects design intent.

B. 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.

C. Content: Include identifiers necessary for tracking the status of each RFI, and information necessary to provide an actionable response.

D. Attachments: Include sketches, coordination drawings, descriptions, photos, submittals, and other information necessary to substantiate the reason for the request.

E. RFI Log: Prepare and maintain a tabular log of RFIs for the duration of the project.

F. Review Time: Architect will respond and return RFIs to Contractor within five 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.

G. 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.

3.05 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 Architect for review for the limited purpose of checking for conformance with information given and the design concept expressed in the contract documents.

C. Samples will be reviewed for aesthetic, color, or finish selection.

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.

3.06 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 Architect's knowledge as contract administrator or for Owner.

3.07 SUBMITTALS FOR PROJECT CLOSEOUT

A. Submit Correction Punch List for Substantial Completion.

B. Submit Final Correction Punch List for Substantial Completion.

C. When the following are specified in individual sections, submit them at project closeout in conformance to requirements of Section 01 78 00 - Closeout Submittals:
   1. Project record documents.
   2. Operation and maintenance data.
   3. Warranties.
   4. Bonds.
      a. As required by Owner
   5. Other types as indicated.

D. Record Drawings

E. Submit for Owner's benefit during and after project completion.

3.08 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. Extra Copies at Project Closeout: See Section 01 78 00.

C. Samples: Submit the number specified in individual specification sections; one of which will be retained by Architect.

1. After review, produce duplicates.
2. Retained samples will not be returned to Contractor unless specifically so stated.

3.09 SUBMITTAL PROCEDURES

A. General Requirements:
   1. Use a separate transmittal for each item.
   2. Submit separate packages of submittals for review and submittals for information, when included in the same specification section.
   3. Transmit using approved form.
      a. Use Contractor's form, subject to prior approval by Architect.
   4. Sequentially identify each item. For revised submittals use original number and a sequential numerical suffix.
   5. Identify: Project; Contractor; subcontractor or supplier; pertinent drawing and detail number; and specification section number and article/paragraph, as appropriate on each copy.
   6. 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.
   7. Deliver each submittal on date noted in submittal schedule, unless an earlier date has been agreed to by all affected parties, and is of the benefit to the project.
      a. Deliver physical submittals to Architect at business address.
      b. Send submittals in electronic format via email to Architect.
   8. Schedule submittals to expedite the Project, and coordinate submission of related items.
      a. For each submittal for review, allow 10 days excluding delivery time to and from the Contractor.
         1) Response period may be shortened or lengthened for specific items, subject to mutual agreement.
   9. Identify variations from Contract Documents and product or system limitations that may be detrimental to successful performance of the completed work.
   10. Provide space for Contractor and Architect review stamps.
   11. When revised for resubmission, identify all changes made since previous submission.
   12. Distribute reviewed submittals. Instruct parties to promptly report inability to comply with requirements.
   13. 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.
   14. Submittals not requested will not be recognized or processed.

B. Product Data Procedures:
   1. Submit only information required by individual specification sections.
   2. Collect required information into a single submittal.
   3. Submit concurrently with related shop drawing submittal.
   4. Do not submit (Material) Safety Data Sheets for materials or products.

C. Shop Drawing Procedures:
   1. Prepare accurate, drawn-to-scale, original shop drawing documentation by interpreting the Contract Documents and coordinating related work.
   2. Do not reproduce the Contract Documents to create shop drawings.
   3. Generic, non-project-specific information submitted as shop drawings do not meet the requirements for shop drawings.

D. Samples Procedures:
   1. Transmit related items together as single package.
   2. Identify each item to allow review for applicability in relation to shop drawings showing installation locations.

3.10 SUBMITTAL REVIEW

A. Submittals for Review: Architect will review each submittal, and approve, or take other appropriate action.

B. Submittals for Information: Architect will acknowledge receipt and review. See below for actions to be taken.

C. Architect'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. Architect's and consultants' actions on items submitted for review:
   1. Authorizing purchasing, fabrication, delivery, and installation:
      a. "Approved", or language with same legal meaning.
      b. "Approved as Noted, Resubmission not required", or language with same legal meaning.
         1) At Contractor's option, submit corrected item, with review notations acknowledged and incorporated.
      c. "Approved as Noted, Resubmit for Record", or language with same legal meaning.
         1) Resubmit corrected item, with review notations acknowledged and incorporated. Resubmit separately, or as part of project record documents.
         2) Non-responsive resubmittals may be rejected.
   2. Not Authorizing fabrication, delivery, and installation:
      a. "Revise and Resubmit".
         1) Resubmit revised item, with review notations acknowledged and incorporated.
         2) Non-responsive resubmittals may be rejected.
      b. "Rejected".
         1) Submit item complying with requirements of Contract Documents.

E. Architect'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:
      a. "Reviewed" - no further action is required from Contractor.

END OF SECTION

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SECTION 01 32 16
CONSTRUCTION PROGRESS SCHEDULE

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Preliminary schedule.

B. Construction progress schedule, bar chart type.

1.02 RELATED SECTIONS

A. Section 01 10 00 - Summary: Work sequence.

1.03 REFERENCE STANDARDS

A. AGC (CPSM) - Construction Planning and Scheduling Manual; 2004.

B. M-H (CPM) - CPM in Construction Management - Project Management with CPM; O'Brien; 2006.

1.04 SUBMITTALS

A. Within 2 days after date of Agreement, submit preliminary schedule defining planned operations for the first 30 days of Work, with a general outline for remainder of Work.

B. If preliminary schedule requires revision after review, submit revised schedule within 1 days.

C. Within 1 days after review of preliminary schedule, submit draft of proposed complete schedule for review.

D. Within 1 days after joint review, submit complete schedule.

E. Submit updated schedule with each Application for Payment.

1.05 QUALITY ASSURANCE

A. Scheduler: Contractor's personnel or specialist Consultant specializing in CPM scheduling with one years minimum experience in scheduling construction work of a complexity comparable to this Project, and having use of computer facilities capable of delivering a detailed graphic printout within 48 hours of request.

1.06 SCHEDULE FORMAT

A. Listings: In chronological order according to the start date for each activity. Identify each activity with the applicable specification section number.

B. Diagram Sheet Size: Maximum 22 x 17 inches (560 x 432 mm).

C. Sheet Size: Multiples of 8-1/2 x 11 inches (216 x 280 mm).

D. Scale and Spacing: To allow for notations and revisions.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 PRELIMINARY SCHEDULE

A. Prepare preliminary schedule in the form of a horizontal bar chart.

3.02 CONTENT

A. Show complete sequence of construction by activity, with dates for beginning and completion of each element of construction.

B. Identify each item by specification section number.

C. Identify work of separate stages and other logically grouped activities.

D. Show accumulated percentage of completion of each item, and total percentage of Work completed, as of the first day of each month.

E. Provide separate schedule of submittal dates for shop drawings, product data, and samples, and dates reviewed submittals will be required from Architect. Indicate decision dates for selection of finishes.

F. Coordinate content with schedule of values specified in Section 01 20 00 - Price and Payment Procedures.

G. Provide legend for symbols and abbreviations used.

3.03 BAR CHARTS

A. Include a separate bar for each major portion of Work or operation.

B. Identify the first work day of each week.

3.04 REVIEW AND EVALUATION OF SCHEDULE

A. Participate in joint review and evaluation of schedule with Architect at each submittal.

B. Evaluate project status to determine work behind schedule and work ahead of schedule.

C. After review, revise as necessary as result of review, and resubmit within 10 days.

3.05 UPDATING SCHEDULE

A. Maintain schedules to record actual start and finish dates of completed activities.

B. Indicate progress of each activity to date of revision, with projected completion date of each activity.

C. Annotate diagrams to graphically depict current status of Work.

D. Identify activities modified since previous submittal, major changes in Work, and other identifiable changes.

E. Indicate changes required to maintain Date of Substantial Completion.

F. Submit reports required to support recommended changes.

3.06 DISTRIBUTION OF SCHEDULE

A. Distribute copies of updated schedules to Contractor's project site file, to subcontractors, suppliers, Architect, Owner, and other concerned parties.

B. Instruct recipients to promptly report, in writing, problems anticipated by projections indicated in schedules.

END OF SECTION

SECTION 01 35 53

SECURITY PROCEDURES

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Security measures including formal security program and miscellaneous restrictions.

1.02 RELATED REQUIREMENTS

A. Section 01 10 00 - Summary: use of premises and occupancy.

1.03 SECURITY PROGRAM

A. Protect Work, existing premises and Owner's operations from theft, vandalism, and unauthorized entry.

B. Initiate program in coordination with Owner's existing security system at project mobilization.

C. Maintain program throughout construction period until Owner acceptance precludes the need for Contractor security.

1.04 RESTRICTIONS

A. Do not allow cameras on site or photographs taken except by written approval of Owner.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 40 00
QUALITY REQUIREMENTS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. References and standards.

B. Testing and inspection agencies and services.

C. Control of installation.

D. Tolerances.

E. Manufacturers' field services.

F. Defect Assessment.

1.02 RELATED REQUIREMENTS

A. Section 01 30 00 - Administrative Requirements: Submittal procedures.

B. Section 01 42 16 - Definitions.

C. Section 01 60 00 - Product Requirements: Requirements for material and product quality.

1.03 REFERENCE STANDARDS

A. ASTM C1021 - Standard Practice for Laboratories Engaged in Testing of Building Sealants; 2008 (Reapproved 2014).

B. ASTM C1077 - Standard Practice for Agencies Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Testing Agency Evaluation; 2017.

C. ASTM E329 - Standard Specification for Agencies Engaged in Construction Inspection, Testing, or Special Inspection; 2018.

D. ASTM E543 - Standard Specification for Agencies Performing Nondestructive Testing; 2015.

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.

B. Conform to reference standard of date of issue current on date of Contract Documents, except where a specific date is established by applicable code.

C. Obtain copies of standards where required by product specification sections.

D. Maintain copy at project site during submittals, planning, and progress of the specific work, until Substantial Completion.

E. Should specified reference standards conflict with Contract Documents, request clarification from Architect before proceeding.

F. Neither the contractual relationships, duties, or responsibilities of the parties in Contract nor those of Architect shall be altered from the Contract Documents by mention or inference otherwise in any reference document.

1.05 TESTING AND INSPECTION AGENCIES AND SERVICES

A. Owner will employ and pay for services of an independent testing agency to perform specified testing and inspection.

B. Employment of agency in no way relieves Contractor of obligation to perform Work in accordance with requirements of Contract Documents.

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 Architect 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. Have work performed by persons qualified to produce required and specified quality.

F. Verify that field measurements are as indicated on shop drawings or as instructed by the manufacturer.

G. 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 Architect before proceeding.

C. Adjust products to appropriate dimensions; position before securing products in place.

3.03 TESTING AND INSPECTION

A. See individual specification sections and drawings for testing and inspection required.

B. Testing Agency Duties:
   1. Provide qualified personnel at site. Cooperate with Architect and Contractor in performance of services.
   2. Perform specified sampling and testing of products in accordance with specified standards.
   3. Ascertain compliance of materials and mixes with requirements of Contract Documents.
   4. Promptly notify Architect and Contractor of observed irregularities or non-conformance of Work or products.
   5. Perform additional tests and inspections required by Architect.
   6. Submit reports of all tests/inspections specified.

C. Limits on Testing/Inspection Agency Authority:
   1. Agency may not release, revoke, alter, or enlarge on requirements of Contract Documents.
   2. Agency may not approve or accept any portion of the Work.
   3. Agency may not assume any duties of Contractor.
   4. Agency has no authority to stop the Work.

D. Contractor Responsibilities:
   1. Deliver to agency at designated location, adequate samples of materials proposed to be used that require testing, along with proposed mix designs.
   2. Cooperate with laboratory personnel, and provide access to the Work and to manufacturers' facilities.
   3. Provide incidental labor and facilities:
      a. To provide access to Work to be tested/inspected.
      b. To obtain and handle samples at the site or at source of Products to be tested/inspected.
      c. To facilitate tests/inspections.

d. To provide storage and curing of test samples.

4. Notify Architect and laboratory 24 hours prior to expected time for operations requiring testing/inspection services.
5. Employ services of an independent qualified testing laboratory and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.
6. Arrange with Owner's agency and pay for additional samples, tests, and inspections required by Contractor beyond specified requirements.

E. Re-testing required because of non-conformance to specified requirements shall be performed by the same agency on instructions by Architect.

F. Re-testing required because of non-conformance to specified requirements shall be paid for by Contractor.

3.04 MANUFACTURERS' FIELD SERVICES

A. When specified in individual specification sections, require material or product suppliers or manufacturers to provide qualified staff personnel to observe site conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust, and balance equipment as applicable, and to initiate instructions when necessary.

B. Report observations and site decisions or instructions given to applicators or installers that are supplemental or contrary to manufacturers' written instructions.

3.05 DEFECT ASSESSMENT

A. Replace work or portions of the work not conforming to specified requirements.

B. If, in the opinion of Owner, it is not practical to remove and replace the work, Owner will direct an appropriate remedy or adjust payment.

END OF SECTION

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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. State of Oregon amendments to some or all of the following.

D. City of Gresham amendments to some or all of the following.

E. ICC A117.1 - Accessible and Usable Buildings and Facilities; 2017.

F. NFPA 1 - Fire Code; 2018.

G. NFPA 101 - Life Safety Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

H. Fire Code: 2014 Oregon Fire Code (OFC).

I. Building Code: 2014 Oregon Structural Specialty Code (OSSC).

J. Plumbing Code: 2014 Oregon Plumbing Specialty Code (OPSC).

K. Mechanical Code: 2014 Oregon Mechanical Specialty Code (OMSC).

L. Electrical Code: 2014 Oregon Electrical Specialty Code (OESC).

M. Energy Code: 2014 Oregon Energy Efficiency Specialty Code (OEESC).

1.02 RELATED REQUIREMENTS

A. Section 01 40 00 - Quality Requirements.

1.03 QUALITY ASSURANCE

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

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 42 16

DEFINITIONS

PART 1 GENERAL

1.01 SUMMARY

A. Other definitions are included in individual specification sections.

1.02 DEFINITIONS

A. Furnish: To supply, deliver, unload, and inspect for damage.

B. Install: To unpack, assemble, erect, apply, place, finish, cure, protect, clean, start up, and make ready for use.

C. 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.

D. Provide: To furnish and install.

E. Supply: Same as Furnish.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 50 00
TEMPORARY FACILITIES AND CONTROLS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Temporary utilities.

B. Temporary telecommunications services.

C. Temporary sanitary facilities.

D. Temporary Controls: Barriers, enclosures, and fencing.

E. Security requirements.

F. Vehicular access and parking.

G. Waste removal facilities and services.

H. Field offices.

1.02 RELATED REQUIREMENTS

A. Section 01 35 53 - Security Procedures

1.03 REFERENCE STANDARDS

A. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2018.

B. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements; 2009 (Reapproved 2016).

1.04 TEMPORARY UTILITIES

A. Owner will provide the following:
   1. Electrical power and metering, consisting of connection to existing facilities.
   2. Water supply, consisting of connection to existing facilities.

B. Existing facilities may be used.

C. Use trigger-operated nozzles for water hoses, to avoid waste of water.

1.05 TELECOMMUNICATIONS SERVICES

A. Provide, maintain, and pay for telecommunications services to field office at time of project mobilization.

B. Architect will pay for own telecommunications services.

1.06 TEMPORARY SANITARY FACILITIES

A. Provide and maintain required facilities and enclosures. Provide at time of project mobilization.

B. Use of existing facilities is permitted.

C. Maintain daily in clean and sanitary condition.

D. At end of construction, return facilities to same or better condition as originally found.

1.07 BARRIERS

A. 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.

D. Protect non-owned vehicular traffic, stored materials, site, and structures from damage.

1.08 FENCING

A. Construction: Contractor's option.

1.09 EXTERIOR ENCLOSURES

A. 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.

1.10 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:

1.11 SECURITY - SEE SECTION 01 35 53

A. Provide security and facilities to protect Work, existing facilities, and Owner's operations from unauthorized entry, vandalism, or theft.

B. Coordinate with Owner's security program.

1.12 VEHICULAR ACCESS AND PARKING

A. Comply with regulations relating to use of streets and sidewalks, access to emergency facilities, and access for emergency vehicles.

B. Coordinate access and haul routes with governing authorities and Owner.

C. Provide and maintain access to fire hydrants, free of obstructions.

D. Provide means of removing mud from vehicle wheels before entering streets.

E. Provide temporary parking areas to accommodate construction personnel. When site space is not adequate, provide additional off-site parking.

F. Existing parking areas may be used for construction parking.
   1. Coordinate with Owner on quantity of available spaces and location.

1.13 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. 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.

D. Open free-fall chutes are not permitted. Terminate closed chutes into appropriate containers with lids.

1.14 FIELD OFFICES

A. Designated existing spaces may be used for field offices: Coordinate with Owner.

B. Office: Weathertight, with lighting, electrical outlets, heating, cooling equipment, and equipped with sturdy furniture, drawing rack, and drawing display table.

C. Provide space for Project meetings, with table and chairs to accommodate 6 persons.

D. Locate offices a minimum distance of 30 feet (10 m) from existing and new structures.

1.15 REMOVAL OF UTILITIES, FACILITIES, AND CONTROLS

A. Remove temporary utilities, equipment, facilities, materials, prior to Date of Substantial Completion inspection.

B. Clean and repair damage caused by installation or use of temporary work.

C. Restore existing facilities used during construction to original condition.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

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SECTION 01 57 13

TEMPORARY EROSION AND SEDIMENT CONTROL

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Prevention of erosion due to construction activities.

B. Prevention of sedimentation of waterways, open drainage ways, and storm and sanitary sewers due to construction activities.

C. Restoration of areas eroded due to insufficient preventive measures.

1.02 REFERENCE STANDARDS

A. EPA (NPDES) - National Pollutant Discharge Elimination System (NPDES), Construction General Permit; Current Edition.

B. FHWA FLP-94-005 - Best Management Practices for Erosion and Sediment Control; 1995.

1.03 PERFORMANCE REQUIREMENTS

A. Comply with requirements of EPA (NPDES) for erosion and sedimentation control, as specified by the NPDES, for Phases I and II, and in compliance with requirements of Construction General Permit (CGP), whether the project is required by law to comply or not.

B. Also comply with all more stringent requirements of State of Oregon Erosion and Sedimentation Control Manual.

C. Timing: Put preventive measures in place as soon as possible after disturbance of surface cover and before precipitation occurs.

D. Storm Water Runoff: Control increased storm water runoff due to disturbance of surface cover due to construction activities for this project.
   1. Prevent runoff into storm and sanitary sewer systems, including open drainage channels, in excess of actual capacity or amount allowed by authorities having jurisdiction, whichever is less.
   2. Anticipate runoff volume due to the most extreme short term and 24-hour rainfall events that might occur in 25 years.

E. Erosion On Site: Minimize wind, water, and vehicular erosion of soil on project site due to construction activities for this project.
   1. Control movement of sediment and soil from temporary stockpiles of soil.
   2. Prevent development of ruts due to equipment and vehicular traffic.
   3. If erosion occurs due to non-compliance with these requirements, restore eroded areas at no cost to Owner.

F. Sedimentation of Waterways On Site: Prevent sedimentation of waterways on the project site, including rivers, streams, lakes, ponds, open drainage ways, storm sewers, and sanitary sewers.
   1. If sedimentation occurs, install or correct preventive measures immediately at no cost to Owner; remove deposited sediments; comply with requirements of authorities having jurisdiction.
   2. If sediment basins are used as temporary preventive measures, pump dry and remove deposited sediment after each storm.

G. Maintenance: Maintain temporary preventive measures until permanent measures have been established.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine site and identify existing features that contribute to erosion resistance; maintain such existing features to greatest extent possible.

3.02 PREPARATION

A. Schedule work so that soil surfaces are left exposed for the minimum amount of time.

3.03 MAINTENANCE

A. Inspect preventive measures weekly, within 24 hours after the end of any storm that produces 0.5 inches (13 mm) or more rainfall at the project site, and daily during prolonged rainfall.

B. Repair deficiencies immediately.

C. Clean out temporary sediment control structures weekly and relocate soil on site.

D. Place sediment in appropriate locations on site; do not remove from site.

3.04 CLEAN UP

A. Remove temporary measures after permanent measures have been installed, unless permitted to remain by Architect.

B. Clean out temporary sediment control structures that are to remain as permanent measures.

C. Where removal of temporary measures would leave exposed soil, shape surface to an acceptable grade and finish to match adjacent ground surfaces.

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.

1.02 RELATED REQUIREMENTS

A. Section 01 61 16 - Volatile Organic Compound (VOC) Content Restrictions: Requirements for VOC-restricted product categories.

1.03 REFERENCE STANDARDS

A. GreenScreen (LIST) - GreenScreen for Safer Chemicals List Translator; Clean Production Action; www.greenscreenchemicals.org.

B. GreenScreen (METH) - GreenScreen for Safer Chemicals Method v1.2; Clean Production Action; www.greenscreenchemicals.org.

1.04 SUBMITTALS

A. Proposed Products List: Submit list of major products proposed for use, with name of manufacturer, trade name, and model number of each product.
   1. Submit within 15 days after date of Agreement.
   2. For products specified only by reference standards, list applicable reference standards.

B. Product Data Submittals: Submit manufacturer's standard published data. Mark each copy to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information specific to this Project.

C. Shop Drawing Submittals: Prepared specifically for this Project; indicate utility and electrical characteristics, utility connection requirements, and location of utility outlets for service for functional equipment and appliances.

D. Sample Submittals: Illustrate functional and aesthetic characteristics of the product, with integral parts and attachment devices. Coordinate sample submittals for interfacing work.
   1. For selection from standard finishes, submit samples of the full range of the manufacturer's standard colors, textures, and patterns.

PART 2 PRODUCTS

2.01 EXISTING PRODUCTS

A. Do not use materials and equipment removed from existing premises unless specifically required or permitted by the Contract Documents.

B. 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.

C. Reused Products: Reused products include materials and equipment previously used in this or other construction, salvaged and refurbished as specified.

D. Specific Products to be Reused: The reuse of certain materials and equipment already existing on the project site is required.
   1. See drawings for list of items required to be salvaged for reuse and relocation.

2.02 NEW PRODUCTS

A. Provide new products unless specifically required or permitted by the Contract Documents.

B. DO NOT USE products having any of the following characteristics:
   1. Made using or containing CFC's or HCFC's.
   2. Made of wood from newly cut old growth timber.
   3. Containing lead, cadmium, asbestos.

C. Where all other criteria are met, Contractor shall give preference to products that:
   1. If used on interior, have lower emissions, as defined in Section 01 61 16.
   2. If wet-applied, have lower VOC content, as defined in Section 01 61 16.
   3. Are extracted, harvested, and/or manufactured closer to the location of the project.
   4. Have longer documented life span under normal use.
   5. Result in less construction waste.
   6. Are made of recycled materials.
   7. If made of wood, are made of sustainably harvested wood, wood chips, or wood fiber.
   8. Have a published Environmental Product Declaration (EPD).
   9. Have a published Health Product Declaration (HPD).
   10. Have a published GreenScreen Chemical Hazard Analysis.

2.03 PRODUCT OPTIONS

A. Products Specified by Reference Standards or by Description Only: Use any product meeting those standards or description.

B. 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.

C. Products Specified by Naming One or More Manufacturers with a Provision for Substitutions: Submit a request for substitution for any manufacturer not named.

2.04 MAINTENANCE MATERIALS

A. Furnish extra materials, spare parts, tools, and software of types and in quantities specified in individual specification sections.

B. Deliver to Project site; obtain receipt prior to final payment.

PART 3 EXECUTION

3.01 SUBSTITUTION LIMITATIONS

A. Submit substitution requests by completing CSI Form 13.1.A; see this section for additional information and instructions. Use only this form; other forms of submission are unacceptable.

B. Substitutions will be considered when a product, through no fault of the Contractor, becomes unavailable or unsuitable due to regulatory change.
   1. Submit request for Substitution for Cause immedately upon discovery of need for substitution, but not later than 5 days prior to time required for review and approval by Architect.

C. Document each request with complete data substantiating compliance of proposed substitution with Contract Documents.

D. A request for substitution constitutes a representation that the submitter:
   1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
   2. Agrees to provide the same warranty for the substitution as for the specified product.
   3. Agrees to coordinate installation and make changes to other Work that may be required for the Work to be complete with no additional cost to Owner.
   4. Waives claims for additional costs or time extension that may subsequently become apparent.

E. Substitutions will not be considered when they are indicated or implied on shop drawing or product data submittals, without separate written request, or when acceptance will require revision to the Contract Ducuments.

F. Substitution Submittal Procedure (after contract award):
   1. Submit PDF copies of request for substitution for consideration. Limit each request to one proposed substitution.
   2. Use CSI Form 13.1.A.
   3. Submit shop drawings, product data, and certified test results attesting to the proposed product equivalence. Burden of proof is on proposer.
   4. Architect will notify Contractor in writing of decision to accept or reject request.

3.02 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.

3.03 STORAGE AND PROTECTION

A. 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.

B. Store and protect products in accordance with manufacturers' instructions.

C. Store with seals and labels intact and legible.

D. Store sensitive products in weather tight, climate controlled, enclosures in an environment favorable to product.

E. For exterior storage of fabricated products, place on sloped supports above ground.

F. Provide bonded off-site storage and protection when site does not permit on-site storage or protection.

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. Do not store products directly on the ground.

J. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to prevent condensation and degradation of products.

K. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.

L. Prevent contact with material that may cause corrosion, discoloration, or staining.

M. Provide equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.

N. 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 61 16

VOLATILE ORGANIC COMPOUND (VOC) CONTENT RESTRICTIONS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Requirements for Indoor-Emissions-Restricted products.

B. Requirements for VOC-Content-Restricted products.

1.02 RELATED REQUIREMENTS

A. Section 01 30 00 - Administrative Requirements: Submittal procedures.

B. Section 01 40 00 - Quality Requirements: Procedures for testing and certifications.

C. Section 01 60 00 - Product Requirements: Fundamental product requirements, substitutions and product options, delivery, storage, and handling.

1.03 DEFINITIONS

A. Indoor-Emissions-Restricted Products: All products in the following product categories, whether specified or not:
   1. Interior paints and coatings applied on site.
   2. Interior adhesives and sealants applied on site, including flooring adhesives.
   3. Flooring.
   4. Composite wood.
   5. Products making up wall and ceiling assemblies.
   6. Thermal and acoustical insulation.

B. VOC-Content-Restricted Products: All products in the following product categories, whether specified or not:
   1. Interior paints and coatings applied on site.
   2. Interior adhesives and sealants applied on site, including flooring adhesives.
   3. Wet-applied roofing and waterproofing.
   4. Other products when specifically stated in the specifications.

C. Interior of Building: Anywhere inside the exterior weather barrier.

D. Adhesives: All gunnable, trowelable, liquid-applied, and aerosol adhesives, whether specified or not; including flooring adhesives, resilient base adhesives, and pipe jointing adhesives.

E. Sealants: All gunnable, trowelable, and liquid-applied joint sealants and sealant primers, whether specified or not; including firestopping sealants and duct joint sealers.

F. Inherently Non-Emitting Materials: Products composed wholly of minerals or metals, unless they include organic-based surface coatings, binders, or sealants; and specifically the following:
   1. Concrete.
   2. Clay brick.
   3. Metals that are plated, anodized, or powder-coated.
   4. Glass.
   5. Ceramics.
   6. Solid wood flooring that is unfinished and untreated.

1.04 REFERENCE STANDARDS

A. 40 CFR 59, Subpart D - National Volatile Organic Compound Emission Standards for Architectural Coatings; U.S. Environmental Protection Agency; current edition.

B. ASTM D3960 - Standard Practice for Determining Volatile Organic Compound (VOC) Content of Paints and Related Coatings; 2005 (Reapproved 2013).

C. CAL (CDPH SM) - Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions From Indoor Sources Using Environmental Chambers; 2017, v1.2.

D. CARB (ATCM) - Airborne Toxic Control Measure to Reduce Formaldehyde Emissions from Composite Wood Products; California Air Resources Board; current edition.

E. CARB (SCM) - Suggested Control Measure for Architectural Coatings; California Air Resources Board; 2007.

F. CHPS (HPPD) - High Performance Products Database; Current Edition at www.chps.net/.

G. CRI (GLP) - Green Label Plus Testing Program - Certified Products; Current Edition.

H. GreenSeal GS-36 - Adhesives for Commercial Use; 2013.

I. SCAQMD 1113 - Architectural Coatings; 1977 (Amended 2016).

J. SCAQMD 1168 - Adhesive and Sealant Applications; 1989 (Amended 2017).

K. SCS (CPD) - SCS Certified Products; Current Edition.

L. UL (GGG) - GREENGUARD Gold Certified Products; Current Edition.

1.05 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Product Data: For each VOC-restricted product used in the project, submit evidence of compliance.

1.06 QUALITY ASSURANCE

A. Indoor Emissions Standard and Test Method: CAL (CDPH SM), using Standard Private Office exposure scenario and the allowable concentrations specified in the method, and range of total VOC's after 14 days.
   1. Wet-Applied Products: State amount applied in mass per surface area.
   2. Paints and Coatings: Test tinted products, not just tinting bases.
   3. Evidence of Compliance: Acceptable types of evidence are the following;
      a. Current UL (GGG) certification.
      b. Current SCS (CPD) Floorscore certification.
      c. Current SCS (CPD) Indoor Advantage Gold certification.
      d. Current listing in CHPS (HPPD) as a low-emitting product.
      e. Current CRI (GLP) certification.
      f. Test report showing compliance and stating exposure scenario used.
   4. Product data submittal showing VOC content is NOT acceptable evidence.
   5. Manufacturer's certification without test report by independent agency is NOT acceptable evidence.

B. VOC Content Test Method: 40 CFR 59, Subpart D (EPA Method 24), or ASTM D3960, unless otherwise indicated.
   1. Evidence of Compliance: Acceptable types of evidence are:
      a. Report of laboratory testing performed in accordance with requirements.
      b. Published product data showing compliance with requirements.
      c. Certification by manufacturer that product complies with requirements.

C. Composite Wood Emissions Standard: CARB (ATCM) for ultra-low emitting formaldehyde (ULEF) resins.
   1. Evidence of Compliance: Acceptable types of evidence are:
      a. Current SCS "No Added Formaldehyde (NAF)" certification; www.scscertified.com.
      b. Report of laboratory testing performed in accordance with requirements.
      c. Published product data showing compliance with requirements.
      d. Certification by manufacturer that product complies with requirements.

D. Testing Agency Qualifications: Independent firm specializing in performing testing and inspections of the type specified in this section.

PART 2 PRODUCTS

2.01 MATERIALS

A. All Products: Comply with the most stringent of federal, State, and local requirements, or these specifications.

B. Indoor-Emissions-Restricted Products: Comply with Indoor Emissions Standard and Test Method, except for:
   1. Composite Wood, Wood Fiber, and Wood Chip Products: Comply with Composite Wood Emissions Standard or contain no added formaldehyde resins.
   2. Inherently Non-Emitting Materials.

C. VOC-Content-Restricted Products: VOC content not greater than required by the following:
   1. Adhesives, Including Flooring Adhesives: SCAQMD 1168 Rule.
   2. Aerosol Adhesives: GreenSeal GS-36.
   3. Joint Sealants: SCAQMD 1168 Rule.
   4. Paints and Coatings: Each color; most stringent of the following:
      a. 40 CFR 59, Subpart D.
      b. SCAQMD 1113 Rule.
      c. CARB (SCM).
   5. Wet-Applied Roofing and Waterproofing: Comply with requirements for paints and coatings.

PART 3 EXECUTION

3.01 FIELD QUALITY CONTROL

A. Owner reserves the right to reject non-compliant products, whether installed or not, and require their removal and replacement with compliant products at no extra cost to Owner.

B. Additional costs to restore indoor air quality due to installation of non-compliant products will be borne by Contractor.

END OF SECTION

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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. Surveying for laying out the work.

F. Cleaning and protection.

G. Starting of systems and equipment.

H. Demonstration and instruction of Owner personnel.

I. Closeout procedures, including Contractor's Correction Punch List, except payment procedures.

1.02 RELATED REQUIREMENTS

A. Section 01 10 00 - Summary: Limitations on working in existing building; continued occupancy; work sequence; identification of salvaged and relocated materials.

B. Section 01 30 00 - Administrative Requirements: Submittals procedures, Electronic document submittal service.

C. Section 01 40 00 - Quality Requirements: Testing and inspection procedures.

D. Section 01 50 00 - Temporary Facilities and Controls: Temporary exterior enclosures.

E. Section 01 50 00 - Temporary Facilities and Controls: Temporary interior partitions.

F. Section 01 57 13 - Temporary Erosion and Sediment Control: Additional erosion and sedimentation control requirements.

G. Section 01 78 00 - Closeout Submittals: Project record documents, operation and maintenance data, warranties, and bonds.

H. Individual Product Specification Sections:
   1. Advance notification to other sections of openings required in work of those sections.
   2. Limitations on cutting structural members.

1.03 REFERENCE STANDARDS

A. NFPA 241 - Standard for Safeguarding Construction, Alteration, and Demolition Operations; 2013.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Survey work: Submit name, address, and telephone number of Surveyor before starting survey work.
   1. On request, submit documentation verifying accuracy of survey work.
   2. Submit a copy of site drawing signed by the Land Surveyor, that the elevations and locations of the work are in conformance with Contract Documents.
   3. Submit surveys and survey logs for the project record.

C. Cutting and Patching: Submit written request in advance of cutting or alteration that affects:
   1. Structural integrity of any element of Project.
   2. Integrity of weather exposed or moisture resistant element.
   3. Efficiency, maintenance, or safety of any operational element.
   4. Visual qualities of sight exposed elements.
   5. Work of Owner or separate Contractor.

6. Include in request:
    a. Identification of Project.
    b. Location and description of affected work.
    c. Necessity for cutting or alteration.
    d. Description of proposed work and products to be used.
    e. Effect on work of Owner or separate Contractor.
    f. Written permission of affected separate Contractor.
    g. Date and time work will be executed.

D. Project Record Documents: Accurately record actual locations of capped and active utilities.

1.05 QUALIFICATIONS

A. For demolition work, employ a firm specializing in the type of work required.
    1. Minimum of five years of documented experience.

B. For surveying work, employ a land surveyor registered in the State in which the Project is located and acceptable to Architect. Submit evidence of surveyor's Errors and Omissions insurance coverage in the form of an Insurance Certificate. Employ only individual(s) trained and experienced in collecting and recording accurate data relevant to ongoing construction activities,

C. For field engineering, employ a professional engineer of the discipline required for specific service on Project, licensed in the State in which the Project is located. Employ only individual(s) trained and experienced in establishing and maintaining horizontal and vertical control points necessary for laying out construction work on project of similar size, scope and/or complexity.

D. For design of temporary shoring and bracing, employ a Professional Engineer experienced in design of this type of work and licensed in the State in which the Project is located.

1.06 PROJECT CONDITIONS

A. Protect site from puddling or running water. Provide water barriers as required to protect site from soil erosion.

B. Ventilate enclosed areas to assist cure of materials, to dissipate humidity, and to prevent accumulation of dust, fumes, vapors, or gases.

C. 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 barriers between construction areas and areas continuing to be occupied by Owner.

D. 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.

E. Noise Control: Provide methods, means, and facilities to minimize noise produced by construction operations.
    1. At All Times: Excessively noisy tools and operations will not be tolerated inside the building at any time of day; excessively noisy includes jackhammers.
    2. Outdoors: Limit conduct of especially noisy exterior work to the hours of 8 am to 5 pm.
    3. Indoors: Limit conduct of especially noisy interior work to the hours of 6 pm to 7 am.

F. Pest and Rodent Control: Provide methods, means, and facilities to prevent pests and insects from damaging the work.

G. 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.

1.07 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 Architect 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 Architect, Owner, participants, and those affected by decisions made.

3.04 LAYING OUT THE WORK

A. Verify locations of survey control points prior to starting work.

B. Promptly notify Architect of any discrepancies discovered.

C. Contractor shall locate and protect survey control and reference points.

D. Protect survey control points prior to starting site work; preserve permanent reference points during construction.

E. Promptly report to Architect the loss or destruction of any reference point or relocation required because of changes in grades or other reasons.

F. Replace dislocated survey control points based on original survey control. Make no changes without prior written notice to Architect.

G. Utilize recognized engineering survey practices.

H. Establish elevations, lines and levels. Locate and lay out by instrumentation and similar appropriate means:
   1. Site improvements including pavements; stakes for grading, fill and topsoil placement; utility locations, slopes, and invert elevations.

I. Periodically verify layouts by same means.

J. Maintain a complete and accurate log of control and survey work as it progresses.

3.05 GENERAL INSTALLATION REQUIREMENTS

A. In addition to compliance with regulatory requirements, conduct construction operations in compliance with NFPA 241, including applicable recommendations in Appendix A.

B. 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.

C. Make vertical elements plumb and horizontal elements level, unless otherwise indicated.

D. Install equipment and fittings plumb and level, neatly aligned with adjacent vertical and horizontal lines, unless otherwise indicated.

E. Make consistent texture on surfaces, with seamless transitions, unless otherwise indicated.

F. Make neat transitions between different surfaces, maintaining texture and appearance.

3.06 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 Architect 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 rotted wood, corroded metals, and deteriorated masonry and concrete; replace with new construction specified.
   2. Remove items indicated on drawings.
   3. Relocate items indicated on drawings.
   4. 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.
   5. 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, Electrical, Telecommunications, and Security): 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. See Section 01 10 00 for other limitations on outages and required notifications.
      c. 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; 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 Architect.
   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 Architect review and request instructions.

4. Trim existing wood and metal 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.

3.07 CUTTING AND PATCHING

A. Whenever possible, execute the work by methods that avoid cutting or patching.

B. See Alterations article above for additional requirements.

C. 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-conforming work.

D. 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.

E. Employ original installer to perform cutting for weather exposed and moisture resistant elements, and sight exposed surfaces.

F. Cut rigid materials using masonry saw or core drill. Pneumatic tools not allowed without prior approval.

G. Restore work with new products in accordance with requirements of Contract Documents.

H. Fit work air tight to pipes, sleeves, ducts, conduit, and other penetrations through surfaces.

I. 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.

J. 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. Match color, texture, and appearance.
3. 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.

3.08 PROGRESS CLEANING

A. Maintain areas free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.

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.

3.09 PROTECTION OF INSTALLED WORK

A. Protect installed work from damage by construction operations.

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. Protect work from spilled liquids. If work is exposed to spilled liquids, immediately remove protective coverings, dry out work, and replace protective coverings.

G. 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.

H. Prohibit traffic from landscaped areas.

I. Remove protective coverings when no longer needed; reuse or recycle coverings if possible.

3.10 SYSTEM STARTUP

A. Coordinate schedule for start-up of various equipment and systems.

B. 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.

C. Verify tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.

D. Verify that wiring and support components for equipment are complete and tested.

E. Execute start-up under supervision of applicable Contractor personnel and manufacturer's representative in accordance with manufacturers' instructions.

F. 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.

G. Submit a written report that equipment or system has been properly installed and is functioning correctly.

3.11 DEMONSTRATION AND INSTRUCTION

A. Demonstrate start-up, operation, control, adjustment, trouble-shooting, servicing, maintenance, and shutdown of each item of equipment at scheduled time, at equipment location.

B. For equipment or systems requiring seasonal operation, perform demonstration for other season within six months.

C. Provide a qualified person who is knowledgeable about the Project to perform demonstration and instruction of Owner's personnel.

D. Utilize operation and maintenance manuals as basis for instruction. Review contents of manual with Owner's personnel in detail to explain all aspects of operation and maintenance.

E. Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instruction.

3.12 ADJUSTING

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

3.13 FINAL CLEANING

A. Execute final cleaning prior to final project assessment.
   1. Clean areas to be occupied by Owner prior to final completion before Owner occupancy.

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. Clean filters of operating equipment.

G. Clean debris from roofs, area drains, and drainage systems.

H. Clean site; sweep paved areas, rake clean landscaped surfaces.

I. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner; do not burn or bury.

3.14 CLOSEOUT PROCEDURES

A. Make submittals that are required by governing or other authorities.
   1. Provide copies to Architect and Owner.

B. Accompany Project Coordinator on preliminary inspection to determine items to be listed for completion or correction in the Contractor's Correction Punch List for Contractor's Notice of Substantial Completion.

C. Notify Architect when work is considered ready for Architect'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 in accordance with Contract Documents and ready for Architect's Substantial Completion inspection.

E. Owner will occupy all of the building as specified in Section 01 10 00.

F. Conduct Substantial Completion inspection and create Final Correction Punch List containing Architect's and Contractor's comprehensive list of items identified to be completed or corrected and submit to Architect.

G. Correct items of work listed in Final Correction Punch List and comply with requirements for access to Owner-occupied areas.

H. Notify Architect when work is considered finally complete and ready for Architect's Substantial Completion final inspection.

I. Complete items of work determined by Architect listed in executed Certificate of Substantial Completion.

END OF SECTION

SECTION 01 74 19

CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

PART 1 GENERAL

1.01 WASTE MANAGEMENT REQUIREMENTS

A. Owner requires that this project generate the least amount of trash and waste possible.

B. Employ processes that ensure the generation of as little waste as possible due to error, poor planning, breakage, mishandling, contamination, or other factors.

C. Minimize trash/waste disposal in landfills; reuse, salvage, or recycle as much waste as economically feasible.

D. Required Recycling, Salvage, and Reuse: The following may not be disposed of in landfills or by incineration:
   1. Aluminum and plastic beverage containers.
   2. Corrugated cardboard.
   3. Wood pallets.
   4. Clean dimensional wood.
   5. Land clearing debris, including brush, branches, logs, and stumps.
   6. Asphalt paving.
   7. Metals, including packaging banding, metal studs, sheet metal, structural steel, piping, reinforcing bars, door frames, and other items made of steel, iron, galvanized steel, stainless steel, aluminum, copper, zinc, lead, brass, and bronze.
   8. Glass.
   9. Gypsum drywall and plaster.
   10. Plastic buckets.
   11. Carpet, carpet cushion, carpet tile, and carpet remnants, both new and removed: DuPont (http://flooring.dupont.com) and Interface (www.interfaceinc.com) conduct reclamation programs.
   12. Asphalt roofing shingles.
   13. Paint.
   14. Plastic sheeting.
   15. Rigid foam insulation.
   16. Windows, doors, and door hardware.
   17. Mechanical and electrical equipment.
   18. Fluorescent lamps (light bulbs).
   19. Acoustical ceiling tile and panels.

E. Contractor shall develop and follow a Waste Management Plan designed to implement these requirements.

F. Methods of trash/waste disposal that are not acceptable are:
   1. Burning on the project site.
   2. Burying on the project site.
   3. Dumping or burying on other property, public or private.
   4. Other illegal dumping or burying.
   5. Incineration, either on- or off-site.

G. Regulatory Requirements: Contractor is responsible for knowing and complying with regulatory requirements, including but not limited to Federal, state and local requirements, pertaining to legal disposal of all construction and demolition waste materials.

1.02 RELATED REQUIREMENTS

A. Section 01 10 00 - Summary: List of items to be salvaged from the existing building for relocation in project or for Owner.

B. Section 01 30 00 - Administrative Requirements: Additional requirements for project meetings, reports, submittal procedures, and project documentation.

C. Section 01 50 00 - Temporary Facilities and Controls: Additional requirements related to trash/waste collection and removal facilities and services.

D. Section 01 60 00 - Product Requirements: Waste prevention requirements related to delivery, storage, and handling.

E. Section 01 70 00 - Execution and Closeout Requirements: Trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

1.03 DEFINITIONS

A. Clean: Untreated and unpainted; not contaminated with oils, solvents, caulk, or the like.

B. Construction and Demolition Waste: Solid wastes typically including building materials, packaging, trash, debris, and rubble resulting from construction, remodeling, repair and demolition operations.

C. Hazardous: Exhibiting the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity or reactivity.

D. Nonhazardous: Exhibiting none of the characteristics of hazardous substances, i.e., ignitibility, corrosivity, toxicity, or reactivity.

E. Nontoxic: Neither immediately poisonous to humans nor poisonous after a long period of exposure.

F. Recyclable: The ability of a product or material to be recovered at the end of its life cycle and remanufactured into a new product for reuse by others.

G. Recycle: To remove a waste material from the project site to another site for remanufacture into a new product for reuse by others.

H. Recycling: The process of sorting, cleansing, treating and reconstituting solid waste and other discarded materials for the purpose of using the altered form. Recycling does not include burning, incinerating, or thermally destroying waste.

I. Return: To give back reusable items or unused products to vendors for credit.

J. Reuse: To reuse a construction waste material in some manner on the project site.

K. Salvage: To remove a waste material from the project site to another site for resale or reuse by others.

L. Sediment: Soil and other debris that has been eroded and transported by storm or well production run-off water.

M. Source Separation: The act of keeping different types of waste materials separate beginning from the first time they become waste.

N. Toxic: Poisonous to humans either immediately or after a long period of exposure.

O. Trash: Any product or material unable to be reused, returned, recycled, or salvaged.

P. Waste: Extra material or material that has reached the end of its useful life in its intended use. Waste includes salvageable, returnable, recyclable, and reusable material.

1.04 SUBMITTALS

A. See Section 01 30 00 - Administrative Requirements, for submittal procedures.

B. Submit Waste Management Plan within 10 calendar days after receipt of Notice of Award of Bid, or prior to any trash or waste removal, whichever occurs sooner; submit projection of all trash and waste that will require disposal and alternatives to landfilling.

C. Waste Management Plan: Include the following information:
   1. Analysis of the trash and waste projected to be generated during the entire project construction cycle, including types and quantities.
   2. Landfill Options: The name, address, and telephone number of the landfill(s) where trash/waste will be disposed of, the applicable landfill tipping fee(s), and the projected cost of disposing of all project trash/waste in the landfill(s).

3. Landfill Alternatives: List all waste materials that will be diverted from landfills by reuse, salvage, or recycling.
   a. List each material proposed to be salvaged, reused, or recycled.
4. Meetings: Describe regular meetings to be held to address waste prevention, reduction, recycling, salvage, reuse, and disposal.
5. Materials Handling Procedures: Describe the means by which materials to be diverted from landfills will be protected from contamination and prepared for acceptance by designated facilities; include separation procedures for recyclables, storage, and packaging.
6. Transportation: Identify the destination and means of transportation of materials to be recycled; i.e. whether materials will be site-separated and self-hauled to designated centers, or whether mixed materials will be collected by a waste hauler.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 WASTE MANAGEMENT PROCEDURES

A. See Section 01 10 00 for list of items to be salvaged from the existing building for relocation in project or for Owner.

B. See Section 01 30 00 for additional requirements for project meetings, reports, submittal procedures, and project documentation.

C. See Section 01 50 00 for additional requirements related to trash/waste collection and removal facilities and services.

D. See Section 01 60 00 for waste prevention requirements related to delivery, storage, and handling.

E. See Section 01 70 00 for trash/waste prevention procedures related to demolition, cutting and patching, installation, protection, and cleaning.

3.02 WASTE MANAGEMENT PLAN IMPLEMENTATION

A. Manager: Designate an on-site person or persons responsible for instructing workers and overseeing and documenting results of the Waste Management Plan.

B. Communication: Distribute copies of the Waste Management Plan to job site foreman, each subcontractor, Owner, and Architect.

C. Instruction: Provide on-site instruction of appropriate separation, handling, and recycling, salvage, reuse, and return methods to be used by all parties at the appropriate stages of the project.

D. Meetings: Discuss trash/waste management goals and issues at project meetings, particularly at:
   1. Pre-construction meeting.

E. Facilities: Provide specific facilities for separation and storage of materials for recycling, salvage, reuse, return, and trash disposal, for use by all contractors and installers.
   1. As a minimum, provide:
      a. Separate area for storage of materials to be reused on-site, such as wood cut-offs for blocking.
      b. Separate dumpsters for each category of recyclable.
      c. Recycling bins at worker lunch area.
   2. Provide containers as required.
   3. Provide adequate space for pick-up and delivery and convenience to subcontractors.
   4. Keep recycling and trash/waste bin areas neat and clean and clearly marked in order to avoid contamination of materials.

F. Hazardous Wastes: Separate, store, and dispose of hazardous wastes according to applicable regulations.

G. Recycling: Separate, store, protect, and handle at the site identified recyclable waste products in order to prevent contamination of materials and to maximize recyclability of identified materials. Arrange for timely pickups from the site or deliveries to recycling facility in order to prevent contamination of recyclable materials.

H. Reuse of Materials On-Site: Set aside, sort, and protect separated products in preparation for reuse.

I. Salvage: Set aside, sort, and protect products to be salvaged for reuse off-site.

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 and bonds.

1.02 RELATED REQUIREMENTS

A. Section 01 30 00 - Administrative Requirements: Submittals procedures, shop drawings, product data, and samples.

B. Section 01 70 00 - Execution and Closeout Requirements: Contract closeout procedures.

C. Individual Product Sections: Specific requirements for operation and maintenance data.

D. Individual Product Sections: Warranties required for specific products or Work.

1.03 SUBMITTALS

A. Project Record Documents: Submit documents to Architect with claim for final Application for Payment.

B. Operation and Maintenance Data:
   1. Submit two copies of preliminary draft or proposed formats and outlines of contents before start of Work. Architect will review draft and return one copy with comments.
   2. For equipment, or component parts of equipment put into service during construction and operated by Owner, submit completed documents within ten days after acceptance.
   3. Submit one copy of completed documents 15 days prior to final inspection. This copy will be reviewed and returned after final inspection, with Architect comments. Revise content of all document sets as required prior to final submission.
   4. Submit two sets of revised final documents in final form within 10 days after final inspection.

C. Warranties and Bonds:
   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.

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 depths of foundations in relation to finish first floor datum.
   2. Measured horizontal and vertical locations of underground utilities and appurtenances, referenced to permanent surface improvements.
   3. Measured locations of internal utilities and appurtenances concealed in construction, referenced to visible and accessible features of the Work.
   4. Field changes of dimension and detail.
   5. Details not on original Contract drawings.

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. For Each Product, Applied Material, and Finish:
   1. Product data, with catalog number, size, composition, and color and texture designations.
   2. Information for re-ordering custom manufactured products.

B. 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.

C. 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.

D. Additional information as specified in individual product specification sections.

E. 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. Panelboard Circuit Directories: Provide electrical service characteristics, controls, and communications; typed.

D. Include color coded wiring diagrams as installed.

E. 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.

F. 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.

G. Provide servicing and lubrication schedule, and list of lubricants required.

H. Include manufacturer's printed operation and maintenance instructions.

I. Include sequence of operation by controls manufacturer.

J. Provide original manufacturer's parts list, illustrations, assembly drawings, and diagrams required for maintenance.

K. Additional Requirements: As specified in individual product specification sections.

3.05 ASSEMBLY OF OPERATION AND MAINTENANCE MANUALS

A. Assemble operation and maintenance data into durable manuals 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 tabbed divider for each system.

C. Prepare instructions and data by personnel experienced in maintenance and operation of described products.

D. Prepare data in the form of an instructional manual.

E. Binders: Commercial quality, 8-1/2 by 11 inch (216 by 280 mm) three D side ring binders with durable plastic covers; 2 inch (50 mm) maximum ring size. When multiple binders are used, correlate data into related consistent groupings.

F. Cover: Identify each binder with typed or printed title OPERATION AND MAINTENANCE INSTRUCTIONS; identify title of Project; identify subject matter of contents.

G. Project Directory: Title and address of Project; names, addresses, and telephone numbers of Architect, Consultants, Contractor and subcontractors, with names of responsible parties.

H. Tables of Contents: List every item separated by a divider, using the same identification as on the divider tab; where multiple volumes are required, include all volumes Tables of Contents in each volume, with the current volume clearly identified.

I. Dividers: Provide tabbed dividers for each separate product and system; identify the contents on the divider tab; immediately following the divider tab include a description of product and major component parts of equipment.

J. Text: Manufacturer's printed data, or typewritten data on 20 pound paper.

K. Drawings: Provide with reinforced punched binder tab. Bind in with text; fold larger drawings to size of text pages.

L. Arrangement of Contents: Organize each volume in parts as follows:
   1. Project Directory.
   2. Table of Contents, of all volumes, and of this volume.
   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.

3.06 WARRANTIES AND BONDS

A. Obtain warranties and bonds, executed in duplicate by responsible Subcontractors, suppliers, and manufacturers, within 10 days after completion of the applicable item of work. Except for items put into use with Owner's permission, leave date of beginning of time of warranty until Date of Substantial completion is determined.

B. Verify that documents are in proper form, contain full information, and are notarized.

C. Co-execute submittals when required.

D. Retain warranties and bonds until time specified for submittal.

E. Include originals of each in operation and maintenance manuals, indexed separately on Table of Contents.
   1. Include PDF copies to be indexed in the PDF set on either DVD or Thumb Drive.

END OF SECTION

DIVISION 02 - EXISTING CONDITIONS

SECTION 02 41 00 - DEMOLITION

GENERAL PROCEDURES AND PROJECT CONDITIONS

Comply with applicable codes and regulations for demolition operations and safety of adjacent structures and the public.

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DIVISION 03 - CONCRETE

SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

FORMWORK

Formwork Design and Construction: Comply with guidelines of ACI 347R to provide formwork that will produce concrete complying with tolerances of ACI 117.

Form Materials: Contractor's choice of standard products with sufficient strength to withstand hydrostatic head without distortion in excess of permitted tolerances.

REINFORCEMENT MATERIALS

Steel Welded Wire Reinforcement (WWR): Galvanized, plain type, ASTM A1064/A1064M.

CONCRETE MATERIALS

Cement: ASTM C150/C150M, Type I - Normal Portland type.

Fine and Coarse Aggregates: ASTM C33/C33M.

Water: Clean and not detrimental to concrete.

ACCESSORY MATERIALS

Underslab Vapor Retarder: Sheet material complying with ASTM E1745, Class A; stated by manufacturer as suitable for installation in contact with soil or granular fill under concrete slabs. The use of single ply polyethylene is prohibited.

Non-Shrink Cementitious Grout: Premixed compound consisting of non-metallic aggregate, cement, water reducing and plasticizing agents.

CURING MATERIALS

Curing Compound, Naturally Dissipating: Clear, water-based, liquid membrane-forming compound; complying with ASTM C309.

Water: Potable, not detrimental to concrete.

CONCRETE MIX DESIGN

Proportioning Normal Weight Concrete: Comply with ACI 211.1 recommendations.

Concrete Strength: Establish required average strength for each type of concrete on the basis of field experience or trial mixtures, as specified in ACI 301.

Normal Weight Concrete:

Compressive Strength, when tested in accordance with ASTM C39/C39M at 28 days: 3,000 pounds per square inch (20.7 MPa).

PLACING CONCRETE

Place concrete in accordance with ACI 304R.

Place concrete for floor slabs in accordance with ACI 302.1R.

SECTION 03 35 11 - CONCRETE FLOOR FINISHES

CONCRETE FLOOR FINISH APPLICATIONS

Unless otherwise indicated, all concrete floors are to be finished using liquid densifier/hardener.

Liquid Densifier/Hardener:

Use at following locations: _____.

Penetrating Clear Sealer:

Use at following locations: _____.

Polished Finish:

Use at following locations: _____.

SURFACE TREATMENTS

Troweling Aid, Densifier and Curing Agent: Liquid reactive colloidal silica-based topical treatment, spray-applied to wet concrete and floated or troweled into the surface.

Product:

DENSIFIERS AND HARDENERS

Liquid Densifier/Hardener: Penetrating chemical compound that reacts with concrete, filling the pores and dustproofing; for application to concrete after set.

COATINGS

Penetrating Sealer: Transparent, non-yellowing, water- or solvent-based coating.

POLISHED CONCRETE SYSTEM

Polished Concrete System: Materials, equipment, and procedures designed and furnished by a single manufacturer to produce dense polished concrete of the specified sheen.

DIVISION 04 - MASONRY

SECTION 04 20 01 - MASONRY VENEER

BRICK UNITS

Facing Brick: ASTM C216, Type FBS Smooth, Grade SW.

MORTAR AND GROUT MATERIALS

Masonry Cement: ASTM C91/C91M Type N.

Portland Cement: ASTM C150/C150M, Type I; color as required to produce approved color sample.

Hydrated Lime: ASTM C207, Type S.

Grout Aggregate: ASTM C404.

Water: Clean and potable.

REINFORCEMENT AND ANCHORAGE

Reinforcing Steel: ASTM A615/A615M, Grade 40 (40,000 psi) (280 MPa) yield strength, deformed billet bars; galvanized.

Joint Reinforcement: Truss type; ASTM A1064/A1064M steel wire, hot dip galvanized after fabrication to ASTM A153/A153M, Class B; 0.1483 inch (3.8 mm) side rods with 0.1483 inch (3.8 mm) cross rods; width as required to provide not more than 1 inch (25 mm) and not less than 1/2 inch (13 mm) of mortar coverage on each exposure.

Masonry Veneer Anchors: 2-piece anchors that permit differential movement between masonry veneer and structural backup, hot dip galvanized to ASTM A 153/A 153M, Class B.

FLASHINGS

Flexible Flashing with Elvaloy KEE: Solid-phase flexibilizer added to membrane flashing.

Pre-Coated Galvanized Steel: ASTM A653/A653M, with G90/Z275 coating, 24 gage, 0.0239 inch (0.61 mm) base metal thickness, shop precoated with fluoropolymer coating in color matching masonry.

ACCESSORIES

Preformed Control Joints: Rubber material. Provide with corner and tee accessories, fused joints.

Cavity Vents: Polyester mesh.

MORTAR AND GROUT MIXES

Mortar for Unit Masonry: ASTM C270, Proportion Specification.

Colored Mortar: Proportion selected pigments and other ingredients to match Architect's sample, without exceeding manufacturer's recommended pigment-to-cement ratio.

Grout: ASTM C476; consistency as required to fill volumes completely for grouting; fine grout for spaces with smallest horizontal dimension of 2 inches (50 mm) or less; coarse grout for spaces with smallest horizontal dimension greater than 2 inches (50 mm).

COURSING

Maintain masonry courses to uniform dimension. Form vertical and horizontal joints of uniform thickness.

Brick Units:

Bond: Running.

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DIVISION 05 - METALS

SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

MATERIALS

Steel Angles and Plates: ASTM A36/A36M.

Hot-Formed Structural Tubing: ASTM A501/A501M, seamless or welded.

Steel Bars: ASTM A108 Grade _____.

Steel Plate: ASTM A514/A514M.

Steel Sheet: ASTM A1011/A1011M, Designation SS, Grade 30 hot-rolled, or ASTM A1008/A1008M, Designation SS, Grade 30 cold-rolled.

Pipe: ASTM A53/A53M, Grade B, Finish black.

Structural Bolts and Nuts: Carbon steel, ASTM A307, Grade A and galvanized in compliance with ASTM A153/A153M, Class C.

Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

Shop and Touch-Up Primer: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

Touch-Up Primer for Galvanized Surfaces: Fabricator's standard, complying with VOC limitations of authorities having jurisdiction.

SECTION 05 12 13 - ARCHITECTURALLY-EXPOSED STRUCTURAL STEEL FRAMING

GENERAL REQUIREMENTS

Comply with Section 05 12 00, except as amended in this section for aesthetic purposes.

Comply with AISC 303, Section 10 for specific AESS category designated on drawings.

MATERIALS

General: Meet requirements of 05 12 00 as amended below.

SECTION 05 31 00 - STEEL DECKING

STEEL DECK

All Deck Types: Select and design metal deck in accordance with SDI Design Manual.

Roof Deck: Non-composite type, fluted steel sheet:

Galvanized Steel Sheet: ASTM A653/A653M, Structural Steel (SS) Grade 33/230, with G90/Z275 galvanized coating.

Primer: Shop coat of manufacturer's standard primer paint over cleaned and phosphatized substrate.

SECTION 05 40 00 - COLD-FORMED METAL FRAMING

FRAMING SYSTEM

Provide primary and secondary framing members, bridging, bracing, plates, gussets, clips, fittings, reinforcement, and fastenings as required to provide a complete framing system.

FRAMING MATERIALS

Studs and Track: ASTM C955; studs formed to channel, "C", or "Sigma" shape with punched web; U-shaped track in matching nominal width and compatible height.

Galvanized in accordance with ASTM A653/A653M, G90/Z275 coating.

Joists and Purlins: Fabricated from ASTM A653/A653M steel sheet, with G90/Z275 hot dipped galvanized coating.

Framing Connectors: Factory-made, formed steel sheet.

Material: ASTM A653/A653M SS Grade 33 and 40 (minimum), with G90/Z275 hot dipped galvanized coating for base metal thickness less than 10 gage, 0.1345 inch (3.42 mm), and factory punched holes and slots.

FASTENERS

Self-Drilling, Self-Tapping Screws, Bolts, Nuts and Washers: Hot dip galvanized per ASTM A153/A153M.

Anchorage Devices: Powder actuated.

Welding: In conformance with AWS D1.1/D1.1M.

WALL SHEATHING

Gypsum Board Wall Sheathing: See Section 09 21 16.

SECTION 05 50 00 - METAL FABRICATIONS

MATERIALS - STEEL

Steel Sections: ASTM A36/A36M.

Steel Tubing: ASTM A501/A501M hot-formed structural tubing.

Plates: ASTM A283/A283M.

Pipe: ASTM A53/A53M, Grade B Schedule 40, black finish.

Bolts, Nuts, and Washers: ASTM A307, Grade A, plain.

Welding Materials: AWS D1.1/D1.1M; type required for materials being welded.

Shop and Touch-Up Primer: SSPC-Paint 15, complying with VOC limitations of authorities having jurisdiction.

Touch-Up Primer for Galvanized Surfaces: SSPC-Paint 20, Type I - Inorganic, complying with VOC limitations of authorities having jurisdiction.

FABRICATION

Fit and shop assemble items in largest practical sections, for delivery to site.

Fabricate items with joints tightly fitted and secured.

FINISHES - STEEL

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

SECTION 06 10 00 - ROUGH CARPENTRY

GENERAL REQUIREMENTS

Dimension Lumber: Comply with PS 20 and requirements of specified grading agencies.

If no species is specified, provide any species graded by the agency specified; if no grading agency is specified, provide lumber graded by any grading agency meeting the specified requirements.

Grading Agency: Any grading agency whose rules are approved by the Board of Review, American Lumber Standard Committee (www.alsc.org) and who provides grading service for the species and grade specified; provide lumber stamped with grade mark unless otherwise indicated.

DIMENSION LUMBER FOR CONCEALED APPLICATIONS

Sizes: Nominal sizes as indicated on drawings, S4S.

Moisture Content: S-dry or MC19.

Miscellaneous Framing, Blocking, Nailers, Grounds, and Furring:

Lumber: S4S, No. 2 or Standard Grade.

Boards: Standard or No. 3.

CONSTRUCTION PANELS

Wall Sheathing: Plywood, PS 1, Grade C-D, Exposure I.

Communications and Electrical Room Mounting Boards: PS 1 A-D plywood, or medium density fiberboard; 3/4 inch (19 mm) thick; flame spread index of 25 or less, smoke developed index of 450 or less, when tested in accordance with ASTM E84.

FACTORY WOOD TREATMENT

Treated Lumber and Plywood: Comply with requirements of AWPA U1 - Use Category System for wood treatments determined by use categories, expected service conditions, and specific applications.

FRAMING INSTALLATION

Set structural members level, plumb, and true to line. Discard pieces with defects that would lower required strength or result in unacceptable appearance of exposed members.

Install structural members full length without splices unless otherwise specifically detailed.

SECTION 06 41 00 - ARCHITECTURAL WOOD CASEWORK

CABINETS

Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

Plastic Laminate Faced Cabinets: Custom grade.

Cabinets:

Finish - Exposed Exterior Surfaces: Decorative laminate.
Finish - Exposed Interior Surfaces: Decorative laminate.
Finish - Concealed Surfaces: White melamine.
Door and Drawer Front Edge Profiles: Square edge with thin applied band.
Casework Construction Type: Type A - Frameless.
Interface Style for Cabinet and Door: Style 1 - Overlay; flush overlay.
Drawer Side Construction: Multiple-dovetailed.
Drawer Construction Technique: Dovetail joints.

LAMINATE MATERIALS

High Pressure Decorative Laminate (HPDL): NEMA LD 3, types as recommended for specific applications.

COUNTERTOPS

Countertops are specified in Section 12 36 00.

SECTION 06 83 16 - FIBERGLASS REINFORCED PANELING

PANEL SYSTEMS

Wall Panels:

Panel Size: 4 by 8 feet (1.2 by 2.4 m).
Panel Thickness: 0.10 inch (2.5 mm).
Surface Design: Smooth.
Color: As indicated on drawings.
Attachment Method: Adhesive only, sealant joints, no trim.

MATERIALS

Panels: Fiberglass reinforced plastic (FRP), complying with ASTM D5319.

Surface Burning Characteristics: Maximum flame spread index of 25 and smoke developed index of 450; when system tested in accordance with ASTM E84.

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

SECTION 07 13 00 - SHEET WATERPROOFING

WATERPROOFING APPLICATIONS

Composite HDPE/Bentonite Sheet Membrane:

Location: _____.

Vertical Surfaces: Adhesive bonded to substrate.

Horizontal Surfaces: Adhesive bonded to substrate.

Cover with protection board.

MEMBRANE MATERIALS

Composite HDPE/Bentonite Sheet Membrane: Comprised of black/gray HDPE and granular bentonite with spun polypropylene fabric facing.

Seaming Materials: As recommended by membrane manufacturer.

Membrane Sealant: As recommended by membrane manufacturer.

SECTION 07 21 00 - THERMAL INSULATION

FIBERBOARD INSULATION MATERIALS

Mineral Fiberboard Insulation: Rigid or semi-rigid mineral fiber, ASTM C612 or ASTM C553; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.

Board Thickness: 1 inch (25 mm).

Thermal Resistance: R-value (RSI-value) of 4.2 degrees F hr sq ft/Btu (0.74 K sq m/W) per inch at 75 degrees F (24 C), minimum, when tested according to ASTM C518.

BATT INSULATION MATERIALS

Mineral Fiber Batt Insulation: Flexible or semi-rigid preformed batt or blanket, complying with ASTM C665; friction fit; unfaced flame spread index of 0 (zero) when tested in accordance with ASTM E84.

Flame Spread Index: 25 or less, when tested in accordance with ASTM E84.

Thermal Resistance: R-value (RSI-value) of ____ (____).

Thickness: __ inch (__ mm).

Flexible Blanket Insulation: Thin profile insulation that conforms to complex shapes, unfaced; flame spread index of 5 (five) and smoke development index of 10 (ten) or less when tested in accordance with ASTM E84.

ACCESSORIES

Sheet Vapor Retarder: Specified in in section 07 25 00.

Adhesive: Type recommended by insulation manufacturer for application.

SECTION 07 25 00 - WEATHER BARRIERS

WEATHER BARRIER ASSEMBLIES

Air Barrier:

Interior Vapor Retarder:

On inside face of studs of exterior walls, under cladding, use mechanically fastened vapor retarder sheet.

On inside face of masonry and concrete walls use vapor retarder coating.

AIR BARRIER MATERIALS (WATER VAPOR PERMEABLE AND WATER-RESISTIVE)

Air Barrier Sheet, Self-Adhered:

Air Permeance: 0.004 cubic feet per minute per square foot (0.02 L/s/sq m), maximum, when tested in accordance with ASTM E2178.

Water Vapor Permeance: 10 perms (572 ng/(Pa s sq m)), minimum, when tested in accordance with ASTM E96/E96M Procedure A (desiccant procedure).

Water Penetration Resistance Around Nails: Pass, when tested in accordance with ASTM D1970/D1970M (modified).

Manufacturers:

VAPOR RETARDER MATERIALS (AIR BARRIER AND WATER-RESISTIVE)

Vapor Retarder Sheet Type ___: ASTM D4397 polyethylene film reinforced with glass fiber square mesh, clear.

SECTION 07 51 00 - BUILT-UP BITUMINOUS ROOFING

ROOFING - PROTECTED MEMBRANE APPLICATION

Built-up Bituminous Roofing: Asphalt felt membrane, four ply, with separation sheet, insulation, water pervious fabric, and ballast.

Ballast: Comply with SPRI RP-4 for System 1, Exposure A, using aggregate over entire surface.

SHEET MATERIALS

Vapor Retarder Felt: Asphalt-saturated organic, ASTM D226/D226M, Type I ("No.15") felt, unperforated.

Base Sheet: ASTM D2178/D2178M Type IV; asphalt-coated glass fiber, unperforated.

Roofing Felt: ASTM D2178/D2178M; Asphalt-saturated glass fiber felt; standard duty.

Base Flashing Material: Modified bitumen, reinforced, smooth surface.

Flexible Flashing Material: Modified bitumen, SBS type.

Separation Sheet: Sheet polyethylene; 2 mil (0.05 mm) thick.

Water Pervious Fabric: Woven polyethylene, UV stabilized, open to moisture movement, black.

BITUMINOUS MATERIALS

Bitumen: ASTM D312/D312M Type I, asphalt.

Primer: ASTM D41/D41M, asphalt type.

Roof Cement: ASTM D4586/D4586M, Type I, asbestos free.

BALLAST MATERIALS - PROTECTED MEMBRANE APPLICATION

No.4 Aggregate: Sound, hard, washed crushed gravel, ASTM D448 Size Classification 4, 3, 24, 2, or 1.

SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

MANUFACTURERS

Sheet Metal Flashing and Trim Manufacturers:

SHEET MATERIALS

Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage, (0.0239 inch) (0.61 mm) thick base metal.

Pre-Finished Galvanized Steel: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 24 gage, (0.0239) inch (0.61 mm) thick base metal, shop pre-coated with PVDF coating.

FABRICATION

Form sections true to shape, accurate in size, square, and free from distortion or defects.

Form pieces in longest possible lengths.

Form material with flat lock seams, except where otherwise indicated; at moving joints, use sealed lapped, bayonet-type or interlocking hooked seams.

ACCESSORIES

Fasteners: Galvanized steel, with soft neoprene washers.

SECTION 07 71 00 - ROOF SPECIALTIES

COMPONENTS

Roof Edge Flashings: Factory fabricated to sizes required; mitered, welded corners; concealed fasteners.

Configuration: Fascia, cant, and edge securement for roof membrane.

Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test methods RE-1 and RE-2 to positive and negative design wind pressure as defined by applicable local building code.

Material: Formed steel sheet, galvanized, 24 gage, 0.024 inch (0.6 mm) thick, minimum.

Copings: Factory fabricated to sizes required; mitered, welded corners; concealed fasteners.

Configuration: Concealed continuous hold down cleat at both legs; internal splice piece at joints of same material, thickness and finish as cap; concealed stainless steel fasteners.

Pull-Off Resistance: Tested in accordance with ANSI/SPRI/FM 4435/ES-1 using test method RE-3 to positive and negative design wind pressure as defined by applicable local building code.

Material: Formed steel sheet, galvanized, 24 gage, 0.024 inch (0.6 mm) thick, minimum.

Pipe and Penetration Flashing: Base of rounded aluminum, compatible with sheet metal roof systems, and capable of accomodating pipes sized between 3/8 inch (9.5 mm) and 12 inch (305 mm).

FINISHES

PVDF (Polyvinylidene Fluoride) Coating: Superior Performance Organic Finish, AAMA 2605; multiple coat, thermally cured fluoropolymer finish system; color as indicated.

SECTION 07 71 23 - MANUFACTURED GUTTERS AND DOWNSPOUTS

MATERIALS

Pre-Finished Galvanized Steel Sheet: ASTM A653/A653M, with G90/Z275 zinc coating; minimum 0.02 inch (0.6 mm) thick base metal.

Finish: Shop pre-coated with modified silicone coating.

COMPONENTS

Gutters: SMACNA square style profile.

Downspouts: SMACNA Square profile.

Anchors and Supports: Profiled to suit gutters and downspouts.

Fasteners: Galvanized steel, with soft neoprene washers.

FABRICATION

Form gutters and downspouts of profiles and size indicated.

Form sections square, true, and accurate in size, in maximum possible lengths, free of distortion or defects detrimental to appearance or performance. Allow for expansion at joints.

FINISHES

Fluoropolymer Coating: High Performance Organic Finish, AAMA 2604; multiple coat, thermally cured fluoropolymer finish system; color as indicated.

SECTION 07 72 00 - ROOF ACCESSORIES

ROOF CURBS

Roof Curbs Mounting Assemblies: Factory fabricated hollow sheet metal construction, internally reinforced, and capable of supporting superimposed live and dead loads and designated equipment load with fully mitered and sealed corner joints welded or mechanically fastened, and integral counterflashing with top and edges formed to shed water.

Sheet Metal Material:

Galvanized Steel: Hot-dip zinc coated steel sheet complying with ASTM A653/A653M, SS Grade 33 (230); G60 (Z180) coating designation; 18 gage, 0.048 inch (1.21 mm) thick.

Curbs at Roof Openings: Provide curb at sides of roof opening, with top of curb horizontal and level for equipment mounting.

Equipment Rail Curbs: Straight curbs on each side of equipment, with top of curbs horizontal and level with each other for equipment mounting.

Equipment Support: Straight curbs on each side of equipment, with top of curbs parallel with metal roofing system and each other for equipment mounting.

Pipe, Duct, or Conduit Mounting Curbs: Vertical posts, minimum 8 inches (400 mm) square unless otherwise indicated.

NON-PENETRATING ROOFTOP SUPPORTS/ASSEMBLIES

Non-Penetrating Rooftop Support/Assemblies: Manufacturer-engineered and factory-fabricated, with pedestal bases that rest on top of roofing membrane, and not requiring any attachment to roof structure and not penetrating roofing assembly.

Design Loadings and Configurations: As required by applicable codes.

Roof Walkways and Platforms: Non-penetrating, mechanically attached walkway system installed over standing seam metal roofs.

Pipe Supports: Provide attachment fixtures complying with MSS SP-58 and as indicated.

SECTION 07 84 00 - FIRESTOPPING

FIRESTOPPING SYSTEMS

Firestopping: Any material meeting requirements.

Fire Ratings: Use system that is listed by FM (AG), ITS (DIR), or UL (FRD) and tested in accordance with ASTM E814, ASTM E119, or UL 1479 with F Rating equal to fire rating of penetrated assembly and minimum T Rating Equal to F Rating and in compliance with other specified requirements.

Fire Ratings: See drawings for required systems and ratings.

Firestopping at Uninsulated Metallic Pipe and Conduit Penetrations, of diameter 4 inches (100 mm) or less: Caulk or putty.

Firestopping at Combustible Pipe and Conduit Penetrations, of diameter 4 inches (100 mm) or less: Any material meeting requirements.

Firestopping at Cable Tray Penetrations: Any material meeting requirements.

Firestopping at Cable Penetrations, not in Conduit or Cable Tray: Caulk or putty.

Firestopping at Control Joints (without Penetrations): Any material meeting requirements.

Firestopping Between Top of Partition Wall and Roof Slab: Fiber firestopping with smoke seal coating; UL Design No. ____, F Rating 1 hour, provide at locations as indicated on drawings.

SECTION 07 92 00 - JOINT SEALANTS

JOINT SEALANT APPLICATIONS

Scope:

Exterior Joints: Seal open joints, whether or not the joint is indicated on drawings, unless specifically indicated not to be sealed. Exterior joints to be sealed include, but are not limited to, the following items.

Wall expansion and control joints.

Joints between door, window, and other frames and adjacent construction.

Joints between different exposed materials.

Openings below ledge angles in masonry.

Other joints indicated below.

Interior Joints: Do not seal interior joints unless specifically indicated to be sealed. Interior joints to be sealed include, but are not limited to, the following items.

Joints between door, window, and other frames and adjacent construction.

In sound-rated wall and ceiling assemblies, gaps at electrical outlets, wiring devices, piping, and other openings; between wall/ceiling and other construction; and other flanking sound paths.

Exception: Such gaps and openings in gypsum board, plaster, and _____ finished stud walls and suspended ceilings.

Exception: Through-penetrations in sound-rated assemblies that are also fire-rated assemblies.

Other joints indicated below.

Do not seal the following types of joints.

Intentional weepholes in masonry.

Joints indicated to be treated with manufactured expansion joint cover or some other type of sealing device.

Joints where sealant is specified to be provided by manufacturer of product to be sealed.

Joints where installation of sealant is specified in another section.

Joints between suspended panel ceilings/grid and walls.

Exterior Joints: Use non-sag non-staining silicone sealant, unless otherwise indicated.

Lap Joints in Sheet Metal Fabrications: Butyl rubber, non-curing.

Control and Expansion Joints in Concrete Paving: Self-leveling polyurethane "traffic-grade" sealant.

Wiring Slots in Concrete Paving: Self-leveling epoxy sealant.

Interior Joints: Use non-sag polyurethane sealant, unless otherwise indicated.

Wall and Ceiling Joints in Non-Wet Areas: Acrylic emulsion latex sealant.

Wall and Ceiling Joints in Wet Areas: Non-sag polyurethane sealant for continuous liquid immersion.

Floor Joints in Wet Areas: Non-sag polyurethane "non-traffic-grade" sealant suitable for continuous liquid immersion.

Wall, Ceiling, and Floor Joints Where Tamper-Resistance is Required: Non-sag tamper-resistant silyl-terminated polyurethane sealant.

Joints between Fixtures in Wet Areas and Floors, Walls, and Ceilings: Mildew-resistant silicone sealant; white.

In Sound-Rated Assemblies: Acrylic emulsion latex sealant.

Other Floor Joints: Self-leveling polyurethane "traffic-grade" sealant.

Interior Wet Areas: Bathrooms, restrooms, kitchens, food service areas, food processing areas, and _____; fixtures in wet areas include plumbing fixtures, food service equipment, countertops, cabinets, other similar items, and _____.

Sound-Rated Assemblies: Walls and ceilings identified as "STC-rated", "sound-rated", or "acoustical".

Areas Where Tamper-Resistance is Required: As indicated on drawings.

JOINT SEALANTS - GENERAL

Sealants and Primers: Provide products with levels of volatile organic compound (VOC) content as indicated in Section 01 61 16.

Colors: As indicated on drawings.

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DIVISION 08 - OPENINGS

SECTION 08 06 71 - DOOR HARDWARE SCHEDULE

SECTION 08 11 13 - HOLLOW METAL DOORS AND FRAMES

DESIGN CRITERIA

Requirements for Hollow Metal Doors and Frames:

Steel used for fabrication of doors and frames shall comply with one or more of the following requirements; Galvannealed steel conforming to ASTM A653/A653M, cold-rolled steel conforming to ASTM A1008/A1008M, or hot-rolled pickled and oiled (HRPO) steel conforming to ASTM A1011/A1011M, Commercial Steel (CS) Type B for each.

Accessibility: Comply with ICC A117.1 and ADA Standards.

Typical Door Face Sheets: Flush.

Hardware Preparations, Selections and Locations: Comply with NAAMM HMMA 830 and NAAMM HMMA 831 or BHMA A156.115 and ANSI/SDI A250.8 (SDI-100) in accordance with specified requirements.

Zinc Coating for Typical Interior and/or Exterior Locations: Provide metal components zinc-coated (galvanized) and/or zinc-iron alloy-coated (galvannealed) by the hot-dip process in accordance with ASTM A653/A653M, with manufacturer's standard coating thickness, unless noted otherwise for specific hollow metal doors and frames.

Based on SDI Standards: Provide at least A40/ZF120 (galvannealed) when necessary, coating not required for typical interior door applications, and at least A60/ZF180 (galvannealed) for corrosive locations.

Hollow Metal Panels: Same construction, performance, and finish as doors.

HOLLOW METAL DOORS

Door Finish: Factory primed and field finished.

Exterior Doors: Thermally insulated. Provide fire-rated door construction as indicated for door Type ___, Fire-Rated Doors and the following exterior door requirements.

Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).

Level 1 - Standard-duty.

Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.

Model 1 - Full Flush.

Door Face Metal Thickness: 20 gage, 0.032 inch (0.8 mm), minimum.

Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.

Door Core Material: Vertical steel stiffeners with fiberglass batts.

Door Thermal Resistance: R-Value of ___.

Door Thickness: 1-3/4 inch (44.5 mm), nominal.

Weatherstripping: Refer to Section 08 71 00.

Interior Doors, Non-Fire Rated:

Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).

Level 1 - Standard-duty.

Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.

Model 1 - Full Flush.

Door Face Metal Thickness: 20 gage, 0.032 inch (0.8 mm), minimum.

Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.

Door Core Material: Manufacturers standard core material/construction and in compliance with requirements.

Door Thickness: 1-3/4 inch (44.5 mm), nominal.

Fire-Rated Doors:

Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).

Level 1 - Standard-duty.

Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.

Model 1 - Full Flush.

Door Face Metal Thickness: 20 gage, 0.032 inch (0.8 mm), minimum.
Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
Fire Rating: As indicated on Door Schedule, tested in accordance with UL 10C and NFPA 252 ("positive pressure fire tests").
Temperature-Rise Rating (TRR) Across Door Thickness: In accordance with local building code and authorities having jurisdiction.
Provide units listed and labeled by UL (DIR) or ITS (DIR).
Smoke and Draft Control Doors (Indicated with letter "S" on Drawings and/or Door Schedule): Self-closing or automatic closing doors in accordance with NFPA 80 and NFPA 105, with fire-resistance-rated wall construction rated the same or greater than the fire-rated doors, and the following;
Maximum Air Leakage: 3.0 cfm/sq ft (0.02 cu m/sec/sq m) of door opening at 0.10 inch w.g. (24.9 Pa) pressure, when tested in accordance with UL 1784 at both ambient and elevated temperatures.
Gasketing: Provide gasketing or edge sealing as necessary to achieve leakage limit.
Label: Include the "S" label on fire-rating label of door.
Door Core Material: Manufacturers standard core material/construction in compliance with requirements.
Door Thickness: 1-3/4 inch (44.5 mm), nominal.

Sound-Rated Interior Doors: Provide fire-rated door construction as indicated for door Type ___, Fire-Rated Doors and the following sound-rated door requirements.
Based on SDI Standards: ANSI/SDI A250.8 (SDI-100).
Level 1 - Standard-duty.
Physical Performance Level C, 250,000 cycles; in accordance with ANSI/SDI A250.4.
Model 1 - Full Flush.
Door Face Metal Thickness: 20 gage, 0.032 inch (0.8 mm), minimum.
Zinc Coating: A60/ZF180 galvannealed coating; ASTM A653/A653M.
Sound Transmission Class (STC) Rating of Door and Frame Assembly: STC of 35, minimum, calculated in accordance with ASTM E413, and tested in accordance with ASTM E90.
Door Core Material: Manufacturer's standard construction as required to meet acoustic requirements indicated.
Door Thickness: As required to meet acoustic requirements indicated.
Sound Seals: Integral, in door and/or frame.
Opening Force of Sound-Rated Doors, Non-Fire Rated: 5 lbs (22.2 N), maximum, in compliance with ADA Standards.

HOLLOW METAL FRAMES

Comply with standards and/or custom guidelines as indicated for corresponding door in accordance with applicable door frame requirements.

Frame Finish: Same as hollow metal door.

Exterior Door Frames: Full profile/continuously welded type.
Galvanizing: Components hot-dipped zinc-iron alloy-coated (galvannealed) in accordance with ASTM A653/A653M, with A40/ZF120 coating.
Frame Metal Thickness: 16 gage, 0.053 inch (1.3 mm), minimum.

Interior Door Frames, Non-Fire Rated: Full profile/continuously welded type.
Terminated Stops: Provide at interior doors; closed end stop terminated 6 inch (150 mm), maximum, above floor at 45 degree angle.
Frame Metal Thickness: 16 gage, 0.053 inch (1.3 mm), minimum.

Door Frames, Fire-Rated: Full profile/continuously welded type.
Fire Rating: Same as door, labeled.
Terminated Stops: Provide at interior doors; closed end stop terminated 6 inch (150 mm), maximum, above floor at 45 degree angle.
Frame Metal Thickness: 14 gage, 0.067 inch (1.7 mm), minimum.

Sound-Rated Door Frames: Full profile/continuously welded type.
Frame Metal Thickness: 16 gage, 0.053 inch (1.3 mm), minimum.

Borrowed Lites Glazing Frames: Construction and face dimensions to match door frames, and as indicated on drawings.

Transom Bars: Fixed, of profile same as jamb and head.

FINISHES

Primer: Rust-inhibiting, complying with ANSI/SDI A250.10, door manufacturer's standard.

ACCESSORIES

SECTION 08 31 00 - ACCESS DOORS AND PANELS

ACCESS DOORS AND PANELS ASSEMBLIES

Wall-Mounted Units:
Location: As indicated on drawings.
Material: Steel.
Size: ___ inch by ___ inch (___ mm by ___ mm).
Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.
Masonry Mounting Criteria: Provide surface-mounted frame with door surface flush with frame surface.

Wall-Mounted Units in Wet Areas:
Location: As indicated on drawings.
Material: Steel, hot-dipped zinc, or zinc-aluminum-alloy coated.
Size: ___ inch by ___ inch (___ mm by ___ mm).
Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.
Wall Mounting Criteria: Provide surface-mounted face frame and door surface flush with frame surface.
Gypsum Board Mounting Criteria: Provide drywall bead frame with door surface flush with wall surface.

Fire-Rated Wall-Mounted Units:
Location: As indicated on drawings.
Wall Fire-Rating: As indicated on drawings.
Material: Steel.
Size: ___ inch by ___ inch (___ mm by ___ mm).
Door/Panel: Insulated double-surface panel, with tool-operated spring or cam lock and no handle.

Ceiling-Mounted Units:
Location: As indicated on drawings.
Material: Steel.
Size - Lay-In Grid Ceilings: To match module of ceiling grid.
Size - Other Ceilings: 12 inch by 12 inch (305 mm by 305 mm).
Door/Panel: Hinged, standard duty, with tool-operated spring or cam lock and no handle.

WALL AND CEILING MOUNTED UNITS

Wall and Ceiling Mounted Units: Factory fabricated door and frame, fully assembled units with corner joints welded, filled and ground flush; square and without rack or warp; coordinate requirements with type of installation assembly being used for each unit.
Style: Exposed frame with door surface flush with frame surface.
Heavy Duty Frames: 14 gage, 0.0747 inch (1.89 mm), minimum thickness.

Double-Skinned Hollow Steel Sheet Door Panels: 16 gage, 0.059 inch (1.52 mm), minimum thickness, on both sides and along each edge.
Door Panels to Receive Wall/Ceiling Finish: Surface recessed 5/8 inch (15.9 mm) back from wall face.
Steel Finish: Primed.
Primed and Factory Finish: Polyester powder coat; color _____.

SECTION 08 33 13 - COILING COUNTER DOORS

SUBMITTALS

Product Data: Submit manufacturer's standard literature showing materials and details of construction and finish. Include data on electrical operation.

Shop Drawings: Indicate rough and actual opening dimensions, anchorage methods, hardware locations, and installation details.

COILING COUNTER DOORS

Coiling Counter Doors, Non-Fire-Rated: Aluminum slat curtain.
Mounting: Interior face mounted.
Provide integral frame and sill of same material and finish.
Nominal Slat Size: 1-1/4 inches (32 mm) wide.
Slat Profile: Flat, perforated.
Finish, Aluminum: Anodized.
Hood Enclosure: Manufacturer's standard; primed steel.
Manual hand crank lift operation.
Locking Devices: Locking wing thumb latch at both jambs, keyed alike.

MATERIALS

Curtain Construction: Interlocking, single thickness slats.

Guide Construction: Continuous, of profile to retain door in place, with mounting brackets of same metal.

Hood Enclosure: Internally reinforced to maintain rigidity and shape.

Lock Hardware:
Cylindrical Locking Mechanism: Latchset lock cylinder, specified in Section 08 71 00.
Latching Mechanism: Inside mounted, adjustable keeper, spring activated latch bar feature to keep in locked or retracted position.
Latch Handle: Manufacturer's standard.

SECTION 08 36 13 - SECTIONAL DOORS

SUBMITTALS

Shop Drawings: Indicate opening dimensions and required tolerances, connection details, anchorage spacing, hardware locations, and installation details.

Product Data: Show component construction, anchorage method, and hardware.

Samples: Submit two panel finish samples, ___ by ___ inch (___ by ___ mm) in size, illustrating color and finish.

ALUMINUM DOORS

Aluminum Doors: Flush aluminum, insulated; standard lift operating style with track and hardware; complying with DASMA 102, Commercial application.
Door Nominal Thickness: 2 inches (50 mm) thick.
Finish: Factory finished with acrylic power coating; color as selected by Architect.
Electric Operation: Electric control station.

Door Panels: Flush aluminum construction; outer aluminum sheet ___ inch (____ mm) thick; inner aluminum sheet ____ inch (____ mm) thick; flat profile; core reinforcement of ____ inch (____ mm) roll formed aluminum; rabbeted weather joints at meeting rails; insulated.

COMPONENTS

Track: Rolled galvanized steel, 0.090 inch (2.3 mm) minimum thickness; 2 inch (50 mm) wide, continuous one piece per side; galvanized steel mounting brackets 1/4 inch (6 mm) thick.

Hinge and Roller Assemblies: Heavy duty hinges and adjustable roller holders of galvanized steel; floating hardened steel bearing rollers, located at top and bottom of each panel, each side.

Lift Mechanism: Torsion spring on cross head shaft, with braided galvanized steel lifting cables.

ELECTRIC OPERATION

Electric Operators:
Mounting: Side mounted on cross head shaft.
Motor Rating: 1/3 hp (250 W); continuous duty.
Motor Controller: NEMA ICS 2, full voltage, reversing magnetic motor starter.
Controller Enclosure: NEMA 250, Type 1.

Control Station: Provide standard three button (Open-Close-Stop) momentary-contact control device for each operator conforming to UL 325.

SECTION 08 71 00 - DOOR HARDWARE

DESIGN AND PERFORMANCE CRITERIA

Provide specified door hardware as required to make doors fully functional, compliant with applicable codes, and secure to extent indicated.

Provide door hardware products that comply with the following requirements:
Applicable provisions of federal, state, and local codes.
Fire-Rated Doors: NFPA 80, listed and labeled by qualified testing agency for fire protection ratings indicated, based on testing at positive pressure in accordance with NFPA 252 or UL 10C.
Hardware on Fire-Rated Doors: Listed and classified by UL (DIR), ITS (DIR), testing firm acceptable to authorities having jurisdiction, or _____ as suitable for application indicated.
Hardware for Smoke and Draft Control Doors (Indicated as "S" on Drawings): Provide door hardware that complies with local codes, and requirements of assemblies tested in accordance with UL 1784.

HINGES

Hinges: Complying with BHMA A156.1, Grade 1.
Provide hinges on every swinging door.
Provide five-knuckle full mortise butt hinges unless otherwise indicated.

FLUSH BOLTS

Flush Bolts: Complying with BHMA A156.16, Grade 1.
Flush Bolt Throw: 3/4 inch (19 mm), minimum.

EXIT DEVICES

Exit Devices: Complying with BHMA A156.3, Grade 1.

ELECTRIC STRIKES

Electric Strikes: Complying with BHMA A156.31, Grade 1.

ELECTROMAGNETIC LOCKS

Electromagnetic Locks: Complying with BHMA A156.23, Grade 1.

LOCK CYLINDERS

Lock Cylinders: Provide key access on outside of each lock, unless otherwise indicated.

CYLINDRICAL LOCKS

Cylindrical Locks (Bored): Complying with BHMA A156.2, Grade 1, 4000 Series.
Bored Hole: 2-1/8 inch (54 mm) diameter.

Latchbolt Throw: 1/2 inch (12.7 mm), minimum.
Backset: 2-3/4 inch (70 mm) unless otherwise indicated.
Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.

MORTISE LOCKS

Mortise Locks: Complying with BHMA A156.13, Grade 1, Security, 1000 Series.
Backset: 2-3/4 inch (70 mm) unless otherwise indicated.
Strikes: Provide manufacturer's standard strike for each latchset or lockset with strike box and curved lip extending to protect frame in compliance with indicated requirements.

ELECTROMECHANICAL LOCKS

Electromechanical Locks: Complying with BHMA A156.25, Grade 1.

AUXILIARY LOCKS (DEADLOCKS)

Auxiliary Locks (Deadlocks): Complying with BHMA A156.36, Grade 1.

DOOR PULLS AND PUSH PLATES

Door Pulls and Push Plates: Complying with BHMA A156.6.
Pull Type: Straight, unless otherwise indicated.
Push Plate Type: Flat, with square corners, unless otherwise indicated.

COORDINATORS

Coordinators: Provide on doors having closers and self-latching or automatic flush bolts to ensure that inactive door leaf closes before active door leaf.
Type: Bar, unless otherwise indicated.

CLOSERS

Closers: Complying with BHMA A156.4, Grade 1.

OVERHEAD STOPS AND HOLDERS

Overhead Stops and Holders (Door Checks): Complying with BHMA A156.8, Grade 1.

PROTECTION PLATES

Protection Plates: Complying with BHMA A156.6.

ARMOR PLATES

Armor Plates: Provide on bottom half of push side of doors that require protection from objects moving through openings that may damage door surface.

KICK PLATES

Kick Plates: Provide along bottom edge of push side of every door with closer, except aluminum storefront and glass entry doors, unless otherwise indicated.

MOP PLATES

Mop Plates: Provide along bottom edge of push side of doors to provide protection from cleaning liquids and equipment damage to door surface.

DOOR EDGE PLATES

Door Edge Plates: Complying with BHMA A156.6.

DOOR HOLDERS

Door Holders: Complying with BHMA A156.16, Grade 1.

ELECTROMAGNETIC DOOR HOLDERS

Electromagnetic Door Holders: Complying with BHMA A156.15.

FLOOR STOPS

Floor Stops: Complying with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.

WALL STOPS

Wall Stops: Complying with BHMA A156.16, Grade 1 and Resilient Material Retention Test as described in this standard.

ASTRAGALS

Astragals: Complying with BHMA A156.22.

THRESHOLDS

Thresholds: Complying with BHMA A156.21.
Provide threshold at each exterior door, unless otherwise indicated.

WEATHERSTRIPPING AND GASKETING

Weatherstripping and Gasketing: Complying with BHMA A156.22.
Head and Jamb Type: Adjustable.
Door Sweep Type: Encased in retainer.

BUMPER GUARD

Bumper Guard: Provide to protect door surface and operating hardware from being damaged by heavy objects that move through opening.

COAT HOOKS

Coat Hooks: Provide on room side of door, screw fastened.

SIGNAGE

Signage (Room Name Plates and Numbers): Provide on doors for individuals to easily identify room names and/or numbers.

SILENCERS

Silencers: Provide at equal locations on door frame to mute sound of door's impact upon closing.

POWER SUPPLY

Power Supply: Hard wired, with multiple zones providing eight (8) breakers for each output panel with individual control switches and LED's; UL (DIR) Class 2 listed.

FINISHES

Finishes: Provide door hardware of same finish, unless otherwise indicated.
Primary Finish: 625; bright chromium plated over nickel, with brass or bronze base material (former US equivalent US26); BHMA A156.18.
Secondary Finish: 626; satin chromium plated over nickel, with brass or bronze base material (former US equivalent US26D); BHMA A156.18.

SECTION 08 80 00 - GLAZING

GLASS MATERIALS

Float Glass: Provide float glass based glazing unless noted otherwise.
Annealed Type: ASTM C1036, Type I - Transparent Flat, Class 1 - Clear, Quality-Q3.
Heat-Strengthened and Fully Tempered Types: ASTM C1048, Kind HS and FT.
Fully Tempered Safety Glass: Complies with ANSI Z97.1 and 16 CFR 1201 criteria.
Tinted Type: ASTM C1036, Class 2 - Tinted, Quality-Q3, color and performance characteristics as indicated.
Thicknesses: As indicated; provide greater thickness as required for exterior glazing wind load design.

INSULATING GLASS UNITS

Insulating Glass Units: Types as indicated.
Durability: Certified by an independent testing agency to comply with ASTM E2190.

Coated Glass: Comply with requirements of ASTM C1376 for pyrolytic (hard-coat) or magnetic sputter vapor deposition (soft-coat) type coatings on flat glass; coated vision glass, Kind CV; coated overhead glass, Kind CO; or coated spandrel glass, Kind CS.
Metal Edge Spacers: Aluminum, bent and soldered corners.
Edge Seal:
Dual-Sealed System: Provide polyisobutylene sealant as primary seal applied between spacer and glass panes, and silicone, polysulfide, or polyurethane sealant as secondary seal applied around perimeter.

Insulating Glass Units: Vision glass, double glazed.
Outboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
Inboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
Total Thickness: 1 inch (25.4 mm).

Insulating Glass Units: Spandrel glazing.
Outboard Lite: Annealed float glass, 1/4 inch (6.4 mm) thick, minimum.
Inboard Lite: Heat-strengthened float glass, 1/4 inch (6.4 mm) thick.
Opacifier: Ceramic frit, on #4 surface.
Total Thickness: 1 inch (25.4 mm).

Type IG-5 - Insulating Glass Units: Safety glazing.
Glass Type: Same as Type _____ except use fully tempered float glass for both outboard and inboard lites.
Total Thickness: 1 inch (25.4 mm).

GLAZING UNITS

Monolithic Interior Vision Glazing:
Glass Type: Annealed float glass.
Thickness: 1/4 inch (6.4 mm), nominal.

Fire-Resistance-Rated Glazing: Type, thickness, and configuration of glazing that contains flame, smoke, and blocks radiant heat, as required to achieve indicated fire-rating period exceeding 45 minutes.
Fire-Rating Period: 60 minutes.
Markings for Fire-Resistance-Rated Glazing Assemblies: Provide permanent markings on fire-resistance-rated glazing in compliance with ICC (IBC), local building code, and authorities having jurisdiction.

Fire-Protection-Rated Glazing: Type, thickness, and configuration of glazing that contains flame, smoke, and does not block radiant heat, as required to achieve fire-doors indicated fire-rating period of 90 minutes or less.
Fire-Rating Period: As indicated on drawings.

Monolithic Safety Glazing: Non-fire-rated.
Glass Type: Fully tempered safety glass as specified.
Thickness: 1/4 inch (6.4 mm), nominal.

GLAZING COMPOUNDS

Silicone Sealant: Single component; neutral curing; capable of water immersion without loss of properties; non-bleeding, non-staining; ASTM C920, Type S, Grade NS, Class 25, Uses M, A, and G; with cured Shore A hardness range of 15 to 25; _____ color.

DIVISION 09 - FINISHES

SECTION 09 05 61 - COMMON WORK RESULTS FOR FLOORING PREPARATION

QUALITY ASSURANCE

Moisture and alkalinity (pH) testing will be performed by an independent testing agency employed and paid by Owner.

Contractor may perform adhesive and bond test with Contractor's own personnel or hire a testing agency.

CONCRETE SLAB PREPARATION

Perform following operations in the order indicated:

Existing concrete slabs (on-grade and elevated) with existing floor coverings:

Visual observation of existing floor covering, for adhesion, water damage, alkaline deposits, and other defects.

Removal of existing floor covering.

Existing concrete slabs with coatings or penetrating sealers/hardeners/dustproofers:

Do not attempt to remove coating or penetrating material.

Do not abrade surface.

Preliminary cleaning.

Moisture vapor emission tests; 3 tests in the first 1000 square feet (100 square meters) and one test in each additional 1000 square feet (100 square meters), unless otherwise indicated or required by flooring manufacturer.

Internal relative humidity tests; in same locations as moisture vapor emission tests, unless otherwise indicated.

Alkalinity (pH) tests; in same locations as moisture vapor emission tests, unless otherwise indicated.

Specified remediation, if required.

Patching, smoothing, and leveling, as required.

Other preparation specified.

Adhesive bond and compatibility test.

Protection.

Remediations:

Active Water Leaks or Continuing Moisture Migration to Surface of Slab: Correct this condition before doing any other remediation; re-test after correction.

Excessive Moisture Emission or Relative Humidity: If an adhesive that is resistant to the level of moisture present is available and acceptable to flooring manufacturer, use that adhesive for installation of the flooring; if not, apply remedial floor coating or remedial sheet membrane over entire suspect floor area.

Excessive Alkalinity (pH): If remedial floor coating is necessary to address excessive moisture, no additional remediation is required; if not, if an adhesive that is resistant to the level present is available and acceptable to the flooring manufacturer, use that adhesive for installation of the flooring; otherwise, apply a skim coat of specified patching compound over entire suspect floor area.

SECTION 09 21 16 - GYPSUM BOARD ASSEMBLIES

METAL FRAMING MATERIALS

Non-Loadbearing Framing System Components: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with ASTM C754 for the spacing indicated, with maximum deflection of wall framing of L/120 at 5 psf (L/120 at 240 Pa).

Area Separation Wall Studs and Accessories: ASTM C645; galvanized sheet steel, of size and properties necessary to comply with specified performance requirements.

Partition Head To Structure Connections: Provide track fastened to structure with legs of sufficient length to accommodate deflection, for friction fit of studs cut short and fastened as indicated on drawings.

BOARD MATERIALS

Gypsum Wallboard: Paper-faced gypsum panels as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
Application: Use for vertical surfaces and ceilings, unless otherwise indicated.
At Assemblies Indicated with Fire-Rating: Use type required by indicated tested assembly; if no tested assembly is indicated, use Type X board, UL or WH listed.

Abuse Resistant Wallboard:
Application: High-traffic areas indicated.

Impact Resistant Wallboard:
Application: High-traffic areas indicated.

Backing Board For Non-Wet Areas: Water-resistant gypsum backing board as defined in ASTM C1396/C1396M; sizes to minimum joints in place; ends square cut.
Application: Vertical surfaces behind thinset tile, restrooms and behind sinks..
Type: Regular and Type X, in locations indicated.

Ceiling Board: Special sag resistant gypsum ceiling board as defined in ASTM C1396/C1396M; sizes to minimize joints in place; ends square cut.
Application: Ceilings, unless otherwise indicated.

Exterior Sheathing Board: As specified in Section 06 10 00.

ACCESSORIES

Acoustic Insulation: As specified in Section 07 21 00.

Finishing Accessories: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.

Beads, Joint Accessories, and Other Trim: ASTM C1047, galvanized steel or rolled zinc, unless noted otherwise.

Joint Materials: ASTM C475/C475M and as recommended by gypsum board manufacturer for project conditions.

SECTION 09 51 00 - ACOUSTICAL CEILINGS

ACOUSTICAL UNITS

Acoustical Units - General: ASTM E1264, Class A.

Acoustical Panels Type ____: Painted mineral fiber, ASTM E1264 Type III, with the following characteristics:
Size: ____by____ inches (____by____ mm).
Thickness: 3/4 inches (19 mm).
Composition: Wet felted.
Surface Color: White.
Surface Pattern: Non-directional fissured.
Suspension System: Exposed grid.

SUSPENSION SYSTEM(S)

Metal Suspension Systems - General: Complying with ASTM C635/C635M; die cut and interlocking components, with stabilizer bars, clips, splices, perimeter moldings, and hold down clips as required.

Exposed Steel Suspension System: Formed steel, commercial quality cold rolled; heavy-duty.
Profile: Tee; 15/16 inch (24 mm) wide face.
Construction: Double web.
Finish: White painted.

SECTION 09 67 00 - FLUID-APPLIED FLOORING

FLUID-APPLIED FLOORING SYSTEMS

Fluid-Applied Flooring: Epoxy base coat(s), with embedded aggregate.
Aggregate: Vinyl flakes.

Base Coat: Standard Set Pigmented Epoxy.
Color: Medium Grey.
Top Coat: Two coats of Clear UV Resistant Epoxy
Protective Coat: One coat of
System Thickness: ____ inch (____ mm), nominal, when dry.
Texture: Slip resistant.
Sheen: Gloss.

ACCESSORIES

Integral Cove Base: Pre-formed impact-resistant cove base moldings made specifically for use with commercial, institutional and industrial resinous floor coatings.
Product: SpeedCove manufactured bySpeedCove, Inc.
Radius Cove Base
90° Inside & Outside Corners
Height: 4-inch
Cove radius: 1"+

SECTION 09 84 30 - SOUND-ABSORBING WALL AND CEILING UNITS

FABRIC-COVERED SOUND-ABSORBING UNITS

Sound Absorbing Units: Prefinished, factory assembled fabric-covered panels.

Fabric-Covered Acoustical Panels for Walls and Ceilings:
Panel Core: Manufacturer's standard rigid or semi-rigid fiberglass core.
Facing: 1/16 inch (1.6 mm) impact-resistant and tackable surface laminated to core.
Mounting Method: On furring strips.

FABRICATION

Fabric Wrapped, General: Fabricate panels to sizes and configurations as indicated, with fabric facing installed without sagging, wrinkles, blisters, or visible seams.

SECTION 09 91 13 - EXTERIOR PAINTING

SECTION INCLUDES

Scope: Finish exterior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated, including the following:
Exposed surfaces of steel lintels and ledge angles.
Mechanical and Electrical:

Do Not Paint or Finish the Following Items:
Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
Items indicated to receive other finishes.
Items indicated to remain unfinished.
Fire rating labels, equipment serial number and capacity labels, and operating parts of equipment.
Non-metallic roofing and flashing.
Stainless steel, anodized aluminum, bronze, terne coated stainless steel, zinc, and lead.
Floors, unless specifically indicated.
Brick, glass unit masonry, architectural concrete, cast stone, integrally colored plaster and stucco.
Glass.
Concealed pipes, ducts, and conduits.

MANUFACTURERS

PAINTS AND FINISHES - GENERAL

Volatile Organic Compound (VOC) Content:

Provide paints and finishes that comply with the most stringent requirements specified in the following:

40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
SCAQMD 1113 Rule.
CARB (SCM).
Ozone Transport Commission (OTC) Model Rule, Architectural, Industrial, and Maintenance Coatings; www.otcair.org; specifically:

Opaque, Flat: 50 g/L, maximum.
Opaque, Nonflat: 150 g/L, maximum.
Opaque, High Gloss: 250 g/L, maximum.
Varnishes: 350 g/L, maximum.

Architectural coatings VOC limits of the State in which the Project is located.

Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

Colors: As indicated on drawings.

PAINT SYSTEMS - EXTERIOR

Paint E-OP - Exterior Surfaces to be Painted, Unless Otherwise Indicated: Including concrete masonry units, primed wood, and primed metal.

Top Coat(s): Exterior Latex; MPI #10, 11, 15, 119, or 214.
Top Coat(s): Exterior Light Industrial Coating, Water Based; MPI #161, 163, or 164.

Paint ME-OP-3L - Ferrous Metals, Unprimed, Latex, 3 Coat:

Paint ME-OP-2L - Ferrous Metals, Primed, Latex, 2 Coat:

Paint MgE-OP-3L - Galvanized Metals, Latex, 3 Coat:

Paint E-Pav - Pavement Marking Paint:

PRIMERS

Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

Interior/Exterior Latex Block Filler; MPI #4.
Water Based Primer for Galvanized Metal; MPI #134.
Rust-Inhibitive Water Based Primer; MPI #107.

SECTION 09 91 23 - INTERIOR PAINTING

SECTION INCLUDES

Scope: Finish interior surfaces exposed to view, unless fully factory-finished and unless otherwise indicated.

Both sides and edges of plywood backboards for electrical and telecom equipment before installing equipment.
Prime surfaces to receive wall coverings.
Mechanical and Electrical:

In finished areas, paint insulated and exposed pipes, conduit, boxes, insulated and exposed ducts, hangers, brackets, collars and supports, mechanical equipment, and electrical equipment, unless otherwise indicated.
In finished areas, paint shop-primed items.
Paint interior surfaces of air ducts and convector and baseboard heating cabinets that are visible through grilles and louvers with one coat of flat black paint to visible surfaces.
Paint dampers exposed behind louvers, grilles, and convector and baseboard cabinets to match face panels.

Do Not Paint or Finish the Following Items:

Items factory-finished unless otherwise indicated; materials and products having factory-applied primers are not considered factory finished.
Items indicated to receive other finishes.
Items indicated to remain unfinished.
Fire rating labels, equipment serial number and capacity labels, bar code labels, and operating parts of equipment.
Stainless steel, anodized aluminum, bronze, terne coated stainless steel, and lead items.
Floors, unless specifically indicated.
Ceramic and other tiles.
Brick, architectural concrete, cast stone, integrally colored plaster and stucco.
Glass.
Acoustical materials, unless specifically indicated.
Concealed pipes, ducts, and conduits.

MANUFACTURERS

PAINTS AND FINISHES - GENERAL

Volatile Organic Compound (VOC) Content:
Provide paints and finishes that comply with the most stringent requirements specified in the following:
40 CFR 59, Subpart D--National Volatile Organic Compound Emission Standards for Architectural Coatings.
SCAQMD 1113 Rule.
CARB (SCM).
Ozone Transport Commission (OTC) Model Rule, Architectural, Industrial, and Maintenance Coatings; www.otcair.org; specifically:
Opaque, Flat: 50 g/L, maximum.
Opaque, Nonflat: 150 g/L, maximum.
Opaque, High Gloss: 250 g/L, maximum.
Varnishes: 350 g/L, maximum.
Architectural coatings VOC limits of the State in which the Project is located.
Determination of VOC Content: Testing and calculation in accordance with 40 CFR 59, Subpart D (EPA Method 24), exclusive of colorants added to a tint base and water added at project site; or other method acceptable to authorities having jurisdiction.

Colors: As indicated on drawings.

PAINT SYSTEMS - INTERIOR

Paint I-OP - Interior Surfaces to be Painted, Unless Otherwise Indicated: Including gypsum board, concrete, concrete masonry units, brick, wood, uncoated steel, shop primed steel, galvanized steel, and aluminum.
Primer: As recommended by top coat manufacturer for specific substrate.

Paint I-OP-MD-DT - Medium Duty Door/Trim: For surfaces subject to frequent contact by occupants, including metals and wood:
Primer: As recommended by top coat manufacturer for specific substrate.

Paint I-OP-MD-WC - Medium Duty Vertical and Overhead: Including gypsum board, plaster, concrete, concrete masonry units, uncoated steel, shop primed steel, galvanized steel, and aluminum.
Primer: As recommended by top coat manufacturer for specific substrate.

Paint I-OP-DF - Dry Fall: Metals; exposed structure and overhead-mounted services in utilitarian spaces, including shop primed steel deck, structural steel, metal fabrications, galvanized ducts, galvanized conduit, galvanized piping, and _____.
Primer: As recommended by top coat manufacturer for specific substrate.

Paint I-OP-FL - Concrete and Wood Floors to be Painted.
Primer: As recommended by top coat manufacturer for specific substrate.

Paint CI-OP-3L - Concrete/Masonry, Opaque, Latex, 3 Coat:

Paint MI-OP-3L - Ferrous Metals, Unprimed, Latex, 3 Coat:

Paint MI-OP-2L - Ferrous Metals, Primed, Latex, 2 Coat:

Paint MgI-OP-3L - Galvanized Metals, Latex, 3 Coat:

Paint GI-OP-3L - Gypsum Board/Plaster, Latex, 3 Coat:

Paint FI-OP-3A - Fabrics/Insulation Jackets, Alkyd, 3 Coat:

PRIMERS

Primers: Provide the following unless other primer is required or recommended by manufacturer of top coats.

Interior Institutional Low Odor/VOC Primer Sealer; MPI #149.
Interior/Exterior Latex Block Filler; MPI #4.
Interior Latex Primer Sealer; MPI #50.
Interior Drywall Primer Sealer.
Interior Rust-Inhibitive Water Based Primer; MPI #107.
Interior Water Based Primer for Galvanized Metal; MPI #134.
Latex Primer for Interior Wood; MPI #39.

DIVISION 10 - SPECIALTIES

SECTION 10 14 00 - SIGNAGE

SIGNAGE APPLICATIONS

Accessibility Compliance: Signs are required to comply with ADA Standards and ICC A117.1 _____, unless otherwise indicated; in the event of conflicting requirements, comply with the most comprehensive and specific requirements.

Room and Door Signs: Provide a sign for every doorway, whether it has a door or not, not including corridors, lobbies, and similar open areas.

Sign Type: Flat signs with applied character panel media as specified.

SIGN TYPES

Flat Signs: Signage media without frame.

SECTION 10 21 23 - CUBICLE CURTAINS AND TRACK

TRACKS AND TRACK COMPONENTS

Track: Extruded aluminum sections; one piece per cubicle track run; I-beam profile.

Curtain Carriers: Nylon slider to accurately fit track; designed to eliminate bind when curtain is pulled; fitted to curtain to prevent accidental curtain removal; __ carriers per foot (__ per meter) of track length.

CURTAINS

Curtain Materials:

Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.

Naturally flame resistant or flameproofed; capable of passing NFPA 701 test.

SECTION 10 22 39 - FOLDING PANEL PARTITIONS

FOLDING PANEL PARTITIONS - HORIZONTAL OPENING

Folding Panel Partitions: Side opening; individual panels; side stacking; manually operated.

Panel Construction:

Frame: 16 gage, 0.0598 inch (1.52 mm) thick formed sheet steel frame top, bottom, jambs, and intermediates; welded construction, with acoustical insulation fill.

Substrate: _____.

Panel Properties:

Thickness With Finish: 3 inches (75 mm).

Panel Finishes:

Facing: _____.

Exposed Metal Trim: Custom powder coated paint finish.

Suspension System:

Track: Formed steel; 1-1/4 by 1-1/4 inch (32 by 32 mm) size; thickness and profile designed to support loads, steel sub-channel and track connectors, and track switches.

Carriers: Nylon wheels on trolley carrier at top of every second panel, sized to carry imposed loads, with threaded pendant bolt for vertical adjustment.

SECTION 10 26 01 - WALL AND CORNER GUARDS

COMPONENTS

Corner Guards - Surface Mounted:

Material: Type 304 stainless steel, No. 4 finish, _____ gage, _____ inch (_____ mm) thick.

Width of Wings: 3 inches (76 mm).

Corner: Square.

SECTION 10 28 00 - TOILET, BATH, AND LAUNDRY ACCESSORIES

MATERIALS

Accessories - General: Shop assembled, free of dents and scratches and packaged complete with anchors and fittings, steel anchor plates, adapters, and anchor components for installation.

COMMERCIAL TOILET ACCESSORIES

Toilet Paper Dispenser: Double roll, semi-recessed, stainless steel unit with pivot hinge, tumbler lock.

Paper Towel Dispenser: Electric, roll paper type.
Paper Discharge: Touchless automatic.
Capacity: 6 inch diameter roll.
Power: Battery operated.

Waste Receptacle: Stainless steel, freestanding style with swing top.

Automated Soap Dispenser: Liquid soap dispenser, wall-mounted, with stainless steel cover and window to gauge soap level, tumbler lock.

Mirrors: Stainless steel framed, 1/4 inch (6 mm) thick annealed float glass; ASTM C1036.

Seat Cover Dispenser: Stainless steel, surface-mounted, reloading by concealed opening at base, tumbler lock.

Grab Bars: Stainless steel, smooth surface.
Standard Duty Grab Bars:
Dimensions: 1-1/4 inch (32 mm) outside diameter, minimum 0.05 inch (1.3 mm) wall thickness, exposed flange mounting, 1-1/2 inch (38 mm) clearance between wall and inside of grab bar.

Purse Shelf: Fold-down, with spring-loaded hinge designed to automatically return shelf to vertical position when not in use; 0.05 inch (1.3 mm) thick satin-finished stainless steel, with rolled or hemmed edge at shelf front.

Sanitary Napkin Disposal Unit: Stainless steel, surface-mounted, self-closing door, locking bottom panel with full-length stainless steel piano-type hinge, removable receptacle.

UNDER-LAVATORY PIPE AND SUPPLY COVERS

Under-Lavatory Pipe and Supply Covers:

UTILITY ROOM ACCESSORIES

Combination Utility Shelf/Mop and Broom Holder: 0.05 inch (1.3 mm) thick stainless steel, Type 304, with 1/2 inch (12 mm) returned edges, 0.06 inch (1.6 mm) steel wall brackets.

SECTION 10 44 00 - FIRE PROTECTION SPECIALTIES

FIRE EXTINGUISHERS

Fire Extinguishers - General: Comply with product requirements of NFPA 10 and applicable codes, whichever is more stringent.

Multipurpose Dry Chemical Type Fire Extinguishers: Carbon steel tank, with pressure gauge.
Class: A:B:C type.
Size: 10 pound (4.54 kg).

FIRE EXTINGUISHER CABINETS

Cabinet Construction: Non-fire rated.
Formed primed steel sheet; 0.036 inch (0.9 mm) thick base metal.

Cabinet Configuration: Semi-recessed type.

Door: 0.036 inch (0.9 mm) metal thickness, reinforced for flatness and rigidity with nylon catch. Hinge doors for 180 degree opening with two butt hinge.

Door Glazing: Float glass, clear, 1/8 inch (3 mm) thick, and set in resilient channel glazing gasket.

DIVISION 12 - FURNISHINGS

SECTION 12 24 00 - WINDOW SHADES

WINDOW SHADE APPLICATIONS

Interior Roller Shades: Blackout shades.
- Type: Roll down, closed position is at window sill.
- Fabric Performance Requirements:
  - Openness Factor: _____.
- Color: _____.
- Mounting: Inside (between jambs).
- Operation: Manual.

Exterior Roller Shades: Privacy shades.
- Fabric Performance Requirements:
  - Openness Factor: _____.
- Color: _____.
- Mounting: Jamb.
- Operation: Manual.

ROLLER SHADES

Roller Shades: Fabric roller shades complete with mounting brackets, roller tubes, hembars, hardware and accessories.
- Drop: Regular roll.
- Size: As indicated on drawings.

Fabric: Non-flammable, color-fast, impervious to heat and moisture, and able to retain its shape under normal operation.
- Privacy Shades: Soften the light yet still reveal some details to the outside; moderate privacy; Openness Factor approximately equal to 1 percent.
- Blackout Shades: Block virtually all the light; Openness Factor equal to zero (0).
- Flammability: Pass NFPA 701 large and small tests.
- Fungal Resistance: No growth when tested according to ASTM G21.

Roller Tubes: As required for type of operation.
- Material: Extruded aluminum or galvanized steel; as required for shade location.
- Size: Manufacturer's standard, selected for suitability for installation conditions, span, and weight of shades.

Hembars: Designed for weight requirements and adaptation to uneven surfaces, to maintain bottom of shade straight and flat.
- Style: Exposed aluminum bottom bar, flat profile with closed ends, containing a spline groove top to receive and secure fabric end.
- Finish: Baked enamel.
- Color: As selected from manufacturer's standard colors.
- Blackout Shades: Provide a slot in bottom bar with wool-pile light seal.

Manual Operation for Interior Shades: Clutch operated continuous loop; beaded ball chain.

Manual Operation for Exterior Shades: Crank operated; removable powder coated steel crank with handle.

ACCESSORIES

Fascias: Size as required to conceal shade mounting.
- Style: As selected by Architect from shade manufacturer’s full selection.
- Material and Color: To match shade.

Brackets and Mounting Hardware: As recommended by manufacturer for mounting configuration and span indicated.

Interior Side Channels: As required for light sealing blackout shade applications.

Exterior Side Channels: As required in exterior applications for guiding and securing shade material.

Lifting Cables: Nylon coated cable for lifting bottom-up type shades.

Fasteners: Non-corrosive, and as recommended by shade manufacturer.

SECTION 12 31 00 - MANUFACTURED METAL CASEWORK

FABRICATION

Casework: Die-formed metal sheet; each unit self-contained and not dependent on adjacent units or building structure for rigidity; factory-fabricated, factory-assembled, and factory-finished.

Style: Flush overlay - square edge.

Primary Cabinet Material: Cold-rolled steel.

Structural Performance: Provide components that safely support the following minimum loads, without deformation or damage:

Base Units: 500 pounds per linear foot (744 kg/linear m) across the cabinet ends.

Tables: 300 pounds (136 kg) on four legs.

Drawers: 125 pounds (57 kg).

Shelves: 100 pounds (45 kg).

Mobile Cabinets: Same construction as fixed base cabinets, with modifications.

FINISHES

Metal (Except Stainless Steel): Degrease and phosphate etch followed by primer; minimum two coats baked epoxy; _____ color as selected.

SECTION 12 36 00 - COUNTERTOPS

COUNTERTOPS

Quality Standard: Custom Grade, in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), unless noted otherwise.

Solid Surfacing Countertops: Solid surfacing sheet or plastic resin casting over continuous substrate.

Flat Sheet Thickness: 1/2 inch (12 mm), minimum.

Solid Surfacing Sheet and Plastic Resin Castings: Complying with ISFA 2-01 and NEMA LD 3; acrylic or polyester resin, mineral filler, and pigments; homogenous, non-porous and capable of being worked and repaired using standard woodworking tools; no surface coating; color and pattern consistent throughout thickness.

Surface Burning Characteristics: Flame spread index of 25, maximum; smoke developed index of 450, maximum; when tested in accordance with ASTM E84.

NSF approved for food contact.

Finish on Exposed Surfaces: Matte, gloss rating of 5 to 20.

Exposed Edge Treatment: Built up to minimum 1-1/4 inch (32 mm) thick; square edge; use marine edge at sinks.

Fabricate in accordance with AWI/AWMAC/WI (AWS) or AWMAC/WI (NAAWS), Section 11 - Countertops, Premium Grade.

Stainless Steel Countertops: ASTM A666, Type 304, stainless steel sheet; 16 gage, 0.0625 inch (1.59 mm) nominal sheet thickness.

Finish: 4B satin brushed finish.

Exposed Edge Shape: Straight turndown with return; 1-1/2 inch (38 mm) high face, 1/2 inch (12 mm) return to face of case; reinforced with hardwood or steel.

Back and End Splashes: Same material; welded 1/4 inch (6 mm) radius coved joint to countertop; square top edge with 1 inch (25 mm) wide top surface and minimum 1/2 inch (12 mm) turndown.

SECTION 12 48 13 - ENTRANCE FLOOR MATS AND FRAMES

MATS

Carpet Mat: Cut nylon pile permanently bonded to vinyl backing; ____ inch (____ mm) wide by ____ inch (____ mm) long with one inch (25 mm) black matching vinyl border on all edges.

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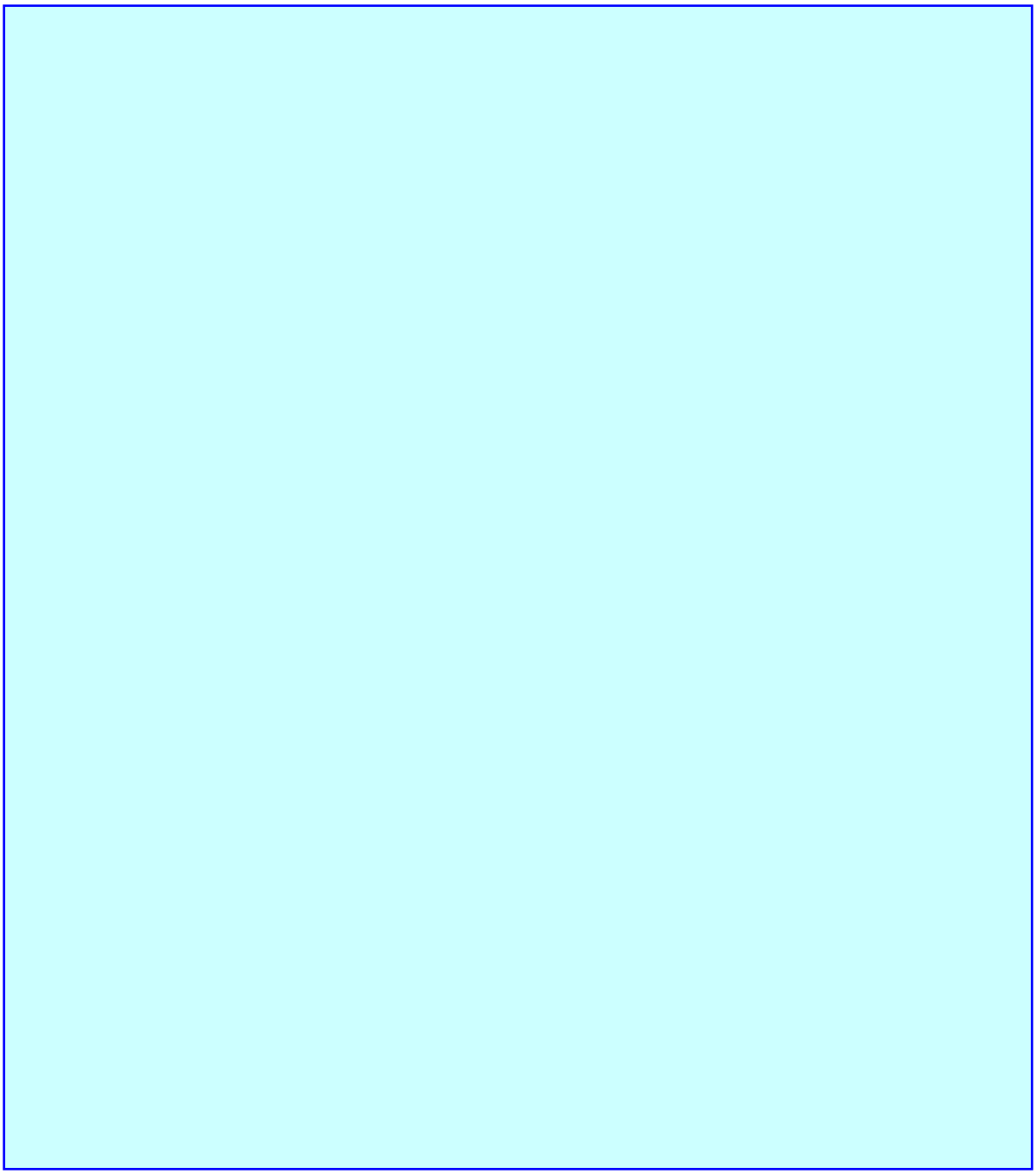

SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes Design-Build work.

B. The intent of Division 21, Fire Suppression Specifications, and the accompanying Drawings is to be a reference for preliminary locations and routing of fire protection system components. Not all components required for a complete system are shown, including but not limited to standpipes, hose connections, sprinkler heads, fire protection zones, air compressors, dry valves, piping, appurtenances, connections, etc.

C. Provide a complete and workable facility with complete systems that comply with the requirements of the state codes, local codes, fire marshal, owner's insurance underwriter, and any other authority having jurisdiction.

D. Division 21, Fire Suppression Specifications and the accompanying Drawings are complimentary and what is called for by one as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa.

E. Imperative language is frequently used in Division 21, Fire Suppression Specifications. Except as otherwise specified, requirements expressed imperatively are to be performed by the Contractor.

F. Piping and sprinkler head locations meet the Architectural design intent for the building in addition to applicable code. The right is reserved to make any reasonable changes in sprinkler head location prior to roughing-in, without cost impact. Deviation from the general routing piping mains, standpipes, or other routing shown must be approved by the architect prior to installation. If additional space is required for fire protection system components, Architect to make a formal request.

G. Heat, heat trace, and associated power required for fire protection system components are the responsibility of the design-build contractor. Request approval from the electrical engineer to use spaces in electrical panels provided at no additional cost.

H. Furnish piping, pipe fittings, valves, gauges, and incidental related items as required for complete systems. Identify valves, piping and equipment components to indicate their function and system served.

I. The General and Supplemental Conditions apply to this Division, including but not limited to:
   1. Drawings and specifications.
   2. Public ordinances, permits.
   3. Include payments and fees required by governing authorities for work of this Division.

J. Division 01, General Requirements, applies to this Division.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 21, Fire Suppression

C. Section 21 10 00, Water Based Fire Suppression Systems

D. Section 21 11 20, Fire Suppression Pumps

E. Section 21 20 00, Gaseous Fire Extinguishing Systems

F. Section 21 30 00, Fire Pumps

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Products and equipment prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment's within this specification

contain these banned substances, provide complying products and equipment's from approved manufacturers with equal performance characteristics.

2. General:
   a. Conform Work and materials to requirements of the local and State codes, fire marshal, the owner's insurance underwriter, and any other authority having jurisdiction; and Federal, State and other applicable laws and regulations.
3. Contractor responsible for obtaining and payment for permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.
4. Fire protection system designs must bear the stamp and seal of the registered Professional Engineer who prepared the documents. The Engineer's stamp certifies that the work was done under the Engineer's supervision and control. Certification from NICET technicians, or other contractors, cannot replace the certification by the Engineer. Verify/coordinate with local building department for their specific requirements.

B. New materials and Equipment:
   1. Good work quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus: Build and install to deliver full rated capacity at the efficiency for which it was designed.

D. The entire system and apparatus operate at full capacity without objectionable noise or vibration.

E. For remodel projects, the existing system must remain fully operational, or provisions made to provide coverage while the new system is being installed. New installation switchover requires minimal down time. Provide method to maintain fire protection or fire watch during any system down time. Include any related cost for materials or labor that is needed for providing continuous coverage.

F. Install equipment level and true equipment. Housekeeping pads and curbs account for floor or roof slope.

G. Materials and Equipment:
   1. Each piece of equipment furnished meet detailed requirements of the Drawings and Specifications and suitable for the installation shown. Equipment not meeting requirements will not be acceptable, even though specified by name along with other manufacturers.
   2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
   3. Furnish materials and equipment of size, make, type, and quality herein specified.
   4. Equipment scheduled by performance or model number considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements, or any other differences which impact the project.

H. Workmanship:
   1. General: Install materials in a neat and professional manner.
   2. Manufacturer's Instructions:
      a. Follow manufacturer's directions where they cover points not specifically indicated. If they are in conflict with the Drawings and Division 21, Fire Suppression Specifications, obtain clarification before starting work.

I. Cutting and Patching:
   1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.

2. Make additional openings required in building construction by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Do not pierce beams or columns without permission of Architect and then only as directed.
5. New or existing work cut or damaged restored to its original condition. Where alterations disturb lawns, paving, walks, etc., the surfaces repaired, refinished, and left in condition existing prior to commencement of work.

1.04 SUBMITTALS

A. Certified Shop Drawings:
1. Drawings indicate the general layout of the piping and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare fire protection system layout Drawings showing locations and types of head or outlets, alarm valves and devices, pipe sizes and cutting lengths, test tees and valves, drain valves, and other related items. New drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. Drawings the same size as Architect's Drawings with title block similar to the Drawings and identifying Architect's Drawing number or any reference drawings. Drawings fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
2. Shop Drawings:
   a. Prepare in [three-dimensional] [two-dimensional] format.
   b. Include but are not limited to:
      1) Sprinkler head layout drawings overlaid with ceiling and floor plans.
      2) Sprinkler floor plans, including piping, equipment, and heads to a minimum of 1/4-inch equals 1-foot scale or same as plans, whichever is greater.
      3) Superplot plans of above ground work with a colored overlay of all trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2-inch equals 1-foot scale.
      4) Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4-inch equals 1-foot scale.
      5) Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1-foot scale.
      6) Fabrication drawings of radiant ceiling panels, architectural metal ceiling, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.
3. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:
1. Submit product data for review on scheduled pieces of equipment, on equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications, and data sheets. Data sheets include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable
2. Provide sample of each type of sprinkler head.
3. Indicate equipment operating weights including bases and weight distribution at support points.

4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Test Reports:
   1. Submit certificates of completion of tests and inspections.

D. Submission Requirements:
   1. Refer to Division 01, General Requirements for additional requirements related to submittals.
   2. Shop Drawings:
      a. Provide three sets of Drawings showing sprinkler head locations and layout coordinated with architectural ceiling details to the Architect for review prior to submitting Drawings to insurance underwriter and Fire Marshal.
      b. Provide six sets of Drawings and calculations to the Architect to be sent to the Owner's insurance underwriter for approval.
      c. Then submit six sets of approved Drawings to Architect for final review.
   3. Product Data:
      a. Submit copies of product data in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, article, and paragraph, and mark if applicable.
      b. Submit electronic copies of shop drawings and product data for Work of Division 21 in PDF format with each item filed under a folder and labeled with its respective specification section number, article, paragraph, and mark, if applicable.
      c. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
      d. Submit shop product data in a single submittal. Partial submittals will not be accepted. Re-submittals submitted after return of the original binder includes a tab similar to that originally submitted. Upon receipt of the returned re-submittals, insert them in the previously submitted binder.

E. Contractor Responsibilities:
   1. See that submittals are submitted at one time and are in proper order.
   2. Obtain approvals and permits from the AHJ.
   3. Ensure that equipment will fit in the space provided.
   4. Assure that deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.05 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNERS INSTRUCTIONS

A. Refer to Division 01, General Requirements for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature on 8-1/2-inch by 11-inch sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for electrically powered equipment.

C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions cover phases of control.

D. Furnish competent engineer knowledgeable in this building system for minimum of one 8-hour day to instruct Owner in operation and maintenance of systems and equipment. Keep a log of this instruction including dates, times, subjects, and those present and present such log when requested by Architect.

E. Provide fire pump as-constructed data, and installation, start-up and testing manuals.

1.06 AS-BUILT DRAWINGS

A. Provide 3D model and record drawings at the end of the project on CD-ROM.

B. 3D model in the following format:
   1. AutoCAD
   2. Revit
   3. Navisworks

C. Provide record drawings in hard copy and PDF format.
   1. Drawings include the following:
      a. Project specific title block.
      b. Notations reflecting the as built conditions of any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.

1.07 PROJECT CONDITIONS

A. Existing Conditions: Prior to bidding, verify and become familiar with existing conditions by visiting the site, and include factors which may affect the execution of this Work. Include related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City, and Utility Company.

1.08 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.09 PROVISIONS FOR LARGE EQUIPMENT

A. Make provisions for the necessary openings in building to allow for admittance of equipment.

1.010 TEST REPORTS AND CERTIFICATES

A. Submit one copy of test reports and certificates specified herein to the Architect.

1.011 SUBSTITUTIONS

A. Submit any requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 PRODUCTS

2.01 ACCESS PANELS

A. Furnish under this Division as specified in another Division of work.

2.02 PIPE SLEEVES

A. Interior Wall and Floor Sleeves:
   1. 18 gauge galvanized steel or another pre-approved water tight system.

B. Interior Wall and Floor Sleeves (fire rated):
   1. Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves:
   1. Cast Iron

D. On Grade Floor Sleeves:
   1. Same as exterior wall sleeves.

2.03 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:
   1. Floor Plates:
      a. Cast brass, chromium plated.
   2. Wall and Ceiling Plates:
      a. Spun aluminum.

2.04 MACHINERY GUARDS

A. Furnish guards for protection on rotating and moving parts of equipment. Provide guards for drives and motor pulleys, regardless of being enclosed in a metal cabinet.

B. Design guards so as not to restrict air flow or heat transfer.

C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards easily removable for pulley adjustment or removal and changing of belts.

D. Meet OSHA requirements including back plates.

2.05 ELECTRICAL EQUIPMENT

A. General:
   1. Equipment and installed work as specified under Division 26, Electrical.

B. Motors:
   1. Furnish as integral part of driven equipment. Drip-proof induction type with ball bearings unless noted otherwise.
   2. Built to NEMA Standards for the service intended.
   3. Rated for the voltage specified, suitable for operation within the range of 10 percent above to 10 percent below the specified voltage.
   4. Manufacturers:
      a. Baldor
      b. Westinghouse
      c. General Electric
      d. Or approved equal.
   5. Where provided, refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
   6. Refer to individual product sections for additional motor requirements.
   7. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.

C. Starters:
   1. Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.

D. Equipment Wiring:
   1. Provide interconnecting wiring within or on a piece of fire suppression equipment with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

E. Control Wiring:
   1. Provide control wiring for fire suppression equipment.

F. Codes:
   1. Electrical equipment and products to bear the UL as required by governing codes and ordinances.

PART 3 EXECUTION

3.01 COORDINATION

A. Coordinate fire protection piping and appurtenances with ducts, other piping, electrical conduit, and other equipment.

B. Conceal fire protection piping and equipment be concealed except in area without ceilings and as noted on the Drawings.

C. Locate piping, heads, and equipment where shown on Drawings.

3.02 GENERAL

A. Install fire protection systems to serve the entire building.

B. The Drawings indicate general location of sprinkler heads in ceiling areas, approximate locations of piping, sprinkler zones, and types of systems. Deviations must be approved.

C. The drawings indicate approximate locations of piping, sprinkler zones, and types of systems. The drawings do not indicate the locations of sprinkler heads in ceiling areas. Locate sprinklers in the center of ceiling panels and symmetrically within rooms and down corridors, coordinated with and in pattern with lights and grilles. Deviations must be approved.

D. Locations of sprinkler heads, outlets, piping, and appurtenances are not shown in areas and therefore are to be installed in accord with code requirements.

E. Location of heads shown in ceiling areas may be changed if required by code requirements, but only after review by the Architect for new head locations for each specific instance.

3.03 SLEEVES

A. Interior Floor and Wall Sleeves:
   1. Provide sleeves large enough to provide clearances around pipe outside diameter as required by NFPA. Penetrations through mechanical room and fan room floors made watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved water tight system.

B. Sleeves through Rated Floors and Walls:
   1. Similar to interior sleeves except install fire-rated system approved by Authority Having Jurisdiction and Owner's Insurance Underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves Below Grade:
   1. Large enough to allow for caulking and made watertight. Caulking from outside using link-seal modular wall and casing seal or lead and oakum. Secure sleeves against displacement.

D. On Grade Floor Sleeves:
   1. Same as below grade exterior wall sleeves, caulked from inside.

E. Exterior Wall Sleeves Above Grade:
   1. Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

F. Layout work prior to concrete forming. Do cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

G. Floor sleeves maintain a water barrier by providing a water tight seal or extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves extend 2-inches above finished floor level. Sleeves through roof extend 8-inches above roof. Wall sleeves flush with face of wall unless otherwise indicated. Sleeves through planters extend 8-inches above planter base.

H. Do not support pipes by resting pipe clamps on floor sleeves. Provide supplementary members so pipes are floor supported.

I. Special sleeves detailed on the Drawings take precedence over this section.

3.04 FLOOR, WALL AND CEILING PLATES

A. Install on piping passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates completely cover opening around pipe and duct.

B. Secure wall and ceiling plates to pipe or structure.

C. Plates not required in mechanical rooms or unfinished spaces.

3.05 CLEANING

A. General:
   1. Clean equipment and piping of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces:
   1. Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.

3.06 EQUIPMENT PROTECTION

A. Keep pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, equipment, and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.07 ACCESSIBILITY

A. General:
   1. Locate valves, indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

B. Gauges:
   1. Install gauges so as to be easily read from the floors, platforms, and walkways.

3.08 PAINTING

A. General:
   1. Coordinate painting of fire suppression equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.

B. Equipment Rooms and Finished Areas:
   1. Hangers
   2. Miscellaneous Iron Work
   3. Structural Steel Stands
   4. Tanks
   5. Equipment Bases:
      a. Paint one coat of black enamel.
   6. Steel Valve Bodies and Bonnets:
      a. One coat of black enamel.
   7. Equipment:
      a. One coat of red machinery enamel. Do not paint nameplates.
   8. Sprinkler Heads:
      a. Not painted.

C. Concealed Spaces (above ceilings, not visible):
   1. Hangers, Miscellaneous Iron Work, Valve Bodies, and Bonnets: Not painted.

D. Sprinkler Piping:
   1. Concealed from View: Not painted.
   2. Exposed to View: Paint pipe and hangers exposed to view, including in equipment spaces, with one coat approved rust inhibiting primer. Final finish coat as specified in conformance with the appropriate Division of Work, Painting.
   3. Exterior: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel. Final finish coat as specified in conformance with the appropriate Division of Work, Painting.
   4. Alarm Bell: Factory paint with two coats of red enamel.

3.09 ADJUSTING AND CLEANING

A. General:
   1. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.
   2. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

B. Piping:
   1. Clean interior of piping before installation.
   2. Flush sediment out of piping systems.

3.010 ELECTRICAL EQUIPMENT

A. Do not install fire suppression systems in switchgear rooms, transformer vaults, telephone rooms, or electric closets except as indicated.

B. Fire Suppression systems not to pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

.

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SECTION 21 10 00

WATER BASED FIRE SUPPRESSION SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes Design-Build work and the following:
1. Detector Double Check
2. Electric Alarm Bell
3. Preaction System
4. Dry Pipe System
5. Fire Department Connection
6. Wet Standpipe Hose Valve (Exposed)
7. Roof Connection
8. Sprinkler Heads
9. Flow Switch
10. Tamper Switch
11. Fire Department Test Station
12. Valves
13. Ductile Iron Water Pipe
14. Black Steel Pipe
15. Flanged Joints
16. Mechanical Pipe Couplings and Fittings
17. Expansion Joints and Compensators
18. Expansion Loops/Seismic Expansion Joints
19. Pressure Gauges
20. Heat Trace Cable (Freeze Protection)
21. Utility Markers
22. Valve Identification
23. Piping Markers
24. Equipment Identification

1.02 RELATED SECTIONS

1. Division 01, General Requirements
2. Division 21, Fire Suppression
3. Section 21 20 00, Gaseous Fire Extinguishing Systems
4. Section 21 30 00, Fire Pumps

1.03 QUALITY ASSURANCE

A. Provide a complete automatic fire sprinkler/combination standpipe system.
1. Grooved joint couplings, fittings, valves, and specialties products of a single manufacturer. Grooving tools of the same manufacturer as the grooved components.
2. Castings used for coupling housings, fittings, valve bodies, etc., date stamped for quality assurance and traceability.

B. Regulatory Requirements:
1. Sprinkler system to comply with NFPA 13 and local Fire Marshal requirements.
2. Refer to Section 21 05 00, Common Work Results for Fire Suppression for additional requirements.
3. Comply with Factory Mutual requirements for Hazard Class and System Design.

C. Hydraulically Calculated Sprinkler System: Sprinkler system to be hydraulically calculated grid system designed to provide:
1. Light Hazard Occupancies: 0.10 GPM/Ft2 density at most remote 1500 SF for public areas, living spaces, or designated by the local fire marshal with an excess of 10 psi additional pressure requirements incorporated into the design over specified pressure requirements.

2. Ordinary Hazard Occupancies Group 1: 0.15 GPM/Ft2 density at most remote 1500 SF for mechanical rooms, kitchen, and parking areas, or designated by the local fire marshal with an excess of 10 psi additional pressure requirements incorporated into the design over specified pressure requirements.
3. Ordinary Hazard Occupancies Group 2: 0.20 GPM/Ft2 density at most remote 1500 SF for mechanical rooms, kitchen, and parking areas, or designated by the local fire marshal with an excess of 10 psi additional pressure requirements incorporated into the design over specified pressure requirements.

D. NFPA 13 (without the use of exceptions found in NFPA 13 systems minimum guideline) used for the location, sizing, and installation of piping and sprinkler systems unless local fire marshal or owner's insurance underwriter requirements are more stringent. Exceptions must be approved by the Engineer prior to usage.

E. Water Service Pressure Basis of Design:
1. Coordination was done to determine fire service water pressure used to develop the fire sprinkler system design information included herein.
2. Fire Protection contractor to obtain current flow test information prior to starting their design of the fire sprinkler system.

F. Automatic sprinklers within elevator hoistways and machine rooms complies with ANSI A17.1-102.2 (c) 4 requirements.

1.04 SUBMITTALS

A. Provide submittal in accordance with Section 21 05 00, Common Work Results for Fire Suppression.

B. Sprinklers referred to on shop drawings and identified by the listed manufacturer's style or series designation. Trade names and abbreviations are not permitted.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Detector Double Check:
1. Conbraco
2. Febco
3. Watts
4. Zurn
5. Or as approved for use in the local jurisdiction.
6. Other Manufacturers: Submit substitution request.

B. Electric Alarm Bell:
1. Potter Electric Signal Company, Model PBA1208

C. Pre-Action System:
1. Single Interlocked Electric Release
   a. Manufacturer: Pre-action system components and required accessories of the same manufacturer.
      1) Viking
      2) Victaulic
2. Double Interlocked [Freezer Applications]

D. Dry Pipe System: Dry pipe system components and required accessories of the same manufacturer.
1. Viking
2. Victaulic

E. Fire Department Connection:
1. Stanchion Type:
   a. Potter-Roemer Model 5763
   b. Standard

2. Flush Type:
    a. Potter-Roemer Figure 5022
    b. Standard

F. Wet Standpipe Hose Valve (Exposed):
1. Potter-Roemer Model 4065
2. Standard

G. Roof Connection:
1. Potter-Roemer Figure 5835 3-way outlet
2. Potter-Roemer flush type hydrant valve control with labeled escutcheon
3. Standard

H. Sprinkler Heads:
1. Viking
2. Victaulic
3. Reliable Automatic Sprinkler
4. Tyco Fire Products

I. Flow Switch:
1. Potter Electric Model VSR-F
2. System Sensor Model WFD

J. Tamper Switch:
1. Potter Electric Signal Company Model PCVS.

K. Fire Department Test Station:
1. Victaulic Style 720
2. Viking

L. Valves:
1. Where only one manufacturer’s model is listed, equivalent products by those specified below, or equal, are acceptable.
2. Use only one manufacturer.
3. Gate, Swing Check:
    a. Jenkins
    b. Victaulic
    c. Crane
    d. Hammond
    e. NIBCO
    f. Kennedy
4. Silent Check:
    a. Jenkins
    b. Victaulic
    c. Mueller
    d. Metraflex
    e. Gustin-Bacon
5. Butterfly:
    a. Jenkins
    b. NIBCO
    c. Keystone
    d. Victaulic
    e. Gustin-Bacon
6. Specialty:
    a. NIBCO
    b. Conbraco
    c. Victaulic

M. Ductile Iron Water Pipe:

1. [ ]

N. Black Steel Pipe:
1. [ ]

O. Flanged Joints:
1. [ ]

P. Mechanical Pipe Couplings and Fittings:
1. Victaulic
2. Gruvlok

Q. Expansion Joints and Compensators:
1. Flexonics
2. Keflex
3. Hyspan
4. Metraflex.
5. Other Manufacturers: Submit substitution request.

R. Expansion Loops/Seismic Expansion Joints:
1. Metraflex Metraloop
2. Other Manufacturers: Submit substitution request.

S. Pressure Gauges:
1. Marsh
2. Ashcroft
3. Weiss
4. Trerice
5. Weksler
6. Tel-Tru

T. Heat Trace Cable (Freeze Protection):
1. Chromalox
2. Raychem.
3. Other Manufacturers: Submit substitution request.

U. Utility Markers:
1. [ ]

V. Piping Markers:
1. W.H. Brady
2. Seton
3. Marking Systems, Inc. (MSI).

2.02 DETECTOR DOUBLE CHECK

A. 3-inch through 10-inch size with 3/4-inch bypass line, OS and Y type of shutoff valve with tattle-tale meter, main line check valve body and cover cast iron epoxy coated internally, bypass line check valve body and cover bronze and check valve trim bronze, and four test cocks.

2.03 ELECTRIC ALARM BELL

A. 8-inch diameter, 120V, 1-phase, red finish, UL and FM approved, labeled Fire Alarm.

2.04 PREACTION SYSTEM

A. Single Interlocked:
1. General:
a. Factory assembled trim package for a single interlocked pre-action system with electric release module in a metal enclosure.
b. Standard trim normally required on a deluge valve has been moved to a single cabinet. The cabinet provides access doors for emergency release and alarm test valve for manual operation of these trim valves.

c. Cabinet is equipped with priming water pressure and water supply gauge view-ports for easy monitoring of water pressures.
d. Cabinet eliminates the installation of alarm trim piping at the deluge valve.
e. Enclosure protects trim valves from inadvertent operation. Included stainless steel hoses from the valve body to the enclosure assembly allows the assembly to be installed remote of the sprinkler riser.
f. UL listed, FM approved TrimPac assembly manufactured by Viking or Fire-Pac Series 745 as manufactured by Victaulic.

2. Operation:
   a. System incorporates an electric release module that controls the pressurization of the priming chamber of the deluge valve.
   b. Water is supplied to the deluge valve's priming chamber from an outlet upstream of the water supply control valve.
   c. Water flow passes through the normally opened priming valve, Y-strainer, 1/16-inch restricted orifice and spring loaded check valve. Supply water to the inlet side of the normally closed solenoid valve and to the priming side of the PORV.
   d. Priming water exits the trim package cabinet passing to the chamber of the deluge valve, pressurizing the deluge valve closed. Once pressure is present in the priming chamber of the deluge valve, the water supply control valve can be opened. Water supply control valve is opened, water will pressurize the inlet chamber of the deluge valve, and water will exit the inlet chamber of the deluge valve and enter the trim package cabinet.
   e. After water enters the trim package cabinet it will pressurize the water supply pressure gauge. Water pressure will now be available on the inlet of the normally closed alarm test valve. Valve and trim assembly is now in a normal operation mode.
3. In Fire Conditions:
   a. Single Interlocked Pre-action Systems with an electric release require a compatible electric release device (or combination of compatible electric release devices) to activate in the hazard area which initiates a power sequence from the listed release control panel to open the normally closed solenoid valve.
   b. Factory assembled trim package in wall mounted cabinet. Solenoid valve opens releasing the water pressure in the deluge valve's priming chamber.
   c. Priming water is discharged from the outlet of the solenoid valve to the drain cup. Once priming water pressure is relieved in the priming chamber of the deluge valve, water supply pressure will pass from the inlet of the deluge valve to the outlet of the deluge valve to the sprinkler piping.
4. Include but not be limited to, the following components:
   a. Water Control Valve:
      1) Deluge of pre-action systems utilizes a 90-degree pattern type of deluge valve. Employ a positive vent on the priming line to ensure that the deluge valve will not prematurely reset.
      2) Inlet and outlet connections of deluge valve can be flanged by flanged or flanged by grooved, respectively.
      3) UL listed and FM approved
      4) Working pressure of 300 psi.
      5) Externally resettable, and internal components replaceable with valve in the installed position.
      6) Valve trim compatible and utilizes a 90-degree pattern type Viking E-1 deluge valve or a straight pattern Viking F-1 or Victaulic Series 769N-NXT deluge valve.
5. Detection:
   a. Activation of the system incorporates as part of the operation, a compatible electric detection system.
   b. Detection devices installed compatible with the deluge valve control panel.
6. Control Panel:
   a. Capable of single hazard cross-zone release.

b. Equipped with a local tone alarm to annunciate loss of A/C power, system trouble, circuit trouble, and low auxiliary D/C power supply.
c. Capable of supervising trouble and audible alarms.
d. Silence trouble and alarms at release panel.
e. House in a vented enclosure with ambient temperature compatibility of 32 degrees F to 120 degrees F. Adequate size to house auxiliary D/C power supply.
f. Auxiliary D/C power supply consists of two 12-volt lead acid batteries of the same ampere hour rating. Actual ampere hour rating will be established by auxiliary D/C power requirement.

7. Solenoid Valve:
   a. Electrical operated solenoid deluge valve priming water release device. Constructed of a 1/2-inch brass body with a stainless steel core tube, core, plug nut, and springs.
   b. Maximum working pressure of 175 psi.
   c. Solenoid valve UL listed for its intended use and listed for use with the deluge valve and flow control valve.
8. Compressed Air Supply:
   a. Provide an air supply capable of restoring system pressure within 30 minutes. Acceptable air supply arrangements are:
      1) A tank-mounted air compressor with an air maintenance device between the air compressor and the air supply inlet on the system riser.
      2) A riser-mounted air compressor feeding an air reservoir. An air maintenance device placed between the air reservoir and the system riser.
      3) A riser-mounted compressor listed as an air maintenance compressor.
      4) System Check Valve:
         a) UL listed and FM approved for use on fire protection systems. Sprinkler riser check valves manufactured with supply side and system side gauge connections and a main drain outlet in accordance with NFPA 13.
         b) Check valves constructed of a ductile iron body with a brass seat and a rubber faced clapper assembly hinged to a removable access cover. Equip with a removable access cover for periodic inspection as required in NFPA 25. Working water pressure of 250 psi.
      5) High-Low Air Pressure Switch:
         a) Maintain supervisory air pressure on pre-action systems with 20 sprinklers or more on the system piping.
         b) Low Air Pressure Alarm:
            (1) Activate by way of a pressure supervisory alarm pressure switch.
            (2) Switch compatible with system devices.
            (3) Enclosure UL listed and FM approved for the application in which it is used.
            (4) Ability to be wired for Class A or Class B service.
      6) Water Flow Pressure Switch:
         a) Activate an alarm by way of an alarm pressure switch.
         b) Compatible with system devices.
         c) Enclosure UL listed and FM approved.
         d) Wired for Class A or Class B service.

B. Single Interlocked Electric Release:
   1. Description:
      a. Method of release of the deluge valve priming water pressure by an electric solenoid valve.
      b. Electric solenoid valve will open upon activation of the electrical supplemental detection system.
      c. Listed and approved assembly.
      d. Equip system riser with rubber seated check valve downstream of the deluge valve and prior to the supervisory air connection.

e. Preaction System:
1) Provide with necessary appurtenances to complete the system.
2) Install in conformance with the current Edition of NFPA 13, Standard for Installation of Sprinkler Systems.
3) Single Interlock Release type.
f. Detection system specified in Division 27, Communications

2. System Devices:
a. Supply and install a single interlocked pre-action cabinet with electric release containing hydraulic and electrical components required for the control of a pre-action system.
b. Cabinet manufactured by Fireflex with Viking components or Victaulic and include the following no substitutions allowed:
1) Self-contained unit (with control panel) in sturdy free-standing 14 gauge steel cabinet, measuring:
a) 71-inch by 36-inch by 20-inch for 1-1/2-inch, 2-inch and 3-inch systems.
b) 71-inch by 46-inch by 24-inch for 4-inch and 6-inch systems.
2) Textured rust proof coating, inside and outside, fire red, oven-baked polyester powder on phosphate base.
3) Two locked access doors to reduce front area required for opening, easily removable without tools to allow easy installation and servicing.
4) Individual access doors for the hydraulic and electrical sections and the emergency release (unlocked) with a neoprene gasket to avoid vibrations.
5) Viking Deluge Valve model E or Victaulic Series 769N-NXT complete with Schedule 40 galvanized steel Viking EZ-Trim rated at 250 psi.
6) Viking PAR-3 Model B-2 or Victaulic integrated control panel, with emergency batteries in a top enclosure including a sprinklers storage rack.
7) Field wiring terminal strips integrated with the cabinet for connection of field wiring for detection system, audible devices, auxiliary contacts, and power supply for air compressor.
8) Pressure gauges to indicate water supply pressure, priming water pressure and air pressure of the system.
9) Release trim with solenoid valve and each supervisory device required.
10) Schedule 40 steel pipe header with grooved ends to be connected to supply water.
11) Schedule 40 steel pipe drain manifold of 2-inch diameter for drain connections. Open drain cups in the cabinet and multiple drain manifolds will not be accepted.
c. Cabinet Assembly: Pre-assembled, pre-wired and factory tested under ISO-9001 conditions, as a Viking TotalPac2 system, by FireFlex Systems Inc. or Victaulic FirePac Series 745. c-UL-us Listed, FM, and MEA approved as an assembled unit.

3. Accessories: Provide required test valves, drain valve, electric pressure switches, etc. for a complete system
4. Install sprinkler heads in pre-action type systems per NFPA 13.

C. Double Interlocked [Freezer Applications]:
1. Description:
a. Provide double interlock electric/pneumatic release pre-action. Method of release of the deluge valve priming water pressure by an electric solenoid valve and a pneumatic actuator.
b. Electric Solenoid Valve: Open upon activation of the electrical supplemental detection system.
c. Pneumatic Actuator:
1) Open upon activation of a sprinkler head on the sprinkler system.
2) Opening of the deluge valve not dependent on the order of activation of the release devices, only that both devices must activate before the deluge valve will open.

3) Listed and approved assembly.

d. Riser: Equip with a rubber seated check valve downstream of the deluge valve and prior to the supervisory air connection. T

e. Pre-Action System:
   1) Provide necessary appurtenances to complete the system. Install in conformance with the current Edition of NFPA 13, Standard for Installation of Sprinkler Systems.
   2) Double interlock release type.

f. Detection system specified in Division 27, Communications.

2. System Devices:
   a. Supply and install a double interlocked pre-action cabinet with electric-pneumatic release containing hydraulic, pneumatic, and electrical components required for the control of a pre-action system.
   b. Cabinet manufactured by FireFlex with Viking components or Victaulic and includes the following, no substitutions allowed:
      1) Self-contained unit (with control panel) in sturdy free-standing 14 gauge steel cabinet, measuring with control panel:
         a) 71-inch by 36-inch by 20-inch for 1-1/2-inch, 2-inch and 3-inch systems
         b) 71-inch by 46-inch by 24-inch for 4-inch and 6-inch systems.
      2) Textured rust proof coating, inside and outside, fire red, oven-baked polyester powder on phosphate base.
      3) Two locked access doors to reduce front area required for opening, easily removable without tools to allow easy installation and servicing.
      4) Individual access doors for the hydraulic and electrical sections and the emergency release (unlocked) with a neoprene gasket to avoid vibrations.
      5) Viking Deluge Valve model E or Victaulic Series 769N-NXT, complete with Schedule 40 galvanized steel trim rated at 250 psi.
      6) Viking PAR-3 Model B-2 or Victaulic integrated control panel, with emergency batteries in a top enclosure including a sprinklers storage rack.
      7) Field wiring terminal strips integrated with the cabinet for connection of field wiring for detection system, audible devices, auxiliary contacts, and power supply for air compressor.
      8) Pressure gauges to indicate water supply pressure, priming water pressure and air pressure of the system.
      9) Release trim with solenoid valve, pneumatic actuator and each supervisory device required.
      10) Schedule 40 steel pipe header with grooved ends to be connected to supply water.
      11) Schedule 40 steel pipe drain manifold of 2-inch diameter for drain connections. Open drain cups in the cabinet and multiple drain manifolds will not be accepted.
   c. Cabinet assembly must be pre-assembled, pre-wired and factory tested under ISO-9001 conditions, as a TotalPac2 system, by FireFlex Systems Inc. c-UL-us Listed, FM, and MEA Approved as an assembled unit.
3. Accessories: Provide required test valves, drain valve, electric pressure switches, etc. for a complete system
4. Install sprinkler heads in pre-action type systems per NFPA 13.

2.05 DRY PIPE SYSTEM

A. Description:
   1. Install a dry sprinkler system in areas with temperatures that cannot be reliably maintained above 40 degrees F. Install in conformance with the current enforced edition of NFPA 13, Standard for Installation of Sprinkler Systems, and manufacturer's guidelines.
   2. System design densities selected per NFPA 13, Occupancy Hazard requirements. System design areas increased 30 percent to allow for delay in water delivery.

3. Provide dry pipe systems in the areas indicated on the drawings including external areas subject to temperatures of 40 degrees F or less.
4. Provide dry pipe valves with a listed quick-opening device where system capacity exceeds 500 gallons.
5. Systems in excess of 750 gallons deliver water to the system test connection in not more than 60 seconds, starting at the normal air pressure on the system and at the time of fully opened inspector's test connection.
6. Allow to exceed 750 gallons only if the above requirements are strictly adhered to.
7. Gridded or looped piping configurations not allowed.
8. Connect dry sprinkler system piping to fire protection main and/or to standpipe risers as indicated on the drawings and as required by regulatory requirements. Each connection to have a supervised indicating control valve, low air pressure switch, and water flow pressure switch.
9. Prevent unwanted water column from accumulating on the dry valve, an anti-column device installed on each riser.

B. System Devices:
   1. Listings and Approvals:
      a. Equipment and devices UL listed and FM Approved for fire protection.
   2. Dry Pipe Valve:
      a. Control by a pitot operated valve that opens and closes based on the position of an internal diaphragm assembly which is pressurized by priming water. The externally resettable valve internally and externally protected with a corrosion-resistant coating, contain an internal check valve, and be designed for 250 psi water pressure.
      b. Air Pressure: 13-psi (90-kPa).
      c. Internal components replaceable with valve in the installed position.
      d. Dry Pipe Valve to be Viking Model G4000 or Victaulic Series 768N-NXT.
   3. Compressed Air Supply:
      a. Provide an air supply capable of restoring system pressure within 30 minutes.
      b. Acceptable air supply arrangements tank mounted air compressor with an air maintenance device between the air compressor and the air supply inlet on the system riser.
   4. Air Maintenance Device:
      a. Air supplies provided for sprinkler systems equipped with an automatic air pressure maintenance device.
      b. Equip with a 1/4-inch air supply bypass with a field adjustable air pressure regulator and a factory setting of 40 psi.
      c. Viking Model D-2 or Victaulic Style 757 Air Maintenance Assembly.
   5. Quick Opening Device:
      a. Where system capacity exceeds 500 gallons, a quick opening device provided on each system riser.
      b. Accelerator from the same manufacturer as the dry pipe valve.
      c. Accelerator to be Viking Model E-1 or Victaulic Series 746.
   6. Anti-Column Device:
      a. Incorporate an internal float that will allow venting of the riser when an accumulation of water is present and automatically seat and close the drain once the water is vented.
      b. Capable of operation with air pressures as low as 7 psi and listed for water pressure up to 250 psi.
      c. Anti-Column Device to be Viking, Model LD-1 or Victaulic Series 75D.
   7. Pressure Supervisory Switch:
      a. Low air pressure supervisory alarm will activate by way of a low air pressure switch.
      b. Compatible with system devices and have the ability to be wired for Class A or Class B service. Low Air Pressure Alarm Switch to be Viking or System Sensor.
      c. Include as part of the pre-trimmed valve assembly.

8. Alarm Pressure Switch:
   a. Water flow alarm will activate by way of an alarm pressure switch.
   b. Compatible with system devices and have the ability to be wired for Class A or Class B service.
   c. Alarm Pressure Switch to be Viking. Included as part of the pre-trimmed valve assembly, no substitutions allowed.
9. Control Valve with Tamper Switch:
   a. Dry system control valve an indicating type valve that is rated for 300 psi system operating pressure.
   b. Valve manufacturer to be Victaulic Series 705 grooved end valve or lug type by Kennedy or NIBCO butterfly valve, included as part of the pre-trimmed valve assembly.

C. Accessories: Provide required test valves, drain valve, pressure switches, and related trim.

2.06 FIRE DEPARTMENT CONNECTION (FDC)

A. Description:
1. Provide on the system riser in accordance with NFPA 13, Standard for Installation of Sprinkler Systems.
2. Brass body with an integral clapper assembly to separate flow between inlets.
3. Install in an area accessible for the first response unit.
4. UL listed and FM approved for fire protection use.
5. At low point near each fire department connection, provide a 90-degree elbow with drain connection to allow for localized system drainage to prevent freezing.
6. Victaulic FireLock 10-DR.

B. Stanchion Type: 24-inch high, polished chrome plated freestanding fire department inlet connection. 6-inch by 2-1/2-inch 2-way inlets with clappers, lettered (Auto. Spkr., OR Auto. Spkr. Standpipe).

C. Flush Type: Polished chrome plated flush fire department inlet connection with clappers, lettered (Auto. Spkr., OR Auto. Spkr. Standpipe) 4-inch by 2-1/2-inch by 2-1/2-inch complete with plugs and chains.

2.07 WET STANDPIPE HOSE VALVE (EXPOSED)

A. 2-1/2-inch by 2-1/2-inch female x male angle hose valve with 1-1/2-inch reducer, cap and chain.

2.08 ROOF CONNECTION

A. 3-way flush fire department connection, with 6-inch back female inlet, three 2-1/2-inch male outlets, and wall type hydrant control.

2.09 SPRINKLER HEADS

A. General:
1. One manufacturer throughout building. Mixing of sprinkler brands is not permitted.
2. Brass frame construction with a coated metal-to-metal seating mechanism. Sprinklers utilizing non-metal parts in the sealing portion of the sprinkler are strictly prohibited.
3. Quick response frangible bulb type fusible element with a temperature rating of 155 degrees or 200 degrees F or a fast response metal type fusible element with a temperature rating of 165 degrees or 212 degrees F.
4. 1/2-inch NPT, a standard orifice, and a 5.6 nominal K Factor.
5. UL listed and FM Approved for working water pressures up to 175 psi. Sprinkler heads in dry and pre-action type systems installed per NFPA 13.
6. Heads, UL approved for application and installation.

B. Provide high temperature, 212 degrees F heads for mechanical rooms, areas below skylights, dishwashing and other areas which have high heat producing equipment to prevent accidental trip page.

C. Sprinklers Installed in Finished Ceilings:

1. Quick response, recessed, bulb type, [chrome] [white] finish, 165 degrees F unless required otherwise.

D. Sprinklers Installed in Finished Ceilings:
   1. Quick response, concealed pendant with [chrome] [white] drop-off cover plate, rough bronze finish, 155 degrees F unless required otherwise.

E. Sprinklers Installed in Unfinished Ceiling Areas (or Above Finished Ceilings Where Required):
   1. Pendant or up-right fusible solder type, rough bronze finish, and adequate temperature for the hazard.

F. Sprinklers Installed in Exterior Perimeter Areas:
   1. Quick response, horizontal dry sidewall sprinkler, fusible solder type, polished chrome finish.

G. Sprinklers Installed in Operating Rooms, Protective Isolation Rooms, Laboratories, Pharmacies, Clean/Sterile Rooms:
   1. Quick response, concealed pendant with [chrome] [white] drop-off cover plate, gasket for dust free environments, rough bronze finish, 155 degrees F unless required otherwise.

H. Sprinklers Installed in [_____] Rooms:
   1. Institutional pendant, quick response, fusible solder type, tamperproof construction, stainless steel.
   2. Institutional sidewall, quick response, tamperproof construction, stainless steel.

I. Sprinklers Installed in Exterior Covered Areas:
   1. Quick response, dry pendant fusible solder type, chrome finish, 165 degrees F unless required otherwise.

J. Life Safety Type Sprinkler Heads (Window Wash to Maintain Ratings at Glazed Openings at Enclosed Stairs):
   1. Quick response, chrome finish, horizontal sidewall or pendant vertical sidewall, Central Model WS Window Sprinkler, or similar listed sprinkler for this application.

K. Sprinkler Heads, Corrosion Resistant:
   1. Pendant type, rough bronze finish, 165 degrees F, with factory applied corrosion resistant coating.

L. Flexible Stainless Steel Hose:
   1. UL rated, FM approved stainless steel hose assembly for individual sprinkler connections, Victaulic Vic-Flex.
   2. Drop includes a UL approved braided hose with a bend radius to 2-inch to allow for proper installation in confined spaces.
   3. Provide union joints for ease of installation.
   4. Attach flexible drop to the ceiling grid using a one-piece open gate bracket. The bracket allows installation before the ceiling tile is in place.
   5. The braided drop system is UL listed and FM Approved for sprinkler services to 175 psi (1206 kPa).

M. Flexible Dry Stainless Steel Hose:
   1. UL rated approved stainless steel hose assembly for individual sprinkler connections, Victaulic VicFlex Dry Sprinkler Style VS1, 5.6 K, Quick and Standard Response.
   2. Drop includes a UL approved braided hose with a minimum bend radius to 2-inch to allow for proper installation in confined spaces, with a maximum number of 4, 90° bends.
   3. Must be installed according to current, applicable NFPA (13, 13D, 13R, ect…) or equivalent standards. These can be installed in wet, dry, or preaction actuated systems.
   4. Follow the current manufactures instructions/assembly for proper installation. Installations must also meet provisions of the local codes, local Authority Having Jurisdiction, as applicable.
   5. The system designer must verify the suitability of the intended fluid media with the 300-Series stainless steel flexible hose.
   6. The braided dry drop system is UL listed for sprinkler services up to 175 psi (1206 kPa).

2.010 FLOW SWITCH

A. Description:
   1. UL listed electric flow switch with retard.
   2. Provide required accessories.

B. Single pole type with normally open and normally closed contacts. Location as shown. Provide rewired related trimmings. Provide one set of contacts for use by the Fire Alarm Contractor. Coordinate with pipe size.

2.011 TAMPER SWITCH

A. Description:
   1. Each sprinkler system control valve equipped with a tamper switch listed by Underwriters Laboratories for the particular location and type of valve supervised.
   2. Initiates a supervisory signal upon a maximum of two complete turns of a valve wheel or closure of ten percent, whichever is less.
   3. Provide number of poles to coordinate with the fire alarm system manufacturer.

2.012 FIRE DEPARTMENT TEST STATION

A. One piece, compact, floor test module for standard alarm test loop, threaded.

2.013 VALVES

A. Gate, butterfly, and check valves meet current MSS standards.

B. Bronze gate and check valves made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.

C. Full lug and grooved butterfly valves suitable for bi-directional dead end service at full rated pressure without use or need of a downstream flange.

D. Valves in Insulated Piping: Valves have 2-inch stem extensions and the following features:

E. Gate Valves: Rising stem type.

F. Butterfly Valves: Extended necks.

G. Valve ends may be threaded, flanged, soldered, or grooved as applicable to piping system.

H. Provide ball drip drains, test orifices, and other related items as required to provide a complete fire protection system.

I. Gate Valves:
   1. Bronze Gate: Bronze body, bronze screwed bonnet, bronze solid wedge, OS&Y pattern, rising stem, pre-grooved stem for supervisory switch mounting, 175 psi CWP, UL listed, FM approved; NIBCO T-104.
   2. Iron Gate: Iron body, bronze trim, OS&Y pattern, solid wedge, pre-grooved stem for supervisory switch mounting, 175 psi CWP, UL listed, FM approved; NIBCO F-607-OTS.
   3. Iron Gate, High Pressure: Iron body, bronze trim, flanged OS&Y pattern, solid wedge, FM approved for 300 psi, UL listed 350 psi; NIBCO F-697-0.

J. Check Valves:
   1. Horizontal Bronze Swing Check:
      a. Bronze body, bronze-mounted, TFE disc, 150 psi SWP, 300 psi CWP; NIBCO T-443-Y, NIBCO S-433-Y.
      b. Check valves in main riser path FM approved.
   2. Horizontal Bronze Swing Check, High Pressure:
      a. Bronze body, bronze-mounted, regrinding bronze disc, 300 psi SWP, 1000 psi CWP; NIBCO T473-B.
      b. Check valves in main riser path FM approved.
   3. Horizontal Iron Swing Check:
      a. Iron body, bronze-mounted, regrinding bronze disc and seat ring, 200 psi CWP; NIBCO F-918-B.
      b. Check valves in main riser path FM approved.

4. Vertical and Silent Check Valves:
   a. Iron body, stainless steel spring, wafer type, globe style, 200 psi CWP; NIBCO 910-B.
   b. Check valves in main riser path, FM approved.
5. Vertical and Silent Check Valves, High Pressure:
   a. Iron body, stainless steel spring, wafer type, globe style, 400 psi CWP; NIBCO W-960-B, NIBCO F-960-B.
   b. Check valves in main riser path, FM approved.

K. Butterfly Valves:
1. Iron Butterfly:
   a. Ductile iron body, aluminum-bronze disc and one-piece stainless steel shaft, copper bushing, fasteners and pins not used to attach stem to disc, gear operator, stem neck length to accommodate insulation where applicable, EPDM liner or disc, 200 psi CWP; NIBCO LD 2000 (lug style), NIBCO GD-4765 (grooved ends).
   b. Butterfly valves in main riser path, FM approved.
2. Iron Butterfly, High Pressure: Ductile iron body, ductile iron disc and one-piece stainless steel shaft, copper bushings, fasteners and pins not used to attach stem to disc, with lever handle and locking feature on valves 6-inches and smaller, gear operator, EPDM liner or disc, 300 psi CWP, integral supervisory switch, UL listed, FM approved; NIBCO GD-4765.

L. Specialty Valves:
1. Drain Valves: Bronze ball valve, garden hose end, cap and chain 3/4-inch size, bronze cast body, chrome-plated full port ball, with handle, Teflon seat, threaded body packnut design (no threaded stem designs allowed) with adjustable stem packing, 600 psi CWP; NIBCO T-585-70-HC.
2. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4-inch; Conbraco 41 series, or equal.

2.014 DUCTILE IRON WATER PIPE

A. Pipe: Ductile iron pipe conforming to ANSI A21.51.

B. Fittings:
1. Below grade, Class 150 Boltite mechanical joint type complete with gaskets, bolts, and nuts, or Tyton for joints employing a single gasket for the joint seal with bell-and-spigot pipe.
2. Above grade, mechanical couplings and fittings as specified herein.
3. Provide interior pipe coating per ANSI Regulation listed.

C. Service: Below grade incoming fire protection main.

2.015 BLACK STEEL PIPE

A. General:
1. UL listed and FM approved for fire protection use.
2. Fittings and joints must be UL listed with pipe chosen for use.
3. Listing restrictions and installation procedures per NFPA 13 and state and local authorities for fire protection use.
4. Pipe/fittings must be hot-dipped galvanized in accordance with ASTM A53 for dry pipe sprinkler systems.

B. Pipe: ASTM A135 or A53.
1. Fire Protection:
   a. Schedule 10 or Schedule 40 in sizes up to 5 inches.
   b. 0.134-inch wall thickness for 6-inch.
   c. 0.188-inch wall thickness for 8-inch and 10-inch.
   d. 0.330-inch wall thickness for 12-inch.

C. Fittings: Roll grooved ends with mechanical couplings as specified.

D. Service Above Grade: Fire protection system only for sizes listed, as approved by NFPA 13.

2.016 FLANGED JOINTS

A. Flanged Joints:
1. Cast iron or steel for screwed piping and forged steel welding neck for welded line sizes.
2. Pressure rating and drilling matches the apparatus, valve, or fitting to which they are attached.
3. Flanges in accordance with ANSI B16.1; 150 lb. for system pressures to 150 psig; 300 pounds for system pressures 150 psig to 400 psig.
4. Gaskets 1/16-inch thick, Cranite, or equal, ring type, coated with graphite and oil to facilitate making a tight joint.
5. Make joint using American Standard hexagon head bolts, lock washers, and nuts (per ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer, and American Standard hexagon head nuts (per ASTM A307 GR.B) for service pressures 150 psig to 400 psig. Use length of bolt required for full nut engagement.
6. Provide electro-cad plated bolts and nuts.

2.017 MECHANICAL PIPE COUPLINGS AND FITTINGS

A. Couplings and Fittings:
1. Coupling housing to be zero flex rigid type coupling with angled bolt pad design. Couplings fully installed at visual pad-to-pad offset contact. Couplings that require gapping of bolt pads or specific torque ratings for proper installation are not permitted. Installation-Ready, for direct stab installation without field disassembly. Similar to Victaulic Type 009N.
2. Flexible couplings to be used only when expansion contraction, deflection or noise and vibration is to be dampened. Flexible Coupling to be similar to Victaulic Installation-Ready Type 005.Coupling gasket similar to Victaulic's Grade E molded synthetic rubber per ASTM D-2000.
3. Coupling bolts oval neck track head type with hexagonal heavy nuts per ASTM A-449 and A-183.

2.018 EXPANSION JOINTS AND COMPENSATORS

A. Expansion compensators to be of the packless, externally pressurized type to allow for axial movement constructed of stainless steel bellows, stainless steel shroud, integral guide rings, internal liner, limit stops, with drain port and plug.

B. Materials of construction and pressure ratings appropriate for the application as specified for each piping material and service.

C. UL listed and FM approved for fire protection use. Listing restrictions and installation procedures per NFPA 13 and state and local authorities for fire protection use.

2.019 EXPANSION LOOPS / SEISMIC EXPANSION JOINTS

A. Flexible stainless steel hose and braid connector.

B. Connector accepts differential support displacement without damaging pipe, equipment connections, or support connections.

C. Materials of construction and pressure ratings appropriate for the application,

D. UL listed and FM approved for fire protection use. Listing restrictions and installation procedures per NFPA 13 and state and local authorities for fire protection use.

2.020 PRESSURE GAUGES

A. Description: 4-1/2-inch dial, molded black polypropylene turret case.

B. Range:

SYSTEM	PRESSURE	GRADUATIONS
Fire Protection	0-160 psi	1 psi
*Provide compound gauge where shown on inlet side of fire pump on open piping systems (30-inch 15 psi). Other ranges may be listed on Drawings in which case they take precedence.		

2.021 HEAT TRACE CABLE (FREEZE PROTECTION)

A. General:
   1. Furnish and install a complete UL listed system of heaters, controllers, and components listed specifically for maintaining a 40 degrees F water temperature over the entire system.
   2. IEEE 515.1 listed for use as trace heating for commercial applications.

B. Self-Regulating Heating Cable: Raychem XL-Trace.
   1. Two 16 AWG nickel-coated copper bus wires embedded in a radiation cross-linked self-regulating polymer core.
   2. Automatically adjusts power output to compensate for temperature changes.
   3. Tinned copper braid
   4. Fluoropolymer dielectric outer jacket
   5. Voltage: 208V
   6. Voltage: 277V

C. Single Circuit System:
   1. Controller: Raychem C910
      a. Adjustable temperature control: 105 degrees F – 140 degrees F
      b. BMS interface
      c. Enclosure: NEMA 4X
      d. Voltage: 208V
      e. Voltage: 277V
   2. Pipe temperature sensor: RTD type.

D. Multiple Circuit System: DigiTrace ACS-30
   1. Central User Interface Terminal: DigiTrace ACS-UIT2.
      a. Touch-screen LCD display
      b. Programmable via USB or Ethernet
      c. 3 programmable alarm contacts
      d. Password Protection
      e. BMS interface
         1) Communication Protocol:
            a) BACnet
            b) LonWorks
            c) Modbus
            d) Metasys N2
         2) Variables reported back to BMS:
            a) Temperature
            b) Ground-Fault
            c) Current Draw
            d) Power Consumption
            e) Alarm
      f. Capable of communicating with up to 52 Power Control Panels.
      g. Enclosure:
         1) NEMA 4
         2) Alarm Light
      h. c-CSA-us Certified
   2. Power Control Panel, ACS-PCM2-5.
      a. Controls up to 5 circuits
      b. Accepts up to 5 temperature inputs
      c. Adjustable temperature control: 105 degrees F – 140 degrees F
      d. Enclosure: NEMA 4/12
      e. c-UL-us Listed
   3. Pipe temperature sensor: RTD type
   4. Ambient temperature sensor: RTD type

2.022 UTILITY MARKERS

A. Provide plastic tape utility markers over buried piping. Provide identification on tape.

B. Material to be Brady Identoline plastic tape, 6-inch, Seton, or as approved.

2.023 VALVE IDENTIFICATION

A. Valve Tags:
   1. General:
      a. Identify valves with metal tags or plastic signs, legends to be stamped or embossed.
      b. Indicate the function of the valve and its normal operating position, and area served; i.e.

3RD FL	(Area Served)
ISOLATION	(Valve Function)
NO	(Normal Operation Position)

   2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
   3. Material: Use 0.050 or 0.064-inch brass tags.
   4. Control Valves:
      a. Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, lamicoid, or equal.
      b. Form letters by exposing center ply.

B. Valve Tag Directory: Include the following:
   1. Tag Number
   2. Location
   3. Exposed or Concealed
   4. Area Served
   5. Valve Size
   6. Valve Manufacturer
   7. Valve Model Number
   8. Normal Operating Position of Valve

2.024 PIPING MARKERS

A. Label pipes with all-vinyl, self-sticking labels or letters.

B. Pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters; above 2-inches outside diameter, 2-inch letters.

C. Identify and color code as follows with white directional arrows.

SERVICE	PIPE MARKER	BACKGROUND COLOR
SPRINKLER WATER	FIRE PROTECTION WATER	RED
AIR, COMPRESSED	*COMPRESSED AIR*	GREEN

2.025 EQUIPMENT IDENTIFICATION

A. Nameplates:
   1. Tag pumps, and miscellaneous equipment with engraved nameplates.
   2. 1/16-inch thick, 3-inch by 5-inch laminated 3-ply plastic, center ply white, outer ply black.
   3. Form letters by exposing center ply.
   4. Identify unit with code number as shown on Drawings and area served.

B. Equipment Nameplate Directory:
   1. List pumps, compressors and other equipment nameplates.
   2. Include Owner and Contractor furnished equipment.
   3. List nameplate designation, manufacturer's model number, location of equipment, area served or function, disconnect location, and normal position of HOA switch.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Provide seismic hangers as required by code.
   2. Provide tamper switches on sprinkler system isolation valves. Provide flow switches for sprinkler zones. See Drawings for locations.
   3. A corrosion-resistant metal placard provided on riser indicating location number of sprinklers, design criteria, water demand, and date of installation.
   4. Install fire sprinklers in exhaust ductwork from grease hood per NFPA 13. Provide access doors for sprinkler access per NFPA 96 and IBC. Provide access doors at a maximum of 10-feet on center in horizontal run. Provide a dry pendant sprinkler head at top of ductwork to prevent freezing.
   5. Provide sprinkler systems in lab ductwork as required by code.
   6. Provide fire sprinkler guards on exposed sprinklers in areas subject to damage.
   7. Quick response sprinklers listed for installation in an Ordinary Hazard occupancy when installed in an Ordinary Hazard occupancy.

B. Flexible Sprinkler Wet and Dry Head Drop:
   1. Install per manufacturer's installation requirements.
   2. Coordinate head location with other trades to assure space is available to maintain proper radius requirements.
   3. Provide flexible sprinkler drops of appropriate length as conditions require.
   4. Provide flexible sprinkler drops at sprinkler heads located in suspended, dropped, or acoustical ceilings. In hard lid ceiling areas, provide flexible heads at Contractor's option.

C. Sprinklers in Elevator Hoistways and Machine Rooms:
   1. Reference Division 26, Electrical for heat detectors provided to disconnect mainline power of elevator prior to application of water from the sprinklers.
   2. A shutoff valve with tamper switch will be provided for each branch service serving these spaces and located in an accessible location outside these spaces.

D. Sprinklers at Glazed Openings:
   1. Glazed opening at [_____] will be protected on both sides of glass by listed quick response Life Safety Type sprinkler heads designated to wet entire surface of glass. Sprinklers spaced 6-feet apart, 8- to 12-inches from the glass, or as required per sprinkler manufacturer's listed installation instructions.

E. Sprinklers above finished ceilings: Include heads above finished ceilings if structure is combustible, or if steel beams are not provided with spray-on fire proofing.

F. Electrical: Electrical work to comply with Division 26, Electrical.

G. Fire Service: Connect to sprinkler line where it enters the building.

H. Standpipe hose connections:
   1. Provide in locations indicated and as required by code.
   2. Confirm with the code official for hose connections that are at their discretion.
   3. Coordinate exact installation location of with the architect and code official.

I. Hangers and Supports:
   1. Install sprinkler system and service main piping, hangers, and supports in accordance with NFPA 13.
   2. Install standpipe piping, hangers, and supports in accordance with NFPA 14.
   3. Connections to structural framing not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

J. Pressure Gauges:
   1. Provide gauges where specified, shown on Drawings, or required by code.
   2. Install additional gauges as required and as recommended by equipment manufacturer or their representative.

3. Locate gauges so that they may be conveniently read at eye level or easily viewed and read from the floor or from the most likely viewing area.
4. Install instruments over 6-1/2-feet above floor, to be viewed from the floor, with face at 30 degrees to horizontal.
5. Provide instrument gauge cock at inlets.

K. Valves:
1. Provide valves at connections to equipment where shown or required for equipment isolation.
2. Install valves accessible and same size as connected piping.
3. Provide separate support for valves where necessary.
4. Provide drain valves in low points in the piping system, and at equipment, as required by code, and as indicated.
5. Fire Suppression Service:
   a. In piping 2-inches and smaller; bronze gate valve, bronze swing check valve, vertical check valve.
   b. In piping 2-1/2-inches and larger; iron gate valve, iron swing check valve, vertical check valve.
   c. UL approved butterfly valves.
   d. Silent check valves on pump discharge.
6. Provide gauge cocks for pressure gauges.

L. Piping Preparation:
1. Measurements, Lines and Levels:
   a. Check dimension at the building site and establish lines and levels for work specified in this Section.
   b. Establish inverts, slopes, and elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
   c. Use established grid and area lines for locating trenches in relation to building and boundaries.

M. Excavation and Backfill:
1. General:
   a. Perform necessary excavation and backfill required for the installation of fire suppression work in accord with Division 02, Existing Conditions.
   b. Repair pipelines or other work damaged during excavation and backfilling.
2. Excavation:
   a. Excavate trenches to the necessary depth and width, removing rocks, roots, and stumps.
   b. Include additional excavation to facilitate utility crossovers, additional offsets, etc.
   c. Excavation material is unclassified.
   d. Width of trench adequate for proper installation of piping. Widen if not wide enough for a proper installation.
3. Bedding:
   a. Cast iron, steel, and copper piping fully bedded on sand.
   b. Place a minimum 4-inch deep layer on the leveled trench bottom for this purpose.
   c. Remove the sand to the necessary depth for piping bells and couplings to maintain contact of the pipe on the sand for its entire length.
   d. Lay other piping on a smooth level trench bottom so that contact is made for its entire length.
4. Backfill:
   a. Place in layers not exceeding 8 inches deep, and compact to 95percent of standard proctor maximum density at optimum moisture content. Earth backfill free of rocks over 2 inches in diameter and foreign matter. Disposal of excess material as directed.

b. Interior: Backfill under interior slabs bank sand or pea gravel.
c. Exterior:
1) Excavated material may be used outside of buildings
2) First 4-inches of sand and final 12-inch layer of course soil.

N. Piping:
1. Hold piping as tight to structure as possible. In general, run piping in areas without ceilings parallel to building elements in a neat, professional manner.
2. Pipe inspector test connections to exterior and discharge as approved by local applicable governing authorities.
3. Provide test tees as required.
4. Install unions in non-flanged piping connections to apparatus and adjacent to screwed control valves, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.
5. Mechanical Couplings:
a. On systems using galvanized pipe and fittings, galvanize fittings at factory.
b. Before assembly of couplings, lightly coat pipe ends and outside of gaskets with approved lubricant.
c. Pipe grooving in accordance with manufacturer's specifications contained in latest published literature.
6. Install piping as to drain per NFPA 13.
7. Support piping independently at apparatus so that its weight not carried by the equipment.
8. Utility Marking:
a. Installed over the entire length of the underground piping utilities. Install plastic tape along both sides and the center line of the trenches at the elevation of approximately 12-inches above the top of utility.
9. Underground Water System:
a. Prior to testing pipe provide concrete thrust blocks at changes in direction.
b. Block size as required for types of fittings involved.

O. Drain Piping:
1. Pitch drain piping 1/2-inch per 10-feet minimum; no traps allowed.
2. Discharge drain piping to outside with suitable splash plate to a location as approved by the architect.

P. Piping Joints:
1. Join pipe and fittings using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.
2. Grooved Joints:
a. Install in accordance with the manufacturer's latest published installation instructions.
b. Clean pipe ends free from indentations, projections and roll marks in the area from pipe end to (and including) groove.
c. Gasket manufactured by the coupling manufacturer and verified as suitable for the intended service.
d. Factory trained representative (direct employee) of the coupling manufacturer to provide on-site training for contractor's field personnel in the use of grooving tools, application of groove, and product installation.
e. Periodically visit the job site and review installation to ensure best practices in grooved joint installation are being followed.
f. Remove and replace any improperly installed products.
3. No couplings installed in floor or wall sleeves.

4. Steel Piping:
   a. Screwed Joints:
      1) Pipes cut evenly with pipe cutter reamed to full inside diameter with burrs and cuttings removed.
      2) Joints made up with suitable lubricant or Teflon tape applied to male threads only, leaving two threads bare.
      3) Joints tightened so that not more than two threads are left showing.
      4) Junctions between galvanized steel waste pipe and bell of cast iron pipe made with tapped spigot or half coupling on steel pipe to form spigot end and caulked.
   b. Flanged Joints:
      1) Pressure rating of flanges match valve or fitting joined.
      2) Coat joint gaskets with graphite and oil.
5. Welded Joints:
   a. Preparation for Welding: Bevel piping on both ends before welding:
      1) Use following weld spacing on buttwelds:

NOMINAL PIPE WALL THICKNESS	SPACING	BEVEL
1/4-inch or less	1/8-inch	37-1/2
Over 1/4-inch, less than 3/4-inch	3/16-inch	27-1/2

      2) Before welding, remove corrosion products and foreign material from surfaces.
   b. Welded Joints:
      1) Use arc-welding process using certified welders. Port openings of fittings must match the inside diameter of the pipe to which they are welded. Use full radius welding elbows for turns, use welding tees for tees. Use reducing fittings for size reduction. Weldolets may be used for branches up through one-half the pipe size of the main to which they are attached. Nipples are not allowed.
   c. Welding Operation:
      1) After deposition, clean each layer of weld metal to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer.
      2) Weld reinforcement no less than 1/16-inch not more than 1/8-inch above normal surface of jointed sections. Reinforcement crowned at center and taper on each side to surfaces being joined. Exposed surface of weld present professional appearance and be free of depressions below surface of jointed members.
      3) Do not weld when temperature of base metal is lower than 0 degrees F. Material to be welded during freezing temperatures made warm and dry before welding is started. Metal warm to the hand or approximately 60 degrees F.
6. Ductile Iron Pipe: Install joints per manufacturer's written instructions.

Q. Expansion Joints and Compensators:
   1. Install in piping risers in wood structures to compensate for 1/2-inch of shrinkage per floor. Determine quantities and locations required.
   2. Install in other locations indicated on the drawings.
   3. Install per manufacturer's installation instructions.

R. Expansion Loops / Seismic Expansion Joints:
   1. Install at building seismic expansion joints.
   2. Install in other locations indicated on the drawings.
   3. Install per manufacturer's installation instructions.

S. Pipe Wrap:
   1. Apply per manufacturer's written instructions.
   2. Apply wrapping to fittings in field after installation.

3.02 HEAT TRACE CABLE (FREEZE PROTECTION)

A. Location: Provide heat trace on piping in unheated spaces as shown or required to prevent freezing.

B. Install heat trace cable on pipes indicated to maintain a minimum of 35 degrees F in an ambient temperature of 0 degrees F. Lay cable parallel on pipe or spiral wrap to maintain adequate temperature as required by pipe size and thermal properties of the pipe insulation to be applied.

C. Attach heat trace cable to metal pipe with GT-66 glass tape at increments not exceeding 1-foot.

D. Attach heat trace cable to plastic pipe with AT-180 aluminum tape at increments not exceeding 1-foot.

E. Install thermostat capillary and bulb to pipe with polyester tape assuring a firm bulb contact with pipe. Bulb not in contact with heat cable.

F. Install ambient sensing thermostat at accessible location adjacent to pipe.

G. Install line sensing thermostat on piping, interior to insulation.

H. Installer responsible for affixing an Electric Traced label to the outside of the pipe's thermal insulation on alternating sides at intervals of five to fifteen feet immediately after the piping has been insulated.

I. Coordinate installation with work under Division 23, Heating, Ventilating, and Air Conditioning for adequate electrical service to each thermostat.

3.03 IDENTIFICATION

A. Valve Identification:
   1. Valve Tags:
      a. Attach to valve with a brass chain.
      b. Valve tag numbers continuous throughout the building for each system. Obtain a list for each system involved from the [Owner] [to establish numbers following the listed sequences:]
         1) [ ]
         2) [ ]
         3) [ ]
         4) [ ]
   2. Valve Tag Directory:
      a. Post final copy in Operation and Maintenance Manual.

B. Piping Markers:
   1. Unless recommendations of ANSI A13.1 are more stringent, apply labels or letters after completion of pipe cleaning, painting, or other similar work, as follows:
      a. Every 20-feet along continuous exposed lines.
      b. Every 10-feet along continuous concealed lines.
      c. Adjacent to each valve and stub out for future.
      d. Where pipe passes through a wall, into and out of concealed spaces.
      e. On each riser.
      f. On each leg of a T.
      g. Locate conspicuously where visible.
   2. Apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above. Apply arrow labels indicating direction of flow. Arrows to be the same color and sizes as identification labels.

C. Equipment Identification:
   1. Nameplates:
      a. Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.
   2. Nameplate Directory:
      a. Post final copy in Operation and Maintenance Manual.

3.04 EXTRA STOCK

A. Provide additional number of heads of each type and temperature rating installed as required to meet NFPA 13 requirements.

B. Provide storage cabinet or cabinets as required to receive reserve sprinkler heads and special installation tools required.

C. Provide index label for each head indicating manufacturer, model, orifice size of K-factor, and temperature rating.

D. Provide, inside cabinet a list of heads stored within and brief description of where installed.

E. Locate cabinet near sprinkler control station as approved.

3.05 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Perform tests and arrange for required inspections of installed system as required.
   2. Notify the Architect 48 hours prior to any test or inspection.
   3. Provide final test and certification in the presence of an Owner representative. Coordinate hereunder.

B. Inspection Service:
   1. At start of warranty year, execute inspection agreement.
   2. Without additional charge to Owner, make quarterly inspection of system during year.
      a. Check and operate control valves.
      b. Lubricate valve parts.

C. Report each inspection to Owner.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes Design-Build work.

B. The intent of Division 22, Plumbing and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include all work specified in Division 22, Plumbing and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.

C. Division 22, Plumbing and the accompanying Drawings are complementary and as binding as if called for by both. Items shown on the Drawings are not necessarily included in the Specifications and vice versa. Specifications supersede drawings in case of conflict.

D. The Drawings that accompany the Division 22, Plumbing, are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in fixture location prior to roughing-in, without cost impact.

E. The General and Supplemental Conditions apply to this Division, including but not limited to:
   1. Drawings and specifications.
   2. Public ordinances, permits.
   3. Include payments and fees required by governing authorities for work of this Division.

1.02 RELATED SECTION

A. Division 01, General Requirements

B. Division 22, Plumbing

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Products and equipment prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
   2. General:
      a. Conform work and materials to local and State codes, and Federal, State and other applicable laws and regulations.
   3. Responsible for obtaining and payment for permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. New materials and equipment. Work of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Build and install apparatus to deliver its full rated capacity at the efficiency for which it was designed.

D. Operate the entire plumbing system and apparatus at full capacity without objectionable noise or vibration.

E. Install equipment level and true. Use housekeeping pads and curbs to account for floor or roof slope.

F. Materials and Equipment:
1. Meet detailed requirements of the Drawings and Specifications and suitable for the installation shown. Equipment not meeting requirements will not be acceptable, even though specified by name along with other manufacturers.
2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
3. Furnish materials and equipment of size, make, type, and quality herein specified.
4. Equipment scheduled by performance or model number considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements or any other differences which impact the project.

G. Workmanship:
1. General:
   a. Install materials in a neat and professional manner.
2. Manufacturer’s Instructions:
   a. Follow manufacturer’s directions where they cover points not specifically indicated.
   b. If in conflict with the Drawings and Division 22, Plumbing, obtain clarification before starting work.

H. Cutting and Patching:
1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
2. Additional openings required in building construction made by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Do not pierce beams or columns without permission of Architect and then only as directed.
5. Restore new or existing work cut or damaged to its original condition. Where there are alterations disturb lawns, paving, walks, etc., repair, refinish, and leave in condition existing prior to commencement of work.

1.04 SUBMITTALS

A. Shop Drawings:
1. Contract Drawings indicate the general layout of the piping, and various items of equipment.
2. Coordinate with other trades and field conditions.
3. Prepare Shop Drawings of piping, and equipment installations.
4. Prepare new Shop Drawings by Contractor and not reproductions or tracings of Architect’s Drawings.
5. Overlay drawings with shop drawings of other trades and check for conflicts.
6. Drawings same size as Architect’s Drawings with title block similar to Contract Drawings and identifying Architect’s Drawing number or any reference drawings.
7. Fully dimensioned including both plan and elevation dimensions.
8. Shop drawings cannot be used to make scope changes.
9. Prepare in [three-dimensional] [two-dimensional] format.
10. Shop drawings include but are not limited to:
    a. Plumbing site plan drawn to same scale as site plan.
    b. Complete floor plans with plumbing to a minimum of 1/4-inch equals 1-foot scale.
    c. Plumbing in mechanical rooms to a minimum of 1/2-inch equals 1-foot scale.

d. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment not less than 1/2-inch equals 1-foot scale.
f. Superplot plans of above ground work with a colored overlay of all trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2-inch equals 1-foot scale.
g. Superplot plans of below ground work with a colored overlay of all trades including, but not limited to, structural footings and foundation, HVAC piping, civil piping, plumbing piping, and power conduit to a minimum of 1/2-inch equals 1-foot scale.
h. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4-inch equals 1-foot scale.
i. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1-foot scale.

11. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:
1. Submit product data for review on scheduled pieces of equipment, on equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications and data sheets. Data includes the following:
a. Capacities
b. RPM
c. BHP
d. Pressure Drop
e. Design and Operating Pressures
f. Temperatures
2. Manufacturer's abbreviations or codes are not acceptable.
3. List the name of the motor manufacturer and service factor for each piece of equipment.
4. Indicate equipment operating weights including bases and weight distribution at support points.
5. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Submission Requirements:
1. Shop Drawings and Product Data:
a. Refer to Division 01, General Requirements for additional requirements related to submittals.
b. Submit copies of shop drawings and product data for Work of Division 22, Plumbing in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, article and paragraph, and mark if applicable.
c. Submit electronic copies of shop drawings and product data for Work of Division 22, Plumbing in PDF format with each item filed under a folder and labeled with its respective specification section number, article, and paragraph and mark, if applicable.
d. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.

e. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, included with the original submittal. Controls and Instrumentation submittals may lag but still complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder includes a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.

D. Contractor Responsibilities:
1. Submit submittals at one time and are in proper order.
2. Ensure equipment will fit in the space provided.
3. Assure that deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.05 AS-BUILT DRAWINGS

A. Provide 3D model and record drawings at the end of the project on CD-ROM.

B. 3D model in the following format:
1. AutoCAD
2. Revit
3. Navisworks

C. Provide record drawings in hard copy and pdf format. Drawings include the following:
1. Project specific titleblock.
2. Notations reflecting the as built conditions of any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.

1.06 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNER'S INSTRUCTIONS

A. Refer to Division 01, General Requirements for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Show literature on 8-1/2-inches by 11-inches sheets or catalogs suitable for side binding.

C. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment.

D. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for electrically powered equipment.

E. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions cover all phases of control.

F. Furnish competent engineer knowledgeable in this building system for minimum of five 8 hour days to instruct Owner in operation and maintenance of systems and equipment. Keep a log of this instruction including dates, times, subjects, and those present and present such log when requested by Architect.

1.07 PROJECT CONDITIONS

A. Existing Conditions:
1. Prior to bidding, verify and become familiar with existing conditions by visiting the site, and include factors which may affect the execution of this Work.
2. Include related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check information and report any discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, City, and Utility Company.

1.08 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.09 PROVISIONS FOR LARGE EQUIPMENT

A. Make provisions for the necessary openings in building to allow for admittance of equipment.

1.010 TEST REPORTS AND CERTIFICATES

A. Submit one copy of test reports and certificates specified herein to the Architect.

1.011 SUBSTITUTIONS

A. Submit requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 PRODUCTS

2.01 ACCESS PANELS

A. Furnish under this Division as specified in another Division of work.

2.02 PIPE SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves, Fire Rated: Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves: Cast iron.

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.03 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:
1. Floor Plates: Cast brass, chromium plated
2. Wall and Ceiling Plates: Spun aluminum

2.04 MACHINERY GUARDS

A. Furnish guards for protection on rotating and moving parts of equipment. Provide guards for metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.

B. Design guards so as not to restrict airflow at fan inlets resulting in reduced capacity.

C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Easily removable for pulley adjustment or removal and changing of belts.

D. Meet OSHA requirements including back plates.

E. Provide inlet and outlet screens on fans in plenums or where exposed to personnel.

2.05 ELECTRICAL EQUIPMENT

A. General:
1. Equipment and installed work as specified under Division 26, Electrical.

B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available interrupting current (AIC) rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment that meets the bracing requirement.

C. Motors – AC Induction:
1. Furnish as integral part of driven equipment. Drip-proof induction type with ball bearings unless noted otherwise. Motors 1 HP and above premium energy efficient type, except for emergency equipment motors. NEMA Standards for the service intended. Rated for the voltage specified, suitable for operation within the range of 10 percent above to 10 percent below the specified voltage.
2. Energy Efficient Motors:
   a. Baldor
   b. Westinghouse
   c. General Electric
   d. Or approved equal.
3. Meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
HP	KW	900	1200	1800	3600
1	0.75	--	82.5	85.5	80.0
1.5	1.15	--	86.5	86.5	85.5
2	1.53	--	87.5	86.5	86.5
3	2.3	84.0	89.5	89.5	88.5
5	3.8	85.5	89.5	89.5	89.5
7.5	5.6	87.5	91.7	91.7	91.0
10	7.5	88.5	91.7	91.7	91.7
15	7.5	88.5	91.7	92.4	91.7
20	15.9	90.2	92.4	93.0	92.4
25	18.8	91.0	93.0	93.6	93.0
30	22.5	91.0	93.6	94.1	93.0
40	30.0	91.7	94.1	94.5	93.6
50	37.5	92.4	94.1	94.5	94.1
60	45.0	93.0	94.5	95.0	94.1
75	56.3	93.0	95.0	95.4	94.5
100	75.0	93.0	95.4	95.4	95.0
125	93.8	94.5	95.4	95.4	95.4
150	112.5	94.5	95.8	95.8	95.4
200	150.0	94.5	95.8	96.2	95.8
250	187.5	94.5	95.1	96.2	95.1
300	225.0	94.5	95.3	96.2	95.3
350	225.0	94.5	95.3	96.2	95.3
400	300.0	94.5	95.4	96.2	95.4
450	337.5	94.5	95.5	96.2	95.5
500	375.0	94.5	95.6	96.2	95.6

4. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
5. Refer to individual product sections for additional motor requirements.
6. Built-in thermal overload protection, or protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.

7. Controlled by variable frequency drives, inverter duty rated and have Class F insulation or better. Able to withstand repeated voltage peaks of 1,600Vs with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
8. Motors served from variable frequency drives equipped with shaft grounding system which provide a path for current to flow between the shaft and motor frame. SGS or equal.
9. Motors located in environment air plenums not tied to air handling functions totally enclosed type motors.

D. Motors – Electronic Commutation (EC):
1. Furnish as integral part of driven equipment.
2. Permanently lubricated with ball bearings unless noted otherwise.
3. Internal motor circuitry convert AC power supplied to the motor to DC power to operate the motor.
4. Speed controllable down to 20 percent of full speed.
5. Motor efficiency minimum of 85 percent at speeds.
6. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
7. Refer to individual product sections for additional motor requirements.
8. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.
9. Motors located in environment air plenums not tied to air handling functions totally enclosed type motors.

E. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.

F. Equipment Wiring:
1. Provide interconnecting wiring within or on a piece of mechanical equipment with the equipment unless shown otherwise. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

G. Control Wiring: Provide control wiring for plumbing equipment

H. Codes: Electrical equipment and products bear the Underwriters label as required by governing codes and ordinances.

PART 3 EXECUTION

3.01 ACCESS PANELS

A. Install in accord with manufacturer's recommendations, coordinated with architectural features.

B. Provide 2-hour fire rated doors where required bearing the UL label.

C. Furnish 18-inch by 18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12-inch by 12-inch for walls unless indicated otherwise.

D. Furnish where indicated and where required to access valves, trap primers, shock arresters, and other appurtenances requiring operation, service, or maintenance. Submit proposed locations for review prior to installation.

3.02 SLEEVES

A. Interior Floor and Wall Sleeves:
1. Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork. Where pipe or ductwork is insulated, insulation pass continuously through sleeve with 3/4-inch clearance between insulation and sleeve.
2. Penetrations through mechanical room and fan room floors made watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.

B. Sleeves Through Rated Floors and Walls:
   1. Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter
   2. Rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves Below Grade:
   1. Provide water tight sleeves. Install at pipes entering building below grade and where shown. Adjust to provide positive hydrostatic seal.
   2. Responsible for following manufacturer's procedure for installing and tightening seal. Secure sleeves against displacement.

D. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.

E. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

F. Layout work prior to concrete forming. Do cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

G. Floor sleeves maintain a water barrier by providing a water tight seal or they extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves extend 2-inches above finished floor level. Sleeves through roof extend 8-inches above roof. Wall sleeves flush with face of wall unless otherwise indicated. Waste stacks using carriers have sleeves flush with floor and sealed. Sleeves through planters extend 8-inches above planter base.

H. Do not support pipes by resting pipe clamps on floor sleeves. Provide supplementary members so pipes are floor supported.

I. Special sleeves detailed on drawings take precedence over this Section.

3.03 CLEANING

A. General: Clean plumbing equipment, fixtures and piping of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.

3.04 EQUIPMENT PROTECTION

A. Keep pipe and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, fixtures, equipment, and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.05 ACCESSIBILITY

A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms, and walkways.

3.06 FLOOR, WALL AND CEILING PLATES

A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates completely cover opening around pipe.

B. Secure wall and ceiling plates to pipe, insulation, or structure.

C. Plates not to penetrate insulation vapor barriers.

D. Plates not required in mechanical rooms or unfinished spaces.

3.07 PAINTING

A. General:
1. Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.
2. Exposed work under this division receives either a factory painted finish or a field prime coat finish, except:
3. Exposed copper piping.
4. Aluminum jacketed outdoor insulated piping.

B. Equipment Rooms and Finished Areas:
1. Insulation: Not painted.
2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
3. Steel Valve Bodies and Bonnets: One coat of black enamel.
4. Brass Valve Bodies: Not painted.
5. Equipment:
   a. One coat of grey machinery enamel.
   b. Do not paint nameplates.

C. Concealed Spaces (above ceilings, not visible):
1. Insulation: Not painted.
2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Valve Bodies and Bonnets: Not painted.

D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.

E. Exterior Black Steel Pipe: Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel. Painting schemes comply with ANSI A13.1.

3.08 ADJUSTING AND CLEANING

A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations made accordingly and that recommended lubricants have been used.

B. Use particular care in lubricating bearings to avoid damage by overlubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.09 ELECTRICAL EQUIPMENT

A. Do not install piping for plumbing systems not serving electrical space in switchgear room, transformer vault, telephone room, or electric closet except as indicated.

B. Piping for plumbing systems not to pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.010 EQUIPMENT CONNECTIONS

A. Make final connections to equipment specified in sections other than Division 22, Plumbing of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.

B. Piping:
   1. Connections include hot and cold water, deionized water, distilled water, natural gas, medical gases, medical air, and vacuum, dental air and vacuum, lab air and vacuum, sanitary waste and vent, lab waste and vent and fuel oil.
   2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
   3. Independently support piping connections to prevent undue strain on equipment.

C. [Refer to Division 11, Equipment, for requirements.]

END OF SECTION

SECTION 22 05 19

METERS AND GAUGES FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Thermometers, Water
   2. Pressure Gauges
   3. Pressure Gauges - High Purity Piping
   4. Water Meter
   5. Water Flow Meter
   6. Natural Gas Flow Meter

1.02 RELATED SECTIONS

A. Division 01, General Requirements

1.03 SUBMITTALS

A. Submit the following:
   1. Products listed in this Section.
   2. Water flow meters, include graph of output signal vs. gpm for each device.
   3. Operating and Maintenance Data.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermometers, Water
   1. Ashcroft
   2. Weiss
   3. Trerice
   4. Marsh
   5. Weksler
   6. Tel-Tru
   7. Other Manufacturers: Submit substitution request.

B. Pressure Gauges:
   1. Marsh
   2. Ashcroft
   3. Weiss
   4. Trerice
   5. Weksler
   6. Tel-Tru
   7. Other Manufacturers: Submit substitution request.

C. Pressure Gauges - High Purity Piping:
   1. N2, O2, Hydrogen, High Purity Compressed Air:
      a. US Gauge 1/4-inch inlet P500 1/4 LM
      b. Weksler
      c. Tel-Tru
   2. Process Vacuum:
      a. US Gauge 1/4-inch inlet V500 1/4 LM
      b. Weksler
      c. Tel-Tru

D. Water Meter:
   1. Mueller Systems
   2. Badger
   3. Sparling

E. Other Manufacturers: Submit substitution request.

F. Water Flow Meter:
1. Onicon
2. Sierra Instruments
3. Badger Meter
4. Other Manufacturers: Submit substitution request.

G. Natural Gas Flow Meter:
1. Onicon
2. Sierra Instruments
3. Other Manufacturers: Submit substitution request.

2.02 THERMOMETERS, WATER

A. Description: Direct drive 5-inch dial type, stainless steel case, separable sockets, stem length to penetrate minimum of 1/2 pipe diameter, adjustable face, extension necks where required to clear insulation.

B. Range:

Plumbing Systems	Temperature	Graduations
Domestic Cold Water	25-125 degrees F	1 degrees F
Domestic Hot Water	30-180 degrees F	2 degrees F
Solar Hot Water	30-240 degrees F	2 degrees F
Reclaimed Water	25-125 degrees F	1 degrees F
Cold Process Water	25-125 degrees F	1 degrees F
Process Grey Water	25-125 degrees F	1 degrees F
Industrial Cold Water	25-125 degrees F	1 degrees F

2.03 PRESSURE GAUGES

A. Description: 4-1/2-inch dial, molded black polypropylene turret case.

B. Range:

Plumbing Systems	Pressure (psi)	Graduations (psi)
Domestic Cold Water	0-160 psi	1 psi
Domestic Hot Water	0-160 psi	1 psi
Compressed Air	0-160 psi	1 psi
Solar Hot Water	0-160 psi	1 psi
Reclaimed Water	0-160 psi	1 psi
Cold Process Water	0-160 psi	1 psi
Process Grey Water	0-160 psi	1 psi
Industrial Cold Water	0-160 psi	1 psi
Other ranges may be listed on Drawings in which case they take precedence		

2.04 PRESSURE GAUGES - HIGH PURITY PIPING

A. Description:
1. Bronze Bourdon tube type mounted in black drawn case with metal dial and glass cover; 2-inch dial diameter.
2. Clean gauges clean for oxygen use.

B. Range:

Plumbing Systems	Pressure	Graduations
Nitrogen, oxygen	0 to 100 psi	5 psi
High purity compressed air	0 to 100 psi	5 psi
Hydrogen	0 to 100 psi	5 psi
Process vacuum	0 to 30-inch Hg	1-inch Hg

2.05 WATER METER

A. Disc type meter, bronze split casing, magnetic drive.

B. Heavy duty gear train, completely sealed, circular meter, totalize in cubic feet with sweep hand.

C. Comply with AWWA performance standards.

2.06 WATER FLOW METERS

A. Single turbine

B. Inline style for 3/4-inch or 1-inch copper pipe sizes

C. Insertion flow meter for copper pipe sizes 1-inch and larger

D. 24 VDC

E. Standard temperature range

F. 3 PSI drop at peak flow rate

G. For domestic water service

H. Weathertight aluminum enclosure

I. Onicon F-1300 for 3/4-inch or 1-inch copper pipe

J. Onicon F-1111 for 1-inch and larger copper pipe

2.07 WATER FLOW METER

A. Bi-directional flow measurement.

B. Multi-featured totalizer.

C. Configurable with field latptop.

D. Digital display

E. Clamp-on capability.

F. For pipe sizes 1/2-inch to 2-inch.

G. Cable length 990-feet.

H. For use on carbon steel, stainless steel, copper and plastic piping.

I. Ultralink software required.

2.08 NATURAL GAS FLOW METERS

A. Thermal mass flow meter

B. Proprietary sensor design

C. [Insertion] [Inline] style

D. Analog output

E. BACnet or Modbus compatible

F. Remote display

G. Built-in flow conditioner for inline installations

H. 12-28 VDC

I. Signal cable [25] [50] [100]-feet

J. Onicon F-5500

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Provide meters and gauges where shown on Drawings.

B. Install gauges and meters as required and as recommended by equipment manufacturer or their representative.

C. Extend connections, wells, cocks, or gauges to a minimum of 1-inch beyond insulation thickness of the various systems.

D. Locate gauges so that they may be conveniently read at eye level or easily viewed and read from the floor or from the most likely viewing area.

E. Install instruments over 6-feet 6-inches above floor, to be viewed from the floor, with face at 30 degrees to horizontal.

3.02 INSTALLATION - PRESSURE GAUGES

A. Provide instrument gauge cock at inlets. Locate pressure gauge taps for measuring pressure drop or increase across pumps, etc., as close to the device as possible.

3.03 WATER METER

A. Installed in accord with manufacturer's recommendations and as shown on the Drawings.

3.04 WATER FLOW METER

A. Installed in accordance with manufacturer's recommendations and shown on the Drawings. Provide conduit and adaptors for output signal routing and remote display.

B. Maintain minimum upstream/downstream pipe diameters per manufacturer's recommendations

C. Provide full-sized normally closed by-pass

D. Allow 30-36-inch of overhead clearance

E. Locate meter in upper 240 degrees of horizontal pipe

F. Vertical installations are an option

3.05 NATURAL GAS FLOW METER

A. Installed in accordance with manufacturer's recommendations and shown on the Drawings. Provide conduit and adaptors for output signal routing and remote display.

B. Allow 30-36-inch of overhead clearance

C. Locate meter in upper 180 degrees of horizontal pipe

D. Vertical installations are an option

END OF SECTION

SECTION 22 05 23

GENERAL DUTY VALVES AND SPECIALTIES FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Gate Valves
2. Globe Valves
3. Check Valves
4. Ball Valves
5. Butterfly Valves
6. Balancing Valves
7. Specialty Valves
8. Water Pressure Reducing Valve Assembly
9. System Specialties
10. Water Relief Valves
11. Strainers
12. Backwater Valves

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

1.03 SUBMITTALS

A. Submit product data.

1.04 DEFINITIONS

A. CWP Cold working pressure

B. EPDM Ethylene propylene copolymer rubber

C. NBR Acrylonitrile-butadiene, Buna-N, or nitrile rubber

D. NRS Nonrising stem

E. OS&Y Outside screw and yoke

F. RS Rising stem

G. PTFE Polytetrafluoroethylene plastic

H. SWP Steam working pressure

I. Lead Free Section 1417 of the Safe Drinking Water Act (SDWA) establishes the definition for lead free as a weighted average of 0.25 percent lead calculated across the wetted surfaces of a pipe, pipe fitting, plumbing fitting, and fixture and 0.2 percent lead for solder and flux. The Act provides a methodology for calculating the weighted average of wetted surfaces.

1.05 QUALITY ASSURANCE

A. ASME Compliance:
1. ASME B16.10 for ferrous valve dimensions.
2. ASME B31.9 for building services piping valves.

B. NSF Compliance: NSF/ANSI 61 and/or NSF/ANSI 372 for valve materials for potable-water service. ANSI/NSF-359

C. NSF Compliance: NSF/ANSI-372 Valves for Cross-linked Polyethylene (PEX) Water Distribution Tubing Systems Valves for domestic water must NSF/UL listed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General: Where only NIBCO figure numbers are listed, equivalent products by those specified below are acceptable.
   1. Valves:
      a. Gate, Globe, Swing Check:
         1) Apollo
         2) Victaulic
         3) Crane
         4) Kennedy
         5) Stockham
         6) Milwaukee
         7) Walworth
         8) Hammond
      b. Silent Check:
         1) Mueller
         2) Metraflex
         3) Victaulic
         4) Bell and Gossett
         5) Milwaukee
         6) Gruvlok
      c. Balancing:
         1) Bell and Gossett
         2) Armstrong
         3) Tour and Anderson
         4) NIBCO
      d. Butterfly:
         1) Apollo
         2) Victaulic
         3) Gruvlok
         4) Crane
         5) Walworth
         6) Milwaukee
         7) Metraflex
      e. Ball:
         1) Gruvlok
         2) Apollo
         3) Crane
         4) Hammond
         5) Milwaukee
         6) Victaulic
      f. Medical Gas Valves:
         1) Hill Rom
         2) Oxequip
         3) Allied (Chemtron)
         4) Puritan Bennett
         5) BeaconMedaes
   2. Specialty Valves:
      a. Gas Cock:
         1) Wooster
         2) Parker
         3) Watts
         4) Jamesbury

5) PGL
6) ASCO

b. Emergency Gas Shutoff
1) Maxon Series CMM11

c. Gauge Cocks:
1) Apollo 41 Series

d. Gas Pressure Regulator:
1) Actaris
2) Maxitrol
3) Fisher
4) Other Manufacturers: Submit substitution request.

B. Other Manufacturers: Submit substitution request.

C. Use only one manufacturer.

D. Valve ends may be threaded, flanged, soldered, or grooved, as applicable to piping system. Refer to Section 22 21 13, Pipe and Pipe Fittings Plumbing for allowable fittings.

2.02 GATE VALVES

A. Bronze Gate: Bronze body, bronze trim, bronze screwed bonnet; solid wedge, 150 psi steam rating, 300 psi WOG, NIBCO 134.

B. Lead Free Bronze Gate: Lead Free Silicon Bronze corrosion resistant body and trim, screwed bonnet, solid wedge, NSR, 300 psi CWP, NIBCO S/T-113-LF.

C. Iron Gate, OS&Y: Iron body, bronze trim, OS&Y pattern, solid wedge, 150 psi rating; NIBCO 637.

D. Lead Free Iron Gate: Class 125, OS&Y, Cast or Ductile Iron body, Stainless steel or Lead Free silicon bronze corrosion resistant trim, OS&Y pattern, solid wedge, 200 psi rating; NIBCO F-607-RWS or F-619-RWS.

2.03 GLOBE VALVES

A. Bronze Globe and Angle Globe: Bronze body, bronze mounted, renewable composition disc, 150 psi rating; NIBCO 235 or 335.

B. Bronze Globe and Angle Globe High Pressure: Bronze body, stainless steel disc, union bonnet, 300 psi steam, NIBCO 276-AP or 376-AP.

2.04 CHECK VALVES

A. Horizontal Y-Pattern Bronze Swing Check: Bronze body, bronze mounted, regrinding bronze disc, 150 psi steam rating, 300 psi WOG; NIBCO 433-Y.

B. Lead Free Y-Pattern Horizontal Bronze Swing Check: Lead Free Silicon Bronze corrosion resistant body, and trim, PTFE renewable seat and disc, 200 psi CWP; NIBCO S/T 413-Y-LF.

C. Horizontal Iron Swing Check: Iron body, bronze mounted, renewable seat and disc, 125 psi steam, 200 psi WOG; NIBCO 918.

D. Lead Free Horizontal Iron Swing Check: Iron body, wafer style, renewable seat and disc, 200 CWP psi rating, 200 psi Non-Shock Cold Working Pressure, NIBCO W-910-LF.

E. Vertical and Silent Check Valves:
1. 250 pound, WOG, iron body, stainless steel spring, wafer type, bronze disc and seat; NIBCO 960.
2. 300 psig CWP, ductile iron body, stainless steel spring and shaft, Victaulic 716.
3. 230 psig CWP, AGS grooved end ductile iron body, stainless steel spring, shaft, and disc, EPDM seat, Victaulic Series W715.

F. Lead Free Vertical and Silent Check Valves:
1. 250 pound, WOG, iron body, stainless steel spring, wafer type, bronze disc, and seat, NIBCO W-960.

2.05 BALL VALVES

A. Bronze Ball: Bronze cast body, chrome-plated full port ball, with handle, Teflon seat, 600 psi WOG, 150 psi steam; NIBCO 585-80.

B. Lead Free Bronze Ball: Two piece, full port, lead free silicon bronze body, Stainless steel or silicon bronze trim, Reinforced PTFE or TFE seats, 600 psi CWP NIBCO T/S-585-80-LF or T/S-585-66-LF.

C. Bronze Ball, Clean Service: Bronze body, union fittings, bronze ball, self-cleaning, Buna-N ball seats 400 psi WOG factory cleaned, capped and bagged for oxygen service in accordance with CGA4.1 (Cleaning equipment for oxygen service) and NFPA 99, Ohmeda 207 Series.

D. PVC Ball: PVC Body, trunnion mounted, Teflon seat, Viton seals; True Blue GSR Asahi.

E. Bronze Ball: Bronze cast body, stainless steel full port ball, with handle, Teflon seat, 600 psi WOG, 150 psi steam; NIBCO 585-70-66.

2.06 BUTTERFLY VALVES

A. Ductile iron body, nickel chrome plated disc and stainless steel shaft, with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, EPDM liner, 200 psi water; NIBCO 2000, NIBCO 4765.

B. Lead Free Butterfly Valve: Ductile iron body, Lead Free Aluminum Bronze disc and stainless steel stem, with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, EPDM liner, 200 psi water; NIBCO LD- 2000N-3/5,

C. Copper Grooved Piping System Butterfly Valve:
   1. Brass body, Aluminum-bronze disc, Fluoroelastomer seat, lever handle, stem length to accommodate insulation, 300 psi water; Victaulic Series 608N.
   2. Grooved ends manufactured to copper-tubing sizes.
   3. Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.

2.07 BALANCING VALVE

A. Lead-Free Calibrated:
   1. Bronze, Ametal (copper-alloy), or ductile iron body, brass globe or ball, differential pressure readout valves with integral checks, calibrated plate, and integral pointer.
   2. Suitable for tight shutoff, memory stops, threaded, grooved or soldered ends, 250 psi water, NSF/ANSI 61 compliant, Bell and Gossett Lead-Free Circuit Setter Plus.

2.08 SPECIALTY VALVES

A. Gas Cock:
   1. Forged brass body, hard chromium plated forged brass ball, with handle, rubber seats meeting ASTM D471, 175 psi WOG.
   2. Test entire unit latest version of ANSI Z21.15, AGA, and UL listed.

B. Emergency Gas Shutoff:
   1. Cast steel, normally closed, manually opened, electrically held open, automatic closing upon power interruption.
   2. Provide manual gas cock upstream of emergency gas shut-off valve.

C. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4 inch.

D. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap, and chain 3/4 inch size.

E. Gas Pressure Regulator:
   1. 0-500 SCFH capacity at 0-14 inches outlet pressure.
   2. Body: Cast iron complying with ANSI 125 pound construction standard.
   3. Orifice: Aluminum
   4. Valve Seat: BUNA-N

5. Diaphragm: BUNA-N
6. Internal relief valve
   a. [Vent limiting device]
   b. Maxitrol 325 series
7. Description: 501-3,000 SCFH capacity at 0-2 psig outlet pressure.
   a. Body: Cast iron complying with ANSI 125 pound construction standard.
   b. Orifice: Brass
   c. Valve Seat: BUNA-N
   d. Diaphragm: BUNA-N
   e. Internal relief valve
   f. Actaris B38 series
8. Description: 3,001-10,000 SCFH capacity at 1-2 psig outlet pressure.
   a. Body: Ductile iron
   b. Orifice: Stainless steel
   c. Valve Seat: Brass with vulcanized BUNA-N
   d. Diaphragm: BUNA-N
   e. External relief valve
   f. Actaris RB1700 series

2.09 WATER PRESSURE REDUCING VALVE ASSEMBLY

A. Manufacturers:
   1. Watts
   2. Fisher
   3. Armstrong
   4. Cash Acme

B. Description:
   1. Lead-free brass body.
   2. Inlet Strainer
   3. Water Tight Spring Cage Assembly
   4. Minimum Working Pressure: 300 psi
   5. Maximum working Temperature 160 degrees F
   6. Adjustable Reduced Pressure Range: 25 psi – 75 psi
   7. Watts LF223S

2.010 SYSTEM SPECIALTIES

A. Manual Air Vents: Coin type; Dole 9 or approved equal.

B. Pressure/Temperature Test Plug:
   1. Manufacturers:
      a. Peterson Engineering, Inc.
      b. Universal Lancaster
      c. Sisco
      d. Trerice
      e. Other Manufacturers: Submit substitution request.
   2. General: 1/2-inch NPT fitting to receive either a temperature or pressure probe 1/8-inch O.D., fitted with a color coded and marked cap with gasket.
   3. Material: Solid brass with valve core of NORDEL.
   4. Rating: Minimum 300 psig at 275 degrees F.
   5. Gauges and Thermometers: Supply Owner with two pressure gauge adapters with 1/8-inch OD probe and two five-inch stem pocket test thermometers 25 degrees F to125 degrees F for chilled water, 40 degrees F to 240 degrees F for heating water.

2.011 WATER RELIEF VALVES

A. Manufacturers:
   1. Consolidated

2. Kunkle
3. B&G
4. Armstrong
5. Cash Acme
6. Other Manufacturers: Submit substitution request.

B. Description: Bronze or steel body, stainless steel or bronze, pressure settings to 160 psi at 250 degrees F, conforming to Section IV of ASME Code, size per manufacturer's recommendations based on Code, setting as indicated; Kunkle Model 537.

2.012 STRAINERS

A. Manufacturers:
1. General:
a. Armstrong
b. McAlear
c. Sarco
d. Steamflo
e. Mueller
f. R.P. & C. Company Titan Flow Control
2. Grooved Coupling Systems:
a. Gruvlok
b. Victaulic
3. Other Manufacturers: Submit substitution request.

B. Wye Pattern:
1. Bronze: Bronze body, 250 psi, 1/16-inch perforated type 304 stainless screen.
2. Ductile Iron: Ductile iron body, 300 psi, 1/16 or 1/8-inch 304 stainless steel screen.
3. Cast Iron: Cast iron body, 125 psi, 1/16-inch perforated type 304 stainless screen.
4. Cast Iron, High Pressure: Cast iron body, 250 psi, 1/16-inch perforated type 304 stainless screen.

2.013 BACKWATER VALVE

A. Manufacturers:
1. J.R. Smith
2. Zorn
3. Josam
4. Other Manufacturers: Submit substitution request.

B. Description:
1. J.R. Smith 7022Y cast iron backwater valve with threaded cover and no-hub connections.
.
2. Model 7022S may be substituted for shallow bury applications where vault access is not required.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide valves at connections to equipment where shown or required for equipment isolation.

B. Provide separate support for valves where necessary.

C. Provide drain valves in low points in the piping system, at coils and equipment, and as indicated.

D. Coordinate gas pressure regulator selection with inlet pressure available at the regulator and the capacity and outlet pressure required by the equipment served.

E. Install in accordance with manufacturer's recommendations.

F. Locate gas cocks and gas regulator readily accessible for servicing.

G. Provide approved gas cock immediately upstream of each gas pressure regulator.

H. Provide separate vent to the outside for each regulator.

3.02 APPLIED LOCATIONS PLUMBING VALVES

A. In piping 2-inches and smaller:

System	Valve Types				
	Gate	Globe	Swing Check	Ball	Butterfly
Domestic Hot	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Not Allowed
Domestic Cold	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Not Allowed
Industrial Cold Water	Bronze	Bronze	Bronze	Bronze	Not Allowed
Compressed Air	Bronze	Bronze	Bronze	Bronze	Not Allowed
Medical Gas	Not Allowed	Not Allowed	Not Allowed	Bronze, Clean Service	Not Allowed
Specialty Gas	Not Allowed	Not Allowed	Not Allowed	Bronze, Clean Service	Not Allowed
Medical Vacuum	Not Allowed	Not Allowed	Not Allowed	Bronze, Clean Service	Not Allowed
Deionized/Distilled Water	Not Allowed	Not Allowed	Not Allowed	PVC	Not Allowed
Solar Hot Water	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Lead Free Bronze	Not Allowed
Reclaimed Water	Bronze	Bronze	Bronze	Bronze	Not Allowed
Cold Process Water	Bronze	Bronze	Bronze	Bronze	Not Allowed
Process Grey Water	Bronze	Bronze	Bronze	Bronze	Not Allowed

B. In piping 2-1/2-inches and larger:

System	Valve Types				
	Gate	Globe	Swing Check	Ball	Butterfly
Domestic Hot	Lead Free Iron	Lead Free Iron	Lead Free Iron	Not Allowed	Lead Free Ductile Iron
Domestic Cold	Lead Free Iron	Lead Free Iron	Lead Free Iron	Not Allowed	Lead Free Ductile Iron
Industrial Cold Water	Iron	Iron	Iron	Not Allowed	Ductile Iron
Compressed Air	Iron	Iron	Iron	Not Allowed	Not Allowed
Medical Gas	Not Allowed	Not Allowed	Not Allowed	Bronze, Clean Service	Not Allowed
Specialty Gas	Not Allowed	Not Allowed	Not Allowed	Bronze, Clean Service	Not Allowed
Medical Vacuum	Not Allowed	Not Allowed	Not Allowed	Bronze, Clean Service	Not Allowed

System	Valve Types				
	Gate	Globe	Swing Check	Ball	Butterfly
Deionized/Distilled Water	Not Allowed	Not Allowed	Not Allowed	PVC	Not Allowed
Solar Hot Water	Lead Free Iron	Lead Free Iron	Lead Free Iron	Not Allowed	Lead Free Ductile Iron
Reclaimed Water	Iron	Iron	Iron	Not Allowed	Ductile Iron
Cold Process Water	Iron	Iron	Iron	Not Allowed	Ductile Iron
Process Grey Water	Iron	Iron	Iron	Not Allowed	Ductile Iron

C. Calibrated balancing valves on domestic hot water. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

D. Silent check valves on pump discharge for domestic cold water, solar hot water, reclaimed water, cold process water, process grey water.

E. Check valves on vertical discharge of sump pumps and sewage ejector pumps, iron swing check with outside weight and lever. Mount in piping at 45 degree angle.

F. Natural Gas Piping:
   1. Gas Cock
   2. Gas Pressure Regulator

G. Provide gauge cock for all pressure gauges.

3.03 VALVE IDENTIFICATION

A. General: Identify valves to indicate their function and system served.

B. Refer to Section 22 05 53, Identification for Plumbing Piping and Equipment.

3.04 MEDICAL GAS VALVES IN CEILING SPACE

A. In accordance with NFPA 99, individual floor medical gas isolation valves located in the ceiling area will be provided in the open position with the handles removed.

B. Provide labels at these locations which note the following: Caution – (name of medical gas) valve. Do not close except in emergency.

3.05 CHAIN OPERATORS

A. Valves in equipment rooms or fan rooms used for equipment or coil isolation and more than 8-feet above floor installed with stem horizontal and equipped with chain wheels and chains extending to 6 feet above floor.

3.06 WATER PRESSURE REDUCING VALVE ASSEMBLY

A. Two valve assembly with smaller valve approximately 33 percent of the total larger valve approximately 66 percent of the total demand. See schedule on drawings for GPM flow rates and pressure settings of valves.

3.07 INSTALLATION

A. Manual Air Vents:
   1. Install at high points where automatic air vents are not used, where noted, and where required for proper venting of system.
   2. Install in accordance with manufacturer's recommendations.

B. Install grooved joints in accordance with the manufacturer's published installation instructions.

C. Mold and produce gaskets by the coupling manufacturer, and suitable for the intended service. Coupling manufacturer's factory trained representative to provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products. Representative to periodically visit the project site to ensure best practices in grooved installation are being followed. Distributor's representative is not considered qualified to conduct the training of field visits.

D. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.

E. Pressure Reducing Valves: Install where indicated and in accordance with manufacturer's recommendations with 3 valve bypass.

F. Water Relief Valves:
   1. Install where indicated, and in accordance with manufacturer's instructions.
   2. Pipe discharge to nearest floor drain using Schedule 40 steel pipe.

G. Strainer:
   1. Applied Locations Plumbing:
      a. Bronze wye, in piping 2-inch and smaller; domestic water, solar hot water, reclaimed water, cold process water, process grey water.
      b. Cast iron, in piping 2-1/2-inch and larger; solar hot water, reclaimed water, cold process water, process grey water
      c. Cast iron, high pressure wye, in piping 2-1/2-inch and larger; domestic water.

H. Backwater Valves:
   1. Install backwater within vault indicated.
   2. If vault not indicated (shallow bury application), provide soil pipe extension to install ferrule and cover at top and flush with floor surface.

END OF SECTION

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SECTION 22 05 29

HANGERS, SUPPORTS, AND ANCHORS FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Supports, Anchorage and Restraint
   2. Pipe Attachments
   3. Pipe Rollers, Insulation Protection Shields and Insulation Protection Saddles
   4. Building Attachments

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

C. Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment

D. Section 22 07 00, Insulation for Plumbing

E. Section 22 21 13, Pipe and Pipe Fittings Plumbing

1.03 SUBMITTALS

A. Submit the following:
   1. Shop Drawings of contractor fabricated piping support structures.
   2. No other submittals required under this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Supports, Anchorage and Restraint:
   1. Unistrut
   2. Superstrut
   3. Powerstrut and Kinline
   4. B-Line Systems
   5. AnvilStrut

B. Pipe Attachments:
   1. Anvil
   2. Superstrut
   3. B-Line Systems
   4. Tolco
   5. ERICO

C. Pipe Rollers, Insulation Protection Shields and Insulation Protection Saddles:
   1. Anvil or equivalent
   2. Super Strut
   3. B-Line Systems
   4. Tolco
   5. ERICO

D. Building Attachments:
   1. Anvil as listed or equivalent products
   2. Elcen
   3. Superstrut
   4. B-Line Systems
   5. Tolco
   6. ERICO

2.02 SUPPORTS, ANCHORAGE AND RESTRAINT

A. General:
   1. Provide pipe and equipment hangers and supports in accordance with the following:
      a. Equipment, supports, and seismic restraints for conduit, piping, and ductwork are not shown on the Drawings, the contractor responsible for their design.
      b. Resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
      c. Seismic restraint not to introduce excessive stresses in the piping caused by thermal expansion or contraction.
      d. Connections to structural framing not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
      e. In accordance with the latest edition of the SMACNA Seismic Restraint Manual - Guidelines for Mechanical Systems for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
      f. In accordance with the applicable code.
      g. Follow provisions described in Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.

B. Engineered Support Systems: Design, detail, and bear the seal of a professional engineer registered in the State having jurisdiction.
   1. Supports and seismic restraints for suspended piping and equipment.
   2. Support frames such as pipe racks or stanchions for piping and equipment which provide support from below.
   3. Equipment and piping support frame anchorage to supporting slab or structure.

C. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required.

D. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.

E. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.

F. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.

G. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.03 PIPE ATTACHMENTS

A. Uninsulated Horizontal Copper Piping:
   1. 2-inch and Smaller: Anvil CT-65, CT-69, CT-99C.
   2. Larger than 2-inch:
      a. Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods.
      b. Electricians' tape is unacceptable.

B. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.

C. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

D. Other Uninsulated Horizontal Pipe:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

E. Other Insulated Horizontal Pipe With Hangers Inside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104, 260 or 300.
   2. Larger than 2-inch: Anvil 260.

F. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 70, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

G. Riser Clamps Copper Pipe:
   1. 4-inch and Smaller: Anvil CT-121, CT-121C or 261C.
   2. Larger than 4-inch: Anvil 261C.

H. Riser Clamps Other Piping: Anvil 261.

2.04 PIPE ROLLERS, INSULATION PROTECTION SHIELDS AND INSULATION PROTECTION SADDLES

A. Pipe Rollers:
   1. Anvil 174 or 274 as required.
   2. Size for pipe plus insulation for insulated pipe.

B. Insulation Protection Shields: Anvil 167

C. Insulation Protection Saddles: Anvil 160 through 166A as required. Saddles for copper pipe, factory, or field copper plated.

2.05 BUILDING ATTACHMENTS

A. Beam Hangers:
   1. On piping 6-inch and smaller: Anvil 86 with retaining clip Figure 89.
   2. On piping larger than 6-inch: Anvil 228, or 292.

B. Inserts:
   1. Anvil 152 malleable iron or 281 steel inserts.
   2. Inserts sized for required rod to support load being carried.

C. Expansion Plugs: Similar and equal to Phillips red-head self-drilling flush shell selected for safety factor of 4.

D. Powder actuated fasteners with silencers as approved by Architect.

PART 3 EXECUTION

3.01 HANGERS AND SUPPORTS

A. General:
   1. Install support systems as detailed and in accordance with manufacturer's recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required, and as detailed on the Drawings.
   2. Provide adjustable hangers for pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
   3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
   4. Except as otherwise indicated for exposed continuous pipe runs, install hangers, and supports of same type and style as installed for adjacent similar piping.
   5. Install cast iron piping in accordance with Cast Iron Soil Pipe Industry (CISPI) Standards.
   6. Support piping within 2-feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:
   1. Refer to Section 22 07 00, Insulation for Plumbing for insulation requirements.
   2. Insulated Piping Systems with Vapor Barrier Insulation:
      a. Install hangers outside of insulation.
      b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.

3. Insulated Piping Systems with Non-Vapor Barrier Insulation:
   a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
   b. If hangers are installed outside of insulation, provide insulation protection shields at support locations on piping 1-1/2-inch and larger.
   c. On piping larger than 2-inch, provide insulation saddles at each support location.
4. Insulated Piping Systems with Non-Vapor Barrier Insulation: As specified for Insulated Piping Systems with Vapor Barrier Insulation.
5. Insulation Protection:
   a. Band insulation protection shields firmly to insulation to prevent slippage.
   b. Tack weld insulation protection saddles to steel pipe. Braze saddles to copper pipe.

C. Vertical Piping:
1. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
2. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
3. Risers that are not subject to thermal change to be supported at each floor of penetration.
4. Risers that are subject to thermal change require engineered supports. Size supports to carry forces exerted by piping system when in operation. Riser supports follow provisions described in Section 22 05 48, Vibration and Seismic Controls for Plumbing Piping and Equipment.
5. PEX-a Riser Supports: Install copper tube size riser clamps at the base of each floor and at the top of every other floor for domestic hot-water systems. Install mid-story guides between each floor. Install CTS riser clamps at the base of each floor and at the top of every fourth floor for domestic cold-water systems. Install mid-story guides.

D. Horizontal Piping:
1. Trapeze Hangers:
   a. Multiple pipe runs where indicated supported on channels with rust resistant finish.
   b. Provide necessary rods and supporting steel.
2. Horizontal PEX-a Piping with PEX-a Pipe Channel: Install hangers for PEX-a piping with horizontal support channel in accordance with local jurisdiction and manufacturer's recommendations.
3. Support Spacing:
   a. Provide support at minimum spacing per MSS SP-69-1996 Pipe Hangers and Supports - Selection and Application:
      1) Support piping within 2-feet of each change in direction.
      2) Steel Pipe, Copper Tubing:

Minimum Pipe Size	Maximum Span Steel	Maximum Span Copper	Maximum Span Pex A pipe with Pex a Pipe Channel	Rod Size
1-inch and smaller	7-feet	5-feet	6-feet	1/4-inch
1-1/4-inch to 2-inch	8-feet	8-feet	8-feet	3/8-inch
2-1/2-inch to 3-inch	11-feet	9-feet	8-feet	1/2-inch
4-inch to 5-inch	14-feet	12-feet	-	1/2-inch
6-inch	17-feet	14-feet	-	1/2-inch
8-inch or larger	19-feet	16-feet	-	5/8-inch
10-inch	20-feet	18-feet	-	3/4-inch
12-inch	23-feet	19-feet	-	7/8-inch
14-inch	25-feet		-	1-inch
16-inch	27-feet		-	1-inch

3) Fuel Gas Piping: Support in accordance with local code requirements.
4) Plumbing Piping: Support in accordance with local plumbing code.
5) Plastic Pipe: Supported a maximum of 3-feet on center for piping 1-inch and smaller and 4-feet on center for piping 1-1/4-inch and larger with rod sizes as recommended by the manufacturer.
6) Piping provided with acoustical lagging wrap supported a maximum of 5-feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:
1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
2. Provide horizontal bracing on horizontal runs 1-1/2 inch and larger and exceeding 50-feet in length at 75-foot intervals and as required to provide stabilized piping systems.
3. Provide additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

END OF SECTION

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SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Neoprene Waffle Pad, Type 1
2. Restrained Neoprene Mount, Type 2
3. Springs, Type 3
4. Springs with Restraints, Type 4
5. Base with Springs, Type 5
6. Inertia Base with Springs, Type 6
7. Isolating Spring Hangers, Type 7
8. Isolating Neoprene Hangers, Type 8
9. Isolating Sleeves
10. Seismic Restraints
11. Flexible Sphere Connector
12. Flexible Hose Connector
13. Expansion Joint/Seismic Connector

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

C. Section 22 05 29 Hangers, Supports and Anchors for Plumbing

1.03 QUALITY ASSURANCE

A. Select a single manufacturer and furnish isolation required, except packaged equipment with integral isolators meeting all the isolation and seismic requirements of this specification.

B. Isolation performance requirements are indicated in the specifications. All deflections indicated are nominal static deflections for specific equipment supported.

C. Seismic snubbers, restrained isolator housings, and cable system components have anchorage preapproval OPA number from OSHPD in the State of California verifying the maximum certified load ratings.

D. Isolator Stability and Rated Capacity:
1. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.
2. Springs have a minimum additional travel to solid equal to 50 percent of the rated deflection.

E. Seismic Restraints:
1. Restraint of equipment and piping to be in accordance with the current state and local Building Code.
2. Calculations in accordance with current state and local Building Code.

1.04 SUBMITTALS

A. Submit the following:
1. Submit Shop Drawings showing complete details of construction for steel and concrete bases including:
a. Equipment mounting holes.
b. Dimensions
c. Isolation selected for each support point
d. Details of mounting brackets for isolator
e. Weight distribution for each isolator
f. Code number assigned to each isolator

2. Submit product data and calculation sheets for isolators, showing:
   a. Size, type, load rating, and rated deflection of each required isolator.
   b. Percent of vibration transmitted based on the lowest disturbing frequency of the equipment.

B. Installation report as specified in PART 3 of this Section.

C. Operation and maintenance data.

1.05 EQUIPMENT VIBRATION ISOLATION

A. Provide a balanced set of vibration isolators for each piece of equipment listed in the Equipment Schedules.

B. Isolation work to include, but not necessarily be limited to, the following:
1. Isolation support of motor-driven equipment.
2. Inertia base frames in conjunction with isolation.
3. Isolation support of piping and piping risers.
4. Penetration isolation of pipework and conduits through walls, floors, or ceilings.
5. Flexible connections of piping to equipment.

C. Each piece of rotating equipment must meet a reasonable criterion for maximum vibration levels at each bearing, while in operation. The criteria for varying operating speeds are given as follows:
1. Rotating equipment operating peak vibration velocities must not exceed 0.08 in./sec.
2. If it is discovered that the operating vibration velocities exceed this criteria, the equipment repaired or replaced at no expense to the owner until approval of the equipment is given by the engineer.

D. Provide components or materials not specially mentioned herein, but necessary to the proper vibration isolation of the equipment.

1.06 CONTRACTOR RESPONSIBILITY

A. Vibration isolation devices, including auxiliary steel bases and pouring forms, designed and furnished by a single manufacturer or suppliers.

B. Adequately restrain equipment and piping to resist seismic forces. Design and select restraint devices to meet seismic requirements as defined in the latest issue of the International Building Code under Earthquake Design and applicable state and local codes.

C. Selection, installation, adjustment, and performance of vibration isolators which will meet the requirements given on the plans or in the specifications.

D. Provide Engineering drawings, details, supervision, and instruction to assure proper installation and performance.

E. Provide whatever assistance necessary to ensure correct installation and adjustment of the isolators.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General:
1. Amber Booth
2. Mason Industries, Inc.
3. Kinetics Corporation
4. Vibrex
5. Approved equal, meeting the conditions and requirements specified herein.

B. Neoprene Waffle Pad, Type 1:
1. Mason Type Super W or Super WM
2. HG Grommet; Similar Amber-Booth
3. Kinetics Corporation

C. Restrained Neoprene Mount, Type 2:
   1. Mason Type BR

D. Springs, Type 3:
   1. Mason Type SLF
   2. Amber-Booth Type SW
   3. Kinetics Corporation
   4. Vibrex

E. Springs with Restraints, Type 4:
   1. Mason type SSLR or SLRS with seismic restraints
   2. Amber-Booth
   3. Kinetics Corporation Model FYS
   4. Vibrex

F. Base with Springs, Type 5:
   1. Mason
   2. Amber-Booth
   3. Kinetics Corporation
   4. Vibrex

G. Inertia Base with Springs, Type 6:
   1. Mason
   2. Amber-Booth
   3. Kinetics Corporation
   4. Vibrex

H. Isolating Spring Hangers, Type 7:
   1. Mason 30N
   2. Amber-Booth
   3. Consolidated Kinetics
   4. Vibrex

I. Isolating Neoprene Hangers, Type 8:
   1. Mason HD
   2. Amber-Booth
   3. Consolidated Kinetics
   4. Vibrex

J. Isolating Sleeves:
   1. Potter-Roemer PR Isolators
   2. Grinnell Semco Trisolators

K. Seismic Restraints:
   1. [_____]

L. Flexible Sphere Connector:
   1. Mason Type SFU, SFDEJ or SFEJ

M. Flexible Hose Connector:
   1. Mason Type BSS, FFL, MN, CPS or CPSB
   2. HCi
   3. Metraflex

N. Expansion Joint/Seismic Connector:
   1. [_____]

2.02 NEOPRENE WAFFLE PAD, TYPE 1

A. 3/4-inch thick neoprene waffle pads with pattern repeating on 1/2-inch centers.

B. Select Duro rating for maximum deflection at average load rating.

C. Include load distribution steel plate as required.

D. Include anchor bolt grommet as required.

2.03 RESTRAINED NEOPRENE MOUNT, TYPE 2

A. Bridge-bearing neoprene mountings have a minimum static deflection of 0.2-inches and all directional seismic capability.

B. Ductile iron casting containing two separated and opposing molded neoprene elements.

C. Prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation.

D. Compound shock absorbing neoprene materials to bridge-bearing specifications.

2.04 SPRINGS, TYPE 3

A. Free standing springs without housings.

B. 1/4-inch thick molded neoprene cup with steel reinforcement washer or neoprene acoustical friction pads between base plate and support.

C. Leveling bolt mounting with height saving brackets.

D. Springs mounted outboard of channels.

E. Attach baseplate screws using neoprene bushings and washers.

F. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.

2.05 SPRINGS WITH RESTRAINTS, TYPE 4

A. Same as springs except housing with seismic restraints to be added.

B. Seismic restraint with molded all directional neoprene bushings an integral part of isolator.

C. Seismic restraint selected for minimum safety factor of 2 from ultimate seismic capacity.

D. Spring mount must have neoprene cup or pad inside the seismic housing to allow anchoring of the housing baseplate without short circuiting pad.

2.06 BASE WITH SPRINGS, TYPE 5

A. Steel Isolating Frame:
   1. Mason WFSL with WF steel beams with a minimum depth of 10 percent of the span between supports.
   2. Provide external height saving brackets.

2.07 INERTIA BASE WITH SPRINGS, TYPE 6

A. Inertia Bases:
   1. Mason BMK or KSL with 1/2-inch square bar reinforcing, integral height saving brackets and steel templates with anchor bolts sleeves.
   2. Bases must be sized to fit stanchions for pump elbows or suction diffusers.
   3. Depth of base equal to 8 percent of the span between supports, 6-inch minimum.

2.08 ISOLATING SPRING HANGERS, TYPE 7

A. Combination rubber-in shear and steel spring isolators installed on the hanger rods.

B. Proper deflection to allow the piping to deflect as a unit with the pump isolators.

C. Hangers designed for 30 degree angular movement.

D. Minimum Deflection: 1-inch

2.09 ISOLATING NEOPRENE HANGERS, TYPE 8

A. Double deflection neoprene hangers, minimum static deflection of 0.35-inches.

B. Provide projecting bushing to prevent steel to steel contact.

2.010 ISOLATING SLEEVES

A. Provided for piping through walls and floors of penthouses and chiller room.

B. Size for piping as required.

2.011 SEISMIC RESTRAINTS

A. General Requirements:
   1. Provide for equipment and piping, both supported and suspended.
   2. Bracing of piping in accordance with the code and with the provisions set forth in the SMACNA seismic restraint manual.
   3. Structural requirements for the restraints, including their attachment to the building structure, reviewed and approved by the structural engineer.
   4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

B. Supported Equipment:
   1. All-directional seismic snubbers consist of interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene.
   2. Replaceable bushing and a minimum of 1/4-inch thick. Rated loadings not to exceed 1000 psi.
   3. Incorporate an air gap of 1/4-inch be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces.
   4. Removable snubber end caps to allow inspection of internal clearances. Neoprene bushings rotated to ensure no short circuits exist before systems are activated.
   5. Snubber Mason Industries, Inc. Type Z-1225

C. Bracing of Pipes:
   1. Provide seismic bracing of all piping as detailed below to meet the building code requirements:
      a. Exception:
         1) Piping suspended by individual hanger's 12-inches or less in length, as measured from the top of the pipe to the bottom of the support where the hanger is attached, need not be braced where the following criteria are met.
            a) Seismic braces are not required on high deformability piping when the Ip=1.0 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 3-inches diameter or less.
            b) Seismic braces are not required on high deformability piping when the Ip=1.5 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 1-inch diameter or less.
   2. Seismic braces for pipes on trapeze hangers may be used.
   3. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints, or where pipes connect to equipment.
   4. Cast iron pipe of all types, glass pipe, and any other pipe jointed with a shield and clamp assembly, where the top of the pipe is 12-inches or more from the supporting structure, braced on each side of a change in direction of 90 degrees or more. Riser joints on unsupported sections of piping braced or stabilized between floors.
   5. Vertical Risers:
      a. Laterally supported with a riser clamp at each floor.
      b. For buildings greater than six stories high or for piping subject to thermal change risers engineered individually.

D. Suspended Equipment and Piping:
   1. Seismic cable restraints consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
   2. Pre-stretch cable to achieve a certified minimum modulus of elasticity. Cable end connections steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
   3. Cable Assemblies: Mason Industries, Inc. Type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod and the clevis or SCBV if clamped to a beam.

4. Steel angles, sized to prevent buckling, clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies Mason Industries, Inc. Type SRC, or UC.
5. Pipe clevis cross-bolt braces are required in all restraint locations. Special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross brace Mason Industries, Inc. Type CCB.

2.012 FLEXIBLE SPHERE CONNECTOR

A. Flexible EPDM pipe connectors manufactured of multiple plies of Kevlar tire cord fabric and EPDM; both molded and cured in hydraulic rubber presses. Do not use steel wire or rings as pressure reinforcement.

B. Connectors up to and including 2-inch diameter may have a single sphere and threaded ends. Connectors 2-1/2-inch and larger manufactured with twin spheres up to 12-inches and a single sphere on larger sizes and floating steel flanges recessed to lock the connectors raised face EPDM flanges.

C. Rated a minimum of 150 psi at 220 degrees F. Pre-extended as recommended by the manufacturer to prevent additional elongation under pressure.

2.013 FLEXIBLE HOSE CONNECTOR

A. Flexible stainless steel hoses manufactured using type 304 stainless steel hose and braid with one fixed and one floating raised face carbon steel plate flange.

B. Sizes 2-1/2-inch and smaller may have threaded male nipples or copper sweat ends. Grooved ends are acceptable in all sizes in grooved piping systems. Weld ends are not acceptable. Copper sweat end hoses for water service all copper or bronze construction.

C. Close pitch annular corrugations for maximum flexibility and low stiffness. Tested hose stiffness at various pressures must be included in the submittals.

D. Capable of continuous operation at 150 psi and system test pressure when installed in piping systems.

E. Same size as the pipe it connects and have pipe thread connectors on both ends with male or female end adapters as required.

2.014 EXPANSION JOINT/SEISMIC CONNECTOR

A. T304 stainless steel hose and braid, Schedule 40 radius elbows and 180 degree bend, flange or weld end Schedule 40 fittings. ASA certified when used for natural gas service. Metraflex Metaloop only.

B. Connector accepts differential support displacement without damaging pipe, equipment connections, or support connections.

PART 3 EXECUTION

3.01 GENERAL

A. Do not install equipment or pipe which makes rigid contact with the building.

B. Installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment, and piping maintained in a rigid position during installation. Load not transferred to the isolator until the installation is complete and under full operational load.

C. Correct, at no additional cost, all installations which are defective in workmanship or materials.

3.02 PREPARATION

A. Treat isolators, including springs, hardware, and housing, with a corrosion protective coating of epoxy powder or electro galvanizing.

B. Coat steel frames exposed to weather with a rustproof metal primer.

C. Provide hot dipped galvanizing on steel frames as indicated on the plans for corrosion protection in severe conditions.

3.03 INSTALLATION

A. General:
   1. Install isolation where indicated on the Drawings by type and location and where indicated below.
   2. Mark assigned code number on isolators and bases to assure placement in the proper location.
   3. Anchor isolator seismic housing baseplate to floor.
   4. Provide rubber grommets and washers to isolate the bolt from the building structure. Do not destroy the isolation efficiency destroyed when bolting the isolators to the building structure.

B. Type 1 Neoprene Waffle Pad: Service: Water Booster Systems

C. Type 2 Restrained Neoprene Mount: Service: _____

D. Type 3 Springs: Service: _____

E. Type 4 Springs with Restraints: Service: _____

F. Type 5 Base with Springs: Service:
   1. Water Booster Systems
   2. Fuel Oil Transfer Pumps
   3. Air Compressors
   4. Vacuum Pumps

G. Type 6 Inertia Base with Springs: Service:
   1. Water Booster Systems
   2. Fuel Oil Transfer Pumps
   3. Air Compressors
   4. Vacuum Pumps

H. Type 7 Isolating Spring Hangers: Service:
   1. In-Line Circulating Pumps
   2. Piping rigidly connected to rotating equipment

I. Type 8 Isolating Neoprene Hangers: Service: In-Line Circulating Pumps

J. Flexible Connectors:
   1. Mechanical Couplings: Provide three or more flexible couplings as vibration isolation as indicated on the drawings and for the following services:
      a. [USER EDIT]
      b. [USER EDIT]
   2. Flexible Sphere Connectors: Provide as indicated on the drawings and for the following services:
      a. [USER EDIT]
      b. [USER EDIT]
   3. Flexible Hose Connectors: Provide as indicated on the drawings and for the following services:
      a. [USER EDIT]
      b. [USER EDIT]
   4. Expansion Joint/Seismic Connector: Provide for piping services where they cross expansion or seismic joints.

3.04 SEISMIC RESTRAINTS

A. General:
   1. Install and adjust seismic restraints so that the equipment and piping support is not degraded by the restraints.

2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Supported Equipment:
   1. Each vibration isolation frame for supported equipment have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.
   2. Care must be taken so that the 1/4-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

C. Bracing of Pipes:
   1. Branch lines may not be used to brace main lines.
   2. Transverse Bracing: Maximum 40-feet, except where a lesser spacing is indicated in the SMACNA tables for bracing of pipes
   3. Longitudinal bracing at 80-feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity to resist both the seismic load and the additional force induced by expansion and contraction.
   4. A rigid piping system not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
   5. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24 inches of the elbow or tee.
   6. Subject to confirmation by field inspection, seismic bracing is not required on piping when the piping is supported by rod hangers and the hangers in the entire run are 12-inches or less in length from the top of the pipe to the supporting structure, hangers are detailed to avoid bending of the hangers and their attachments and provisions are made for piping to accommodate expected deflections.

D. Suspended Equipment, Piping, Cable Method:
   1. Adjust cables to a degree of slackness approved by the Structural Engineer.
   2. Uplift and downward restraint nuts and Mason type RW neoprene covered steel rebound washers for the Type 6 hangers adjusted with a maximum 1/4-inch clearance.

3.05 FIELD QUALITY CONTROL

A. Installation Report: Isolation manufacturer's representative confirms that isolation is installed correctly and submit report stating that isolators are installed as shown on Shop Drawings, isolators are free to work properly, and that installed deflections are as scheduled and as specified.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Valve Identification
   2. Piping Markers
   3. Equipment Identification

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

1.03 SUBMITTALS

A. Submit the following:
   1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
   2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
   3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Piping Markers:
   1. W.H. Brady
   2. Seton
   3. Marking Systems, Inc. (MSI)
   4. Other Manufacturers: Submit substitution request.

2.02 VALVE IDENTIFICATION

A. Valve Tags:
   1. General: Identify valves with metal tags, legends to be stamped or embossed. Indicate function of the valve and its normal operating position.

56 HW	(NUMBER AND CONTENT OF PIPE)
ISOLATION	(VALVE FUNCTION)
NO	(NORMAL OPERATION POSITION)

   2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
   3. Material: Use 0.04-inch brass tags.
   4. Automatic Valves and Regulating Valves: Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, lamicoid, or equal. Form letters by exposing center ply.
   5. Buildings Systems: Contact the [Owner] for coordination with existing building tagging system and supplementary information required for specific systems before valve tagging begins.

B. Valve Tag Directory: Include tag number, location, exposed or concealed, service, valve size, valve manufacturer, valve model number, and normal operating position of valve.

2.03 PIPING MARKERS

A. Label pipes with all-vinyl, self-sticking labels or letters.

B. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters.

C. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters, above 2-inches outside diameter, 2-inch letters.

D. Identify and color-code pipe markers as follows with black directional arrows.

PLUMBING SERVICE	PIPE MARKER*	BACKGROUND COLOR
COLD WATER	DOMESTIC COLD WATER	GREEN
HOT WATER	DOMESTIC HOT WATER SUPPLY	YELLOW
	DOM. HOT WATER RECIRC	YELLOW OR GREEN
AIR, COMPRESSED	COMPRESSED AIR	BLUE
AIR, INSTRUMENT	INSTRUMENT AIR	BLUE
SANITARY WASTE	SANITARY WASTE	GREEN
STORM DRAIN	STORM DRAIN	GREEN
OVERFLOW DRAIN	OVERFLOW DRAIN	GREEN
VENT	VENT	GREEN
NATURAL GAS	NATURAL GAS	YELLOW
COLD PROCESS WATER	PROCESS COLD WATER	GREEN
PROCESS GREY WATER	PROCESS GREY WATER	GREEN
EMERGENCY EYEWASH AND SHOWER	EMERGENCY SHOWER	YELLOW
DEIONIZED WATER	DI SUPPLY	GREEN
	DI RETURN	GREEN
	DI RECLAIM	GREEN
ACID WASTE	ACID WASTE	ORANGE
FLUORIDE WASTE	FLUORIDE WASTE	YELLOW OR ORANGE
SOLVENT WASTE	SOLVENT WASTE	ORANGE
PROCESS VACUUM	PROCESS VACUUM	GREEN
CLEAN-UP VACUUM	HOUSE CLEAN VACUUM	GREEN
COMPRESSED AIR	HIGH PURITY COMPRESSED AIR	BLUE OR YELLOW
LIQUID NITROGEN	LIQUID NITROGEN	BLACK
GASEOUS HYDROGEN	HYDROGEN	BROWN
GASEOUS OXYGEN	OXYGEN	GREEN
GASEOUS NITROGEN	NITROGEN	BLACK
SPECIALTY GASES	**AS IDENTIFIED BY OWNER FOR VARIOUS TOXIC GASES	BLUE
INDUSTRIAL COLD WATER	INDUSTRIAL COLD WATER	GREEN
FUEL OIL	FUEL OIL SUPPLY	YELLOW
	FUEL OIL RETURN	
FUEL OIL VENT	FUEL OIL VENT	YELLOW
NATURAL GAS VENT	NATURAL GAS VENT	YELLOW
RECLAIMED WATER	CAUTION: RECLAIMED WATER, DO OT DRINK	PURPLE
SOLAR HOT WATER	SOLAR HOT WATER SUPPLY	YELLOW
	SOLAR HOT WATER RETURN	YELLOW
* Directional arrow applied adjacent to pipe marker indicating direction of flow.		
** Provide custom marker labels for piping for which no standard manufactured marker is available. Submit sample for approval.		

MEDICAL GAS SERVICE	PIPE MARKER *	BACKGROUND/TEXT COLOR
MEDICAL AIR	MED AIR	YELLOW/BLACK
CARBON DIOXIDE	CARBON DIOXIDE	GRAY/BLACK
HELIUM	HELIUM	BROWN/WHITE
NITROGEN	NITROGEN	BLACK/WHITE

MEDICAL GAS SERVICE	PIPE MARKER *	BACKGROUND/TEXT COLOR
NITROUS OXIDE	NITROUS OXIDE	BLUE/WHITE
OXYGEN	OXYGEN	GREEN/WHITE
MEDICAL-SURGICAL VACUUM	MED VAC	WHITE/BLACK
WASTE ANESTHETIC GAS DISPOSAL	WAGD	VIOLET/WHITE
NONMEDICAL AIR (LEVEL 3 GAS-POWERED DEVICE)	NON-MED AIR	YELLOW-AND-WHITE DIAGONAL STRIPE/ BLACK
NONMEDICAL AND LEVEL 3 VACUUM	NON-MED VAC	WHITE-AND-BLACK DIAGONAL STRIPE/ BLACK BOXED
LABORATORY AIR	LAB AIR	YELLOW-AND-WHITE CHECKERBOARD/BLACK
LABORATORY VACUUM	LAB VAC	WHITE-AND-BLACK CHECKERBOARD/BLACK BOXED
INSTRUMENT AIR	INSTRUMENT AIR	RED/WHITE
* Directional arrow applied adjacent to pipe marker indicating direction of flow.		

E. Reclaimed Water:
   1. Continuously wrap reclaimed water pipe and fittings with purple-colored Mylar tape over insulation, with the words CAUTION: RECLAIMED WATER, DO NOT DRINK.
   2. Imprint lettering in two parallel lines, after wrapping the pipe with a 1/2 width overlap, one full line of text. Make text visible.
   3. Wrapping tape is not required for buried PVC pipe manufactured with purple color integral to the plastic and marked on opposite sides to read CAUTION: RECLAIMED WATER, DO NOT DRINK in intervals not to exceed 3-feet.
   4. Outlets and fixtures served with harvester rainwater easily recognizable by color or symbol for non-potable water.
   5. Reference local ruling for additional requirements.

F. Specialty Gases: Identify piping with Brady B-60 fiber tags with chemical symbol on tag.

2.04 EQUIPMENT IDENTIFICATION

A. Nameplates:
   1. Tag pumps, converters, and miscellaneous items of mechanical equipment with engraved nameplates.
   2. 1/16-inch thick, 3-inch by 5-inch laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
   3. Identify unit with code number as shown on Drawings and area served.

B. Equipment Nameplate Directory:
   1. List pumps, and other equipment nameplates.
   2. Include Owner and Contractor furnished equipment.
   3. List nameplate designation, manufacturer's model number, location of equipment, area served or function, disconnect location, and normal position of HOA switch.

PART 3 EXECUTION

3.01 VALVE IDENTIFICATION

A. Valve Tags:
   1. Attach to valve with a brass chain.
   2. Continuous valve tag numbers throughout the building for each system. Obtain a list for each system involved from the [Owner.] [to establish numbers following the listed sequences:]

B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.02 PIPING MARKERS

A. Unless recommendations of ANSI A13.1 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:
   1. Every 20-feet along continuous exposed lines.
   2. Every 10-feet along continuous concealed lines.
   3. Adjacent to each valve and stub-out for future.
   4. Where pipe passes through a wall, into and out of concealed spaces.
   5. On each riser.
   6. On each leg of a T.
   7. Locate conspicuously where visible.
   8. Provide pipe identification (over insulation) for reclaimed water systems in accordance with current local codes and rulings.

B. Apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above.

C. Apply arrow labels indicating direction of flow. Arrows to be the same color and sizes as identification labels.

D. Install tags on specialty gas piping valves with brass chain.

3.03 EQUIPMENT IDENTIFICATION

A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

END OF SECTION

SECTION 22 05 90

PRESSURE TESTING FOR PLUMBING SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Pressure Testing of Piping System

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

1.03 QUALITY ASSURANCE

A. Code Compliance: Perform required tests in the presence of the authority having jurisdiction.

B. Owner Witness: Perform all tests in the presence of the Owner's representative.

C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe all tests or selected tests to assure compliance with the specifications.

D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's Representative, and the Engineer's representative need not occur simultaneously.

1.04 SUBMITTALS

A. Submit the following test reports:
   1. Certificate of completion, inspection, and test by authority having jurisdiction on required piping systems.
   2. Certificate of test approval by Owner's representative on all systems.
   3. Engineer's representative will record witnessed tests.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 GENERAL

A. Piping:
   1. Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties.
   2. Conduct tests with all valves but those used to isolate the test section 10 percent closed.

B. Leaks: Repair leaks and retest until stipulated results are achieved.

C. Notification:
   1. Advise the [Architect] [Engineer] [Construction Manager] 72 hours in advance of each test.
   2. Failure to so notify will require test to be rescheduled.

D. Testing Equipment: Provide all necessary pumps, gauges, connections, and similar items required to perform the tests.

3.02 TESTING REQUIREMENTS

A. Sanitary and Roof Drainage Systems:
   1. Test entire system or sections of system by closing all openings in piping except highest opening and filling system with water to point of overflow. If system is tested in sections, plug each opening except highest opening of section under test and fill each section with water, but none with less than 10 feet head of water.
   2. Keep water in system or in portions under test for at least 45 minutes before inspection starts. Test for 2 hours with no drop allowed. Locate and repair leaks.

B. Domestic and Reclaimed Water Systems:
   1. Test entire system by closing all openings in piping except highest opening and filling system with water to point of overflow.
   2. Keep water in system under test for a minimum of 45 minutes before inspection starts.

3. Test at full working pressure for 2 hours with no drop allowed. Locate and repair leaks.

C. Piping - General:
1. Test piping as noted below, with no leaks or loss in pressure for time indicated.
2. Repair or replace defective piping until tests are completed successfully:

Plumbing Systems	Test Pressure	Test Medium	Test Duration
Industrial water	150 psig	Water	4 hours
Natural gas piping	60 psig	Air	4 hours

D. Piping - High Purity:
1. General: Materials and quality of work subject to inspection and examination by the Owner or Owner's representative at any place where fabrication or erection are carried on.
a. Prior to Testing Operation:
1) Open valves and blow out pipelines to remove foreign matter which may have accumulated in the pipes.
2) Lines may be purged out by progressively opening and closing valves.
b. Perform testing in the presence of the Owner's representative.
c. Use only high purity cryogenic nitrogen for leak pressure testing.
d. Argon test gas for H2 lines unless specified.
e. Use nitrogen for test gas for O2, N2, specialty gases, and high purity compressed air. Do not use nitrogen from plant system without the written consent of the Owner.
f. Test high purity piping systems as follows:

System	Test Pressure	Test Duration
Oil free compressed air	150 psig	24 hours
High purity compressed air	150 psig	24 hours
Oxygen	200 psig	24 hours
Nitrogen	200 psig	24 hours
Hydrogen	200 psig	24 hours
Specialty gases	200 psig	24 hours

g. No pounding or hammering on any joints or equipment unless specifically authorized by Owner's representative.
h. For safety reasons, constantly observed. Hydrogen and oxygen are hazardous gases, and extreme care must be exercised in all work associated with them.
2. Testing Procedure:
a. Check systems to assure compliance with revision Drawings. Check pressure and temperature rating of all valves to assure compliance with Owner's design standard.
b. Check safety valves for pressure settings. In the event adjustments or corrections are required to assure conformance with drawings, they should be made prior to proceeding with the testing activity. Do not exceed pressure ratings of installed equipment.
c. Install and test gauges and test medium source connections made to convenient process connections. After completion of testing, the gauges and source connection removed and the specified process attachments replaced as shown on drawings.
d. Test joints with bubble leak detecting solution when pressure reading indicates leakage. The specified test pressure held as previously specified without loss in pressure.
e. Use gauges cleaned for O2 service.

3.03 MEDICAL GAS TESTING

A. Meet requirements of current NFPA 99 and NEC Class II signal requirements.

B. Testing of altered medical gas systems in addition to the new systems is required. Tests include but not be limited to the following:
1. Installer Performance Testing (Piped Gas Systems):
a. Test conducted prior to required test listed:
1) Blow Down

2) Initial Pressure Test
3) Standing Pressure Test
4) Piping Purge Test
5) Cross-Connection Test

2. System Verification (Piped Gas Systems):
   a. Test conducted after required test listed:
      1) Standing Pressure Test
      2) Cross-Connection Test
      3) Valve Test
      4) Alarm Testing
      5) Piping Purge Test
      6) Piping Particulate Test
      7) Piping Purity Test
      8) Final Tie-In Test
      9) Operational Pressure Test
      10) Medical Gasses Concentration Test
      11) Medical Air Purity Test.

C. Forward the following certifications to: [Licensing Plan Review Program, 3420 Cherry Avenue NE, Keizer, Oregon 97303.] [Building Department, City of _____, Washington.]
   1. Certification of the medical gas brazing is being performed by individuals who are qualified per NFPA 99.
   2. Certification of the medical gas and vacuum system installer performance testing per NFPA 99.
   3. Certification of the medical gas and vacuum system verification testing per NFPA 99.

END OF SECTION

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SECTION 22 05 93

TESTING, ADJUSTING, AND BALANCING FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Domestic Hot Water Recirculation Systems
   2. Pumping Systems

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

C. Section 22 08 00, Commissioning for Plumbing

D. Section 23 09 00, Instrumentation and Controls for HVAC

1.03 QUALITY ASSURANCE

A. Acceptable Testing and Balancing Firms:
   1. A.I.R., Inc.
   2. Air Balance Specialty, Inc.
   3. Neudorfer Engineers, Inc.
   4. Northwest Engineering Services
   5. Pacific Coast Air Balance
   6. Accurate Balancing Agency, Inc.

B. Other Firms: Submit substitution requests prior to bid date.

C. Acceptable Testing and Balancing Firms:
   1. Air Balance Associates
   2. Airtest Company
   3. MacDonald Miller
   4. National Indoor Air Care
   5. Neudorfer Engineers

D. Other Firms: Submit substitution requests prior to bid date.

E. Acceptable Testing and Balancing Firms:
   1. RSA Analysis
   2. National Air Balance
   3. AIRCO Commercial Services
   4. United Mechanical Incorporated

F. Other Firms: Submit substitution requests prior to bid date.

G. Testing and Balancing Firm Qualifications:
   1. Procure the services of an independent balance and testing agency, approved by the Architect, which specializes in the balancing and testing of plumbing, heating, ventilating, and air conditioning systems, to balance, adjust and test water circulating and air moving equipment and air distribution or exhaust systems as herein specified.
   2. Testing agency to provide proof of having successfully completed at least five projects of similar size and scope.
   3. Testing and balancing work done under direct supervision of registered professional engineer who has been employed by the Agency a minimum of one year prior to start of project.
   4. Certification: National Environmental Balancing Bureau (NEBB)

H. Industrial Standards:
   1. NEBB, American Society of Heating, Refrigerating
   2. Air Conditioning Engineers (ASHRAE)

3. American National Standards Institute (ANSI) as follows:
    a. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
    b. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
    c. ANSI:
        1) S1.4 Specifications for sound level meters.
        2) S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.

I. Instrument Certification: Instruments used accurately calibrated and certified within six months of balancing and maintained in good working order.

J. Test Observation: If requested, conduct test in the presence of the Architect or the Architect's representative.

K. Pre-Balancing Conference:
1. Review with the Engineer prior to starting balancing, general techniques.
2. Conference must occur prior to measuring existing conditions.
3. Measuring of existing conditions must occur prior to any demolition or new work.
4. Review existing conditions and systems to be affected by the project

1.04 SUBMITTALS

A. Submit the following:
1. Balancing Log:
    a. Include water outlets, actual field measured water volume, and percentage of design volumes.
    b. Provide drawings identifying location of outlets.
2. Equipment Data Sheets:
    a. Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
3. Additional Data: Submit additional data as provided by Associated Air Balance Council (AABC) Standard forms.
4. Number of Copies: Submit six copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
5. Instrument Certification: When requested, submit certificate of calibration for equipment to be used.

B. Record data on NEBB forms or forms approved by the Architect.

1.05 PROJECT CONDITIONS

A. Where existing systems are to be adjusted, establish flow rates in all branches prior to making any modifications to system. Submit preliminary report indicating existing conditions prior to making any modifications to existing systems. Adjust central equipment as required and restore unmodified branches and outlets to original condition. Obtain existing system drawings from Owner and become familiar with extent and nature of existing systems.

B. Do not perform final testing, adjusting, and balancing work until equipment has been completely installed and operating continuously as required.

C. Conduct testing and balancing with clean strainers and filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.06 WARRANTIES

A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 DOMESTIC HOT WATER RECIRCULATION SYSTEMS

A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
   1. List complete data of tested equipment and verify against Contract Documents.
   2. Open line valves to full open position.
   3. Set master mixing valve as described by manufacturer's recommendations to achieve desired leaving water temperature.
   4. For each pump:
      a. Verify rotation.
      b. Test and record pump shut-off head.
      c. Test and record pump wide-open head.
   5. Verify proper system pressures.

C. Distribution:
   1. Read and adjust water flow for design conditions.
   2. Set memory stops and mark position of adjuster on balancing valves.

3.02 DOMESTIC HOT WATER POINT OF USE MIXING VALVES

A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
   1. List complete data of tested equipment and verify against Contract Documents.
   2. Open line valves to full open position.

C. Distribution:
   1. Adjust water flow for design conditions.
   2. Set mixing valve to achieve desired leaving water temperature.
   3. Set memory stops and mark position of adjuster on balancing valves.

3.03 SOLAR HOT WATER PUMPING SYSTEMS

A. General: Make measurements in accordance with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
   1. List complete data of tested equipment and verify against Contract Documents.
   2. Open all line valves to full open position.
   3. Set master mixing valve as described by manufacturer's recommendations.
   4. For each pump:
      a. Verify rotation.
      b. Test and record pump shut-off head.
      c. Test and record pump wide-open head.
   5. Verify proper system pressures.
   6. Verify air vents in high points of water are properly installed and operating freely.

C. Distribution:
   1. Read and adjust water flow for design conditions.
   2. Set memory stops and mark position of adjuster on balancing valves.

3.04 AUTOMATIC CONTROL SYSTEM

A. In cooperation with control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

B. Testing organization to verify controls for proper calibration and list controls requiring adjustment by control system installer.

3.05 COORDINATION

A. Coordinate work with other trades to ensure rapid completion of the project.

B. Deficiencies noted during the course of balancing in the mechanical installation promptly reported to the Architect to allow corrective action to proceed.

C. Provide periodic review of progress as requested.

END OF SECTION

SECTION 22 07 00

INSULATION FOR PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Pipe Insulation
   2. Pipe Acoustical Wrap
   3. Block Insulation
   4. Accessories Piping

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

C. Section 22 05 29, Hangers, Supports and Anchors for Plumbing

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Insulating products prohibited from containing pentabrominated, octabrominated and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
   2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723 or ASTM E84.
   3. Energy Codes: Local Building and Energy Codes govern where insulation performance requirements for thickness exceeds thickness specified.

B. Protection: Protect against dirt, water, chemical, or mechanical damage before, during, and after installation. Repair or replace damaged insulation at no additional cost.

C. Source Quality Control:
   1. Service: Use insulation specifically manufactured for service specified.
   2. Labeling: Insulation labeled or stamped with brand name and number.
   3. Insulation and accessories not to provide nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin. Asbestos free and no interaction with corrosively with equipment, piping, or ductwork.

1.04 SUBMITTALS

A. Submit the following.
   1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. General:
   1. Johns Manville
   2. Knauf
   3. Owens Corning
   4. CertainTeed
   5. Such insulation by one manufacturer.
   6. Other Manufacturers: Submit substitution request.

B. Pipe Insulation:
   1. Fiberglass:
      a. Johns Manville Microlok HP
   2. Calcium Silicate:

a. Johns Manville Thermo-12 Gold
3. Elastomeric:
a. Armacell AP Armaflex, Rubatex, K-Flex.

C. Pipe Acoustical Wrap:
1. Kinectics Noise Control KNM-100ALQ.

D. Block Insulation:
1. Johns Manville 1000 Series.

E. Accessories Piping:
1. [_____]

2.02 PIPE INSULATION

A. Fiberglass: Split sectional or Snap-On type with 0.23 per inch maximum thermal conductivity (K-factor) at 75 degrees F mean temperature, 850 degrees F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system.

B. Calcium Silicate: Sectional with 14 pcf nominal density, 0.40 maximum K-factor at 300 degrees F mean temperature and 1200 degrees F maximum service rating.

C. Elastomeric:
1. Expanded closed cell, 0.27 per inch maximum K-factor at 75 degrees F mean temperature, 220 degrees F maximum service rating with fitting covers and paintable surface.
2. Color:
a. Concealed Locations: Black
b. Exposed Locations: White.

2.03 PIPE ACOUSTICAL WRAP

A. Barrier
1. Construct 0.10-inch thick mass loaded, limp vinyl sheet bonded to a layer of reinforced aluminum foil on one side.
2. Nominal density of 1 pound per square foot and minimum STC rating of 28.
3. Minimum thermal conductivity value of 0.29 and a rated service temperature range of -40 degrees F to 220 degrees F.
4. Flame spread index of no more than 10 and a smoke development index of less than 40.

B. Decoupling Layer: Combination of 1-inch fiberglass batting, nonwoven porous scrim-coated glass cloth, quilted together in a matrix of 4-inch diamond stitch pattern which encapsulates the glass fibers.

C. Composite Material: Fabricated to include a nominal 6-inch wide barrier overlap tab extending beyond the quilted fiber glass to facilitate a leak-tight seal around field joints.

2.04 BLOCK INSULATION

A. Fiberglass: 1-1/2-inch thick unless specified or shown otherwise with 3 pcf nominal density, 0.23 per inch maximum K-factor at 75°F mean temperature and 450°F maximum operating temperature limit.

2.05 ACCESSORIES PIPING

A. Adhesives:
1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
2. Fiberglass: Integral closure system.
3. Calcium Silicate: Benjamin Foster 30-36.
4. Elastomeric: Armacell 520 BLV.

B. Cements:
1. Insulating: Ryder.
2. Heat Transfer: Chemax Tracit-300.

C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

D. Pipe Fitting Covers:
   1. One piece PVC insulated pipe fitting covers.
   2. Zeston, Ceel-Co.

E. Grooved Coupling Insulation:
   1. One piece PVC insulated fitting cover.
   2. Zeston, Ceel-Co.

F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.

G. Cloth Facing: Presized fiberglass cloth.

H. Tapes:
   1. Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F.
   2. Zeston Z-tape.

I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

PART 3 EXECUTION

3.01 GENERAL

A. Workmanship:
   1. Installation: Insulation installed in first class, neat professional manner.
   2. Applicators: Employed by firm that specializes in insulation work.

B. Preparation: Surfaces of piping and equipment clean, free of oil or dirt, and dry before insulation is applied.

C. Stamps: ASME stamps, UL labels, and similar stamps and labels are not covered.

3.02 PLUMBING PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – Plumbing Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Domestic Cold Water, Above Grade	1-1/4-inch and smaller	Fiberglass, all-purpose jacket or Elastomeric	1-inch	Note 1 Note 2
Domestic Cold Water, Above Grade	Above 1-1/4-inch	Fiberglass, all-purpose jacket	1 1/2-inch	Note 1
Industrial Cold Water, Above Grade	1-1/4-inch and smaller	Fiberglass, all-purpose jacket or Elastomeric	1-inch	Note 1 Note 2
Industrial Cold Water, Above Grade	Above 1-1/4-inch	Fiberglass, all-purpose jacket	1 1/2-inch	Note 1
Non-Potable Cold Water, Above Grade	1-1/4-inch and smaller	Fiberglass, all-purpose jacket or Elastomeric	1-inch	Note 1 Note 2
Non-Potable Cold Water, Above Grade	Above 1-1/4-inch	Fiberglass, all-purpose jacket	1 1/2-inch	Note 1
Reclaimed Water, Above Grade	1-1/4-inch and smaller	Fiberglass, all-purpose jacket or Elastomeric	1-inch	Note 1 Note 2
Reclaimed Water, Above Grade	Above 1-1/4-inch	Fiberglass, all-purpose jacket	1 1/2-inch	Note 1
Domestic Hot Water Supply/Return, Above Grade	1-1/2-inch and smaller	Fiberglass, all-purpose jacket or Elastomeric	1 1/2-inch	Note 1 Note 2

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Domestic Hot Water Supply/Return, Above Grade	Above 1-1/2-inch	Fiberglass, all-purpose jacket	2-inch	Note 1
Domestic Hot Water Supply/Return, Below Grade	1-1/2-inch and smaller	Elastomeric	1 1/2-inch	Note 1 Note 2
Domestic Hot Water Supply/Return, Below Grade	Above 1-1/2-inch	Elastomeric	2-inch	Note 1
Solar Hot Water	1-1/2-inch and smaller	Fiberglass, all-purpose jacket or Elastomeric	1 1/2-inch	Note 1 Note 2
Solar Hot Water	Above 1-1/2-inch	Fiberglass, all-purpose jacket	2-inch	Note 1
Interior Storm Drain and Interior Overflow Drains	All	Fiberglass, all-purpose jacket	1/2-inch	Note 3
Traps and trap priming lines (In unheated Spaces)	All	Fiberglass, all-purpose jacket	1-inch	Insulate over heat tape
Irrigation Piping, Inside Building	All	Fiberglass, all-purpose jacket or Elastomeric	1/2-inch	Note 2
Central Compressed Air	All	Elastomeric	1/2-inch	Note 2
Condensate or other cold water drains	All	Elastomeric	1/2-inch	Note 2
Storage Tanks	All	Fiberglass, all-purpose jacket	3 1/2-inch	
Storage Tanks	All	Elastomeric	3 1/2-inch	
Note 1: Cover with metal pipe jacket where exposed to weather, and over heat trace cable. Note 2: Elastomeric insulation not allowed over heat trace cable. Note 3: Drain bodies, insulate the first 10-feet connected to the drain body, and horizontal piping. Do not insulate main vertical stack.				

B. The following piping is not insulated:
   1. Waste and vent, except where heat traced.
   2. Natural Gas
   3. Fuel Oil
   4. Specialty Gases
   5. Medical Gases
   6. Domestic cold water runouts to single fixture less than 12-inch long and exposed supplies.
   7. Priming lines except where heat traced.

C. Insulation include the following:
   1. Fittings
   2. Unions
   3. Flanges
   4. Mechanical Couplings
   5. Valve Bodies
   6. Valve Bonnets
   7. Piping through Sleeves except Valve Bonnets

8. Unions and Flanges need not be insulated on the following systems:
    a. Domestic Hot Water
    b. Solar Hot Water
    c. Inside Building

D. Insulate valves and irregular fittings with section of pipe insulation and insulating cement, securely fastened, and finished with 6 oz. canvas and Foster 30-36 lagging adhesive.

E. Flanges, valves, strainers, not requiring a vapor barrier to insulate with removable replaceable pads fabricated of 1-inch layer of Pittsburgh Corning Temp Mat sandwiched between inner and outer layer of 8 oz. glass cloth held together with stainless staples with sufficient stainless lacing hooks to hold pad firmly to flange or valve with minimum 3-inch overlap onto adjacent pipe insulation using 18 gauge SS lacing wire.

F. Expansion Joints and Flexible Connectors: Pipe insulation or block of same material and thickness as adjacent piping.

3.03 PIPING INSTALLATION

A. General:
1. Joints: Coat both sides of complete joining area with applicable adhesive.
    a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
    b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
    c. Multiple Layered Insulation: Joints staggered.
2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
3. Voids:
    a. Fill voids, chipped corners and other openings with insulating cement or material compatible with insulating material.
    b. In insulation with heat tracing where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
4. Seal joints, seams, and fittings of metal watertight jackets at exterior locations.

B. Fiberglass Insulation: Exterior insulation encased in metal jacket.

C. Calcium Silicate Insulation:
1. Secure with 18-gauge wire embedded into insulation.
2. Cover with continuous vapor barrier jacket.

D. Elastomeric Insulation:
1. Slit full length and snap around pipe.
2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
3. Do not stretch insulation to cover joints or fittings.
4. Seal joints in elastomeric insulation with adhesive.
5. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
6. Sealing joints with tape will not be allowed.

E. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.
1. On Elastomeric Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.

F. Unions, Mechanical Joints, Valves, Etc.:
1. General:
    a. As specified for fittings.

b. Minimum thickness same as specified for piping.
2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
4. Flanged Valves: Insulation with square corners.

G. Vapor Barrier Insulation:
1. Refer to Section 22 05 29, Hangers, Supports, and Anchors for Plumbing for support requirements.
2. Piping which requires vapor barrier protection of continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
a. Domestic cold water.
b. Industrial cold water.
c. Non-potable cold water.
d. Other piping systems with a nominal operating temperature below 65 degrees F.
3. Vapor Barrier Insulation:
a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 22 05 29, Hangers, Supports, and Anchors for Plumbing.

H. Non-Vapor Barrier Insulation:
1. Refer to Section 22 05 29, Hangers, Supports, and Anchors for Plumbing for support requirements.
2. At contractor's option, insulation may be interrupted at supports. Butt insulation tight to support.
3. If contractor elects to continue insulation at supports, installation as specified for piping systems with vapor barrier installation.
4. Void between saddle and pipe filled with insulation.

I. Non-Vapor Barrier Insulation:
1. Refer to Section 22 05 29, Hangers, Supports, and Anchors for Plumbing for support requirements.
2. For pipe 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
3. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation. Provide pipe shield specified in Section 22 05 29, Hangers, Supports, and Anchors for Plumbing.

J. Acoustical Wrap:
1. Install in accordance with the manufacturer's instructions.
2. Applied locations for piping systems where specified or indicated on drawings.

3.04 EQUIPMENT INSTALLATION

A. General: Install true and smooth. Insulation over curved surfaces conform to curves of surface.
1. Access:
a. Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance provided with covers or section that are easily removable and replaceable.
b. Reinforce openings in adjacent insulation with metal beading. In vapor barriered insulation, coat joints with vapor barrier mastic.
2. Voids, Depressions and Cavities: Fill voids, chipped corners, and other openings with insulating cement or material compatible with insulating material.
3. Vapor Barrier Insulation: Barrier not to be pierced or broken.
a. Coat defects with vapor barrier mastic and patched with insulation facing or tape.
b. Staples brush coated with vapor barrier coating.

c. Cover raw edges coated with vapor barrier mastic sealed to equipment surface.

4. Non-Vapor Barriered Insulation:
   a. Patch tears with insulation facing or tape.
   b. Cover and neatly bevel raw edges to equipment surface.
5. Multilayered Insulation: With staggered joints.

B. Fiberglass Block:
1. Anchors: Lug nuts 10 gauge black annealed iron wire welded to metal surfaces.
2. Banding: Block secured to surface with 1/2-inch wide stainless steel bands maximum 18-inches on center and secured to anchors.
3. Insulating Cement: Block covered with insulating cement minimum thickness of 1/2-inch with smooth finish.
4. Vapor Barrier System: Apply continuous coat of vapor barrier mastic.
5. Finish: Finish with cloth facing secured with adhesive and lapped a minimum of 2 inches. Defects touched up with finishing cement.

C. Elastomeric Blanket:
1. Cut insulation to size, make corners with mitering cuts to preclude raw edges, continuously cement insulation to equipment with adhesive.
2. Cement both surfaces of joints and butt tightly together and cover raw edges with two coats of adhesive.

D. Expansion Joints: Covered with larger size pipe insulation to allow full movement and be removable, ends turned back to pipe, coat with vapor barrier mastic on joints in vapor barriered system, and finished with cloth facing cemented to insulation with adhesive.

E. Heat Exchangers: Insulation thickness and material as specified for piping and applicable service.

3.05 FIELD QUALITY CONTROL

A. Field Test: Test and approve systems prior to installation of insulation.

B. Existing Insulation:
1. Repair existing insulation damaged during construction.
2. Make neat connections where new and existing insulation meet.
3. Where existing piping, or equipment is removed, cover existing surfaces neatly to match existing.

END OF SECTION

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SECTION 22 15 00

GENERAL SERVICE COMPRESSED AIR SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Oil Free Rotary Screw Air Compressor
2. Oil Free Piston Air Compressor
3. Oil Flooded Rotary Screw Air Compressor
4. Air Drier
5. Refrigerated Air Dryer
6. Water Cooled After Cooler
7. Compressed Air Receiver
8. Filters
9. Oil-Free Air Compressor (CDA, IA)
10. Hygrometer
11. Air Dryer and Filters
12. Compressed Air Receiver
13. Respirator Air (RA)

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

1.03 SUBMITTALS

A. Submit the following:
1. Shop Drawings of equipment when standard manufacturers' product data does not describe the product in sufficient detail to allow the contractor to rough-in equipment.
2. Performance Data: Include air and water flows, pressure drops, capacities, electrical data, control schematics.
3. Product Data: Include manufacturer's current recommended methods of installation.
4. Operating and Maintenance Data

1.04 QUALITY ASSURANCE

A. Select rotary screw compressors so that motor nameplate rating plus safety factor exceeds required brake horsepower at design conditions.

B. Provide compressed air receivers, pressure relief valves, and other devices in compliance with applicable ASME codes, and stamped with appropriate code symbol as required by the State of Oregon. Provide ASME stamp on equipment where specified.

C. Provide electrical components which have been listed and labeled by Underwriters Laboratories, Canadian Standards Association or other testing agency as approved.

1.05 GUARANTEE

A. Provide per the General and Supplementary Conditions of the Contract.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Oil Free Rotary Screw Air Compressor:
1. Kobelco Northwest
2. Atlas Copco ZR Series

B. Oil Free Piston Air Compressor:
1. Quincy Northwest

C. Oil Flooded Rotary Screw Air Compressor:
1. Quincy Northwest

2. Sullair
3. Atlas
4. Copco
5. Other Manufacturers: Submit substitution request.

D. Air Drier:
1. Pall 250CDA-4
2. Zurn

E. Refrigerated Air Dryer:
1. Wilkerson Model A11-HH-P00.
2. Other Manufacturers: Submit substitution request.

F. Water Cooled After Cooler:
1. Adams Model SAF-9.
2. Other Manufacturers: Submit substitution request.

G. Compressed Air Receiver:
1. Hansen

H. Filters:
1. Coalescing Prefilter:
a. Fine Aire DH5D-6C20-130.
2. Particulate After Filters:
a. Fine Aire DH5D-3PU20-130.
3. Finer Filter:
a. Housing: Pall SLLIG16E.
b. Filters: Pall nylon 66, Model No. AB3V0015-7E.

I. Oil-Free Air Compressor (CDA, IA):
1. Atlas Copco
2. Kobelco
3. Ingersoll Rand

J. Hygrometer:
1. [_____]

K. Air Dryer and Filters:
1. Dual Tower Dryer (CDA, IA)
a. Pneumatic Products, Ingersoll Rand:
2. Air Filters (CDA, HPCDA, IA)
a. Pneumatic Products, Pall:

L. Compressed Air Receiver:
1. Roy E. Hanson Jr.

M. Respirator Air (RA):
1. Dynamation ABL-4021-1 Auto-Cal Carbon Monoxide and Oxygen.

2.02 OIL FREE ROTARY SCREW AIR COMPRESSOR

A. General Requirements:
1. Provide positive displacement water-cooled rotary screw air compressor to deliver 100 percent oil free air.
2. No lubricant allowed within the compressor chamber.
3. Unit fully packaged including air compressor, electric motor, motor starters, coolers, lubrication system, regulation and control systems, inlet air filter, inlet and discharge silencers, cooling water system, mounted on a common vibration isolation base frame with sound enclosure.

B. Compressor Design:
1. Provide two stage compressor as required to meet performance, consisting of a casing enclosing two screw type rotors.

2. Flange stages to an integral speed increaser.
3. Each stage driven from a common bull gear.

C. Compressor Casings: Provide cast iron, one piece housing with cooling water jackets.

D. Rotors: Provide screw type rotors of one piece steel construction with corrosion resistant coating, dynamically balanced to operate without vibration.

E. Timing Gears: Provide timing gears fitted on rotor shafts to maintain the rotors in correct position relative to each other.

F. Bearings: Provide roller bearings to carry radial loads and ball bearings to carry axial loads.

G. Seals: Provide seals constructed to prevent air and oil leakage from the compressor and oil from contaminating the air.

H. Speed Increaser:
1. Provide an integral part of the compressor unit including the main drive and bull gear.
2. Support main drive shaft through bearings.

I. Coolers: Provide the following coolers:
1. Oil cooler.
2. Intercooler with moisture separator and automatic drain.
3. Aftercooler with moisture separator and automatic drain.

J. Electrical: Provide motor with unit mounted x-line starter.

K. Cabinet: Provide acoustical cabinet for sound attenuation. Cabinet to reduce noise generation to 75 DBA at 3-feet from cabinet.

L. Instrument Panel: Provide the following indicator lights and gauges mounted on the main instrument panel.
1. Air inlet filter condition indicator.
2. First stage discharge pressure gauge.
3. Second stage discharge pressure gauge.
4. First stage discharge air temperature gauge.
5. Second stage suction air temperature gauge.
6. Second stage discharge air temperature gauge.
7. Oil temperature gauge.
8. Oil pressure gauge.
9. Oil level gauge.
10. Oil filter condition indicator.
11. Hour meter running time.
12. Hour meter loaded time.
13. Power-on light.
14. Oil pump run light.
15. Compressor run light.
16. Compressor load light.

M. Safety Devices:
1. Provide the following safety devices.
2. Provide each monitoring point with auxiliary contacts where applicable.
    a. Motor overload shutdown and light.
    b. Low oil pressure shutdown and light.
    c. High first stage air discharge temperature shutdown and light.
    d. High second stage air discharge temperature shutdown and light.
    e. High oil temperature shutdown and light.
    f. Alarm bell.
    g. Bell cancel switch.
    h. Lamp test switch.
    i. Reset switch.

N. Controls: Provide integral solid state programmable controller to monitor and control compressor operation, including lead/lag functions and monitoring and alarm of points and safety devices on the instrument panel for intertie to the building DDC System.

O. Accessories: Provide the following accessories.
   1. Discharge Check Valve
   2. Discharge Silencer
   3. Automatic thermostatically controlled cooling water regulating valve.

2.03 OIL FREE PISTON AIR COMPRESSOR

1. 2 stage, water cooled oil free type.
2. Assembly includes air intake filter, pressure switch, pressure gauge, pressure relief valve, and related standard equipment.

2.04 OIL FLOODED ROTARY SCREW COMPRESSOR

A. Description:
   1. Single stage, rotary, oil-flooded screw unit, capable of delivering CFM scheduled and capable of operating at full capacity up to maximum of 175 psig.
   2. V-belt driven and OSHA approved V-belt guard. Male rotor speed not to exceed 2,550 rpm.

B. Motor: Energy efficient 1800 rpm, horizontal, ball bearing, drip-proof, NEMA design B with Class B insulation.

C. Cooled Oil Cooler:
   1. Compressor unit incorporates air-cooled oil cooler of sufficient size to insure that the inlet oil temperature to the compressor and not exceed 200 degrees F on a 105 degrees F day at full load.
   2. Include thermostatic valve to ensure that the inlet oil temperature does not fall below 140 degrees F on cold days.
   3. Cooling fan direct driven from the compressor motor shaft.

D. Air-Cooled After Cooler:
   1. Equip each air compressor with an internal air-cooled aftercooler and moisture separator with automatic drain trap.
   2. Cool the air to within 15 degrees F of the ambient air temperature.

E. Mount compressor assembly on a fabricated steel base.

F. Reheater:
   1. Equip each air compressor with an air reheater.
   2. Air coming from the aftercooler or air dryer reheated to within 15 degrees F of the compressor discharge temperature, utilizing waste energy in the hot oil to reduce relative humidity to approximately 8 percent.
   3. Mount reheater package is to on the compressor frame, in series with, and downstream from the aftercooler moisture separator.

G. Receiver-Separator:
   1. Equip with a combination air receiver/oil separator assembly, rated at 200 psig.
   2. Incorporate a means of observing the oil level while the compressor is operating, an ASME Coded safety valve of adequate size set at 125 psig, and an oil separator element to minimize oil consumption, designed for 5000 hour minimum life under normal operating conditions.

H. Air Inlet Filter: Heavy-duty, dry type.

I. Oil Filter and Oil Change Intervals:
   1. Full flow type oil filter.
   2. Spin-on cartridge element capable of at least 1000-hour operation between changes.
   3. Oil change intervals not less than 1000 hours under normal operating conditions.

J. Safety Controls: Adequate safety devices incorporated to shut down the unit and require manual reset in the event of:
   1. Loss of Cooling Water
   2. High Oil Temperature
   3. High Air Temperature
   4. Low Oil Level
   5. Cold Ambient Starting
   6. Low Oil Pressure

K. Instrumentation includes the following:
   1. Hour Meter
   2. Air usage indicator calibrated in percent of capacity.
   3. Oil Temperature Gauge
   4. Air Pressure Gauge

L. Energy Saving Controls:
   1. Compressor package will have an energy savings low unloaded horsepower control. This system will save energy during periods of low demand by reducing the required unloaded BHP to 15-18 percent of full load.
   2. Units with time delay shut down will automatically turn off when operating unloaded for 15 minutes and will restart on demand.

M. Assembly:
   1. Assembled unit, including aftercooler and reheater, factory tested prior to shipment.
   2. Start-up and training at the plant sit made under factory surveillance.

N. Miscellaneous:
   1. Include other items not mentioned above that are normally supplied on a standard unit to assure proper operation of the unit.
   2. Include interconnecting piping and wiring, initial oil supply, steel base with equipment mounted on the base, and an enclosed V-belt guard.

2.05 AIR DRIER

A. General:
   1. Provide dual tower heatless regenerative type air drier to maintain less than 0.1 ppm moisture in the compressed air steam.
   2. Prewired and pretested at the factory, complete and ready for installation. ASME stamp.

B. Provide dryer complete with molecular sieve desiccant threaded inlet and outlet, complete with all standard accessories, and:
   1. 10 minute NEMA cycle.
   2. Switch failure alarm.

C. Controls: Provide panel mounted on/off switch with power light, inlet and outlet air temperature and pressure gauge, chamber pressure and temperature gauges.

D. Accessories: Provide air inlet and outlet high temperature warning lights, air outlet temperature and pressure gauges.

2.06 REFRIGERATED AIR DRIER

A. General:
   1. Provide air drier to remove moisture by cooling the compressed air to a temperature of 35 degrees F to 39 degrees F using a refrigeration system.
   2. House unit in a casing with removable panels.
   3. Prewired and pretested at the factory, complete and ready for installation.
   4. ASME stamp.

B. Refrigerant Circuit:
   1. Hermetically sealed compressor, air cooled condenser, receiver filter/drier, moisture indicator, sight glass, thermostatic expansion valve, and air to refrigerant heat exchanger.

2. Provide a hot gas bypass for capacity control and evaporator to prevent freeze up. Provide crankcase heater.

C. Compressed Air Circuit:
1. Precool air with copper tube-in-tube, entering air-to-dry air, counter flow heat exchanger.
2. Provide moisture separator with automatic drain downstream of drier.
3. Final reheating takes place in the air-to-air heat exchanger to prevent condensation.

D. Controls: Provide ON/OFF switch with power light, refrigerant analysis gauge, inlet air temperature and pressure gauges, compressor high and low pressure cut-outs, and low ambient fan control.

E. Accessories: Provide air inlet and outlet high temperature warning lights, air outlet temperature, and pressure gauges.

F. Capacity:
1. 435 SCFM of 125 psig, 90 degrees F entering air with 35 degrees F - 39 degrees F dewpoint.
2. 100 degrees F ambient.
3. Maximum APD:
a. 3 psig, 4.3KW, 480V, 3 phase
b. Approximate operating weight: 1,100 pounds

2.07 WATER COOLED AFTER COOLER

A. General:
1. Provide water cooled pipe line aftercooler with separator of counterflow design with air in tubes and water in shell.
2. Tubes: 5/8-inch OD-18 gauge minimum with floating rear tube sheets to prevent stress on tube joints due to expansion.
3. Provide baffles in shell and cyclonic separator on discharge with site glass and shut-off cocks.

B. Performance: 95 CFM at 125 pounds from 350 degrees F to 95 degrees F with 2.14 GPM of 80 degrees F entering water. ASME

2.08 COMPRESSED AIR RECEIVER

A. Compressed Air Receiver:
1. Provide ASME stamped, vertical cylindrical welded steel compressed air receivers, with safety pressure relief valves, pressure gauge, angle legs, inspection openings, 200 psi working pressure.
2. Equip with auto drain.

2.09 FILTERS

A. Coalescing Prefilter:
1. Provide coalescing type filters in 300 psi, 225 degrees F with 304 stainless steel housing.
2. Equip with filter cartridge for removal of water and oil aerosols with reduced orifice automatic drain.
3. Capacity: 250 CFM at 150 psig. Maximum 1 psi pressure drop.
4. Manufacturer:
a. Fine Aire DH5D-6C20-130.

B. Particulate After Filters:
1. Provide coalescing type after filters in a 300 psi 225 degrees F with 304 stainless steel housing filters rated at 0.3 micron.
2. Capacity 250 CFM at 150 psi, maximum 1.0 psi pressure drop.
3. Manufacturer:
a. Fine Aire DH5D-3PU20-130.

C. Finer Filter:
   1. Provide final membrane type filter assembly with type 316 pickled and passivated stainless steel housing. Filters rated at 0.01 micron.
   2. Capacity 250 CFM at 150 psi maximum 1.0 psi pressure drop.
   3. Manufacturer:
      a. Housing: Pall SLLIG16E.
      b. Filters: Pall nylon 66, Model No. AB3V0015-7E.

2.010 OIL FREE AIR COMPRESSOR (CDA, IA)

A. Air compressor oil free rotary screw or centrifugal, two or three-stage, water-cooled (CDA) or air-cooled (IA) packaged air compressor with open drip-proof motor with part winding closed transition magnetic starter and 3-leg overload protection.

B. Complete with soundproof enclosure to 78 dB; air intake filter and silencer; inter-cooler; after cooler; regulating and control systems; cooling water thermostatic valve, solenoid control valve, and pressure regulating valve; and discharge check valve and internal flex/expansion lines. Entire unit to be assembled on a common base frame.

C. Compressor delivers the required capacity at 3,000 feet above sea level.

D. Control system integral to the compressor package and provide manual and automatic operation. Compressor package includes the following monitor operation (as required for water or air cooled):
   1. Intercooler air pressure gauge
   2. Discharge air pressure gauge
   3. Oil pressure gauge
   4. Vacuum gauge for air intake filter
   5. Compressor discharge water temperature gauge
   6. Aftercooler discharge water temperature gauge
   7. 1st, 2nd, and 3rd stage discharge air temperature gauge
   8. 2nd stage inlet air temperature gauge
   9. High oil temperature light
   10. Low oil pressure light
   11. High 1st and 2nd stage discharge air temperature lights
   12. High 2nd stage inlet air temperature light
   13. Hour meter-run time
   14. Hour meter-loaded time
   15. Auto operation light
   16. Power on light
   17. Motor overload light
   18. Oil temperature gauge
   19. Stainless steel heat exchangers
   20. Inputs and outputs able to be connected to Owner’s PLC
   21. Factory sequencing if owner requires.

E. Provide automatic shut-off switches for the following:
   1. Low oil pressure
   2. High 1st and 2nd stage discharge air temperature
   3. High 2nd stage inlet air temperature
   4. High oil temperature
   5. Motor overload

F. Provide SPDT contacts for remote annunciation and operation as follows:
   1. Hand status
   2. Auto status
   3. Run status
   4. Compressor fault
   5. Remote start

G. Provide ventilating fan in control cabinet where transformer and motor magnetic starters are mounted.

2.011 HYGROMETER

A. Provide Panametrics Pana-Dry with remote sensor to allow continuous monitoring of compressed air system. Unit to alarm conditions outside of setpoint range.

2.012 AIR DRYER AND FILTERS

A. Dual Tower Dryer (CDA, IA:
   1. Dual tower heater-less, activated alumina desiccant air dryer capable of continuously drying the air, even during tower switch-over to -100 degrees F (CDA) or -40 degrees F (IA) dew-point air, with automatic moisture load control. Each dryer tower sized for a minimum pressure of 125 psig, and an entering air temperature of 100 degrees F. Each dryer must be able to perform as specified at a minimum flow of 25 percent of the rated capacity; Electrical NEMA 4, 120V, 1-PH, 60 Hz. With ON/OFF switch for maintenance and repair located on unit.
   2. ASME constructed and stamped for 150 pound working pressure, with relief valves on each chamber
   3. Fully automatic repressurizing system which will pressurize the newly reactivated desiccant tower prior to switch-over. Equip each tower with a remote muffler system which reduces the noise level output throughout the entire cycle including depressurization to less than 85 dbA.
   4. Dryer Unit:
      a. Skid mounted, pre-piped with all necessary valves and gauges, pre-wired with all necessary controls and instrumentation and completely pre-assembled and painted at the factory to make a packaged unit.
      b. Include pre-filters and after filters.
   5. Piping: Oil-free with all threaded joints with Teflon® tape and all valves non-lubricated.
   6. Dryer package panel have the following to monitor operation:
      a. Newest style automatic moisture sensing panel
      b. Chamber pressure gauges
      c. Purge flow indicator
      d. Moisture indicator
      e. Inlet and outlet pressure gauges
      f. Switching failure alarm
      g. High humidity alarm
      h. Dryer status auxiliary contact
      i. Dryer fault auxiliary contact
      j. Dryer outlet moisture (4-20ma signal)
   7. Prior to shipment, the dryer shell pressure tested for leaks. The equipment receives standard cleaning and painting, which consists of wire brushing, solvent cleaning and a coat of machinery enamel. Ship dryer completely assembled. Individually support towers by legs connected together by an angle frame. If the dryer is larger than 1200 cfm, the desiccant shipped in a separate container and loaded into the dryers at the job site after installation.

B. Air Filters (CDA, HPCDA, IA):
   1. Pre-filter:
      a. Coalescing filter assembly complete with solid state automatic drain valve, 120/1/60, NEMA 4, 150 pounds (200 pounds for HPCDA), carbon steel oil-free housing.
      b. Filter assembly to remove 99.99 percent of incident liquid water and oil droplets at rated flow (based on ASTM D 2986-781 DOP efficiency test) and to have a 99.99 percent particle removal rating of 0.3 microns.
   2. After-filter:
      a. Particulate resin impregnated cellulose filter assembly,150 pounds (200 pounds for HPCDA), Carbon steel oil-free housing.

b. 0.9 microns absolute rating.

3. Final Filter: 150 pounds (200 pounds for HPCDA), Type 316L stainless steel, oil-free housing with mounting legs, with Nylon 66 membrane filter cartridges. Filters rated at 0.01 microns absolute (CDA and HPCDA) and 0.1 microns absolute (IA).

2.013 COMPRESSED AIR RECEIVER

A. Furnish a vertical steel tank sitable for a maximum working pressure at the top tangent line, of 10 percent above the highest normal operating pressure or 25 psig, whichever is greater, and furnished with ASME stamp and certification papers.

B. Support of 4 angle legs equally spaced, designed for Seismic Zone 4 and bottom of tank 12-inches above floor.

C. Internal: Line with a combination epoxy and polyamide-type resin; Plasite 7133 or approved equal.

D. Exterior: Sandblasted, primed and painted with a coat of machinery enamel.

E. Provide the following accessories:
1. 11-inch by 15-inch manway
2. Flanged inlet and outlet nozzles
3. 2-inch NPT drain
4. 3-inch NPT for a relief valve
5. 3/4-inch NPT for pressure gauge
6. Lifting lugs
7. 150 psi relief valve on each vessel, if shown.
8. Automatic electric drain trap with timer (Pallmatic, 1/2-inch, 120V), if shown.
9. Nozzle gaskets (EPDM)

2.014 RESPIRATOR AIR (RA)

A. This system to provide grade D or better breathing air to the user, from an air purifying system mounted in-line from the plant compressed air source. The plant air source is to be certified class 10 or better.

B. The air purifying system continuously monitors the air purity. If the air purity falls below a set standard, the system will activate
1. Mechanical solenoid.
2. Audible alarm at the station and a flashing amber light at each user area. The mechanical solenoid, when activated, will immediately isolate the air-flow from the air stations to the users. The relay to shut off the air must be latching and require an assigned responder to reset the alarm and air supply to the panel.

PART 3 EXECUTION

3.01 OIL FREE AND OIL FLOODED ROTARY SCREW COMPRESSOR

A. Install per manufacturer's recommendations, written instructions, applicable requirements of ANSI B31.1, and in accordance with recognized industry practices.

B. Make piping connections.

C. Provide the services of a factory trained mechanic to inspect, ready, and start and test equipment to assure that it is in proper working order. Instruct the Owner on the machine operation.

3.02 PIPING

A. General:
1. Where different pipe materials interconnect, provide appropriate manufactured adapters or flanged connections with using expanded PTFE, non-ink embossed Gore-Tex cut sheet gaskets; 1/8 inch thick. Teflon® gasket. Torque to manufacturer’s specifications.
2. Locate hand operated vertical valves which require daily or more frequent operation, at a height not more than 7-feet above floor.

3. Stubs: Install valves where indicated on the drawings and elsewhere to facilitate pipe cleaning, venting, drainage, flushing or testing.
4. Label piping in accordance with Section 22 05 53, Identification for Plumbing Piping and Equipment.

B. Plastic:
1. Install plastic piping systems in strict accordance with pipe manufacturer's recommendations, including preparation of pipe and fittings for jointing, curing and installation.
2. Prior to fabricating system, demonstrate in the presence of the QAR Representative, the proposed field method of making joints.

C. Copper:
1. Cut copper piping with wheel cutter.
2. Debur cut ends and blow out chips with nitrogen, or CDA.

D. Clean Dry Air: Provide valved stubs with removable Swagelok or Parker equal caps as required to facilitate testing and special cleaning of systems where indicated on drawings.

E. LN2, IA, and CDA Piping: Nitrogen for copper and argon for stainless steel purge during welding and open ends to remain capped and under pressure when not being worked on, unless directed otherwise.

3.03 OIL FREE RECIPROCATING AIR COMPRESSOR

A. Install per manufacturer's recommendations.

B. Provide concrete inertia base with air spring vibration isolation and height saving brackets. Base a minimum of 7-feet-8-inches by 5-feet-2’inches by 14-inches thick with concrete fill to provide total base weight of minimum 7,000 pounds. Provide a minimum of four air springs.

C. Make water piping connections using 2-foot long neoprene flexible hose. Make each air piping connection using two braided flexible connectors, one on each arm of a 90 degree bend.

3.04 SPECIFIC INSTALLATION REQUIREMENTS FOR RESPIRATOR AIR (RA)

A. Supply piping is to be rigid and supported. Copper pipe painted respirator green from the plant compressed air source. Stainless steel tubing from the respirator air filter station to the Hansen Quick Disconnects, tubing striped or continuously wrapped with green vinyl tape for quality assurance. Trace to be solid green stripe. Piping from the CDA branch isolation valve to the air station must be sufficiently labeled as RESPIRATOR AIR.

B. Piping must be tested for in-line particulates by Owner approved Analytical Contractor before acceptance. Three consecutive laser counter readings at 0.20 micron must be recorded before approval of system.

C. Dynamation air monitor housed in a Hoffman type electrical box, to eliminate the radio frequency interference problem causing false alarms. Connections exterior of the box nonconductive, to maintain the radio frequency isolation.

D. The system must have a normal closed mechanical valve that is pneumatically held open in the system that will close immediately if there is loss of compressed air, or air purity is below standard. The relay to be latching, and requires manual reset.

E. Hansen fittings must be tandem mounted stemming from the same minimum 1/2 inch pipe. Exact location of the fitting will be determined and appropriately posted during fit-up.

F. Hansen fittings must be rigidly supported.

G. Piping from the air station to point of connection by user must be stainless steel or ACR type copper, cleaned for oxygen service and be sufficiently labeled as RESPIRATOR AIR.

H. Alarm lights must be mounted in each user area in such a location the alarm can be seen by the respirator user.

I. Once system has passed pressure and analytical testing, Purge system with CDA and check O2 counts before turning over to Owner.

3.05 RECEIVER, DRYER, FILTERS

A. Install per manufacturer's recommendations.

B. Provide the services of a factory trained mechanic to inspect, ready, and start and test equipment to assure that it is in proper working order. Instruct the Owner on the machine operation.

3.06 COPPER AND STAINLESS PIPE INSTALLATION (CDA, IA, RA, HRW)

A. Installation:
1. Materials and installation work conforms to applicable codes and regulations. Complete work in a competent manner using the latest techniques of the trade.
a. Copper Pipe:
1) Contractor is responsible to supply qualified brazers, equipment, and materials for scope of work. Refer to 22 05 00, Common Work Results for Plumbing for Brazing qualification requirements.
2) Brazing conforms to the following:
a) Braze using an oxygen-fuel flame.
b) Copper Lines: Braze joints with AWS – BcuP – 5 Classification; Silverflow – 15 or owner approved equal.
c) During brazing gas lines must be continuously purged with 0.1 micron absolute filtered nitrogen gas, which is allowed to escape into the atmosphere through a purge restrictor. Purge relief vent will be positioned above the plane of the pipe. Open ends will be closed and spool piece stored at ambient temperature until installed. Portable hand held oxygen monitors will be used on pipe sizes 2-1/2-inch and larger. Monitors are to read in parts per million (ppm) level, percentage monitors are not acceptable. Welding and brazing will be done at less than or equal to 50ppm oxygen concentrations. For sizes 2-inches and down, timed purging is acceptable.

Tube OD Diameter	Tube ID Flowrate	Purge Time
0.250	15 CFH	2 minutes
0.375	15 CFH	2-1/2 minutes
0.500	20 CFH	3 minutes
0.750	20 CFH	3-1/2 minutes
1.00	20 CFH	4 minutes
1.50	20 CFH	6 minutes
2.00	20CFH	8 minutes
*Based upon 20-foot linear footage		

Purge Restrictor Size	
Tube OD Diameter	Orifice Size
3/8-inch and smaller	1/8-inch
1/2-inch up to 1-1/12-inch	1/4-inch
2-inch	3/8-inch
4-inch to 6-inch	1/2-inch
8-inch and larger	3/4-inch

d) No brazed joint can be less than 12-inches away from the end of the purge line, which will require, in many instances, that an extension be used.
e) Verification of all purge lines at the end of each shift. If project only has one shift, reduce purge to a trickle purge for overnight purging or capped under pressure. Inspect each flow meter for proper flow and verify that source of nitrogen will be sufficient until next shift startup.
f) Maintain installation and purge procedures, for all pipe runs, until installation is complete and accepted by the Owner.

g) Replace joints which show evidence of overheating, cracking, poor penetration, or other defects of fit-up or workmanship, at the Contractor's expense.
h) If the system becomes contaminated due to fabrication techniques, prior to Owner's written acceptance, the installing contractor performs a total system re-clean or replacement. Expenses borne by the installing contractor, with no expense to the Owner.
i) No more than 60-feet of pipe should be assembled in line prior to brazing.
j) Cut pipes with ends squared and true to size. Only clean tubing cutters with sharp cutting wheels used. Do not use hacksaws or similar type cutting tools. Remove burrs.
k) When cool, wire brush fittings.

2. Thread Fitting / Connections: Only 100 percent pure PTFE Teflon® tape is acceptable for all Process Piping Systems.
3. Stainless Steel:
   a. Supply and qualify welders, equipment, and materials for scope of work. Qualifications of welding procedures, welders, and welding operators in accordance with the requirements of ASME, Section IX. Refer to Section 22 05 00, Common Work Results for Plumbing, for Welding qualification requirements.
   b. Welding conforms to the following:
      1) Stainless Steel:
         a) Tac-welding using the tungsten inert gas (TIG) arc welding process.
         b) Non- UHP Stainless steel tubing to be Orbital Welded.
         c) Alternate welding procedures may be submitted to the owner for review and approval.
      2) During welding, gas lines must be continuously purged with argon and allowed to escape into the atmosphere through a purge restrictor. Lines are under restricted purge or under pressure at all times during installation (purge relief will vent above the plane of pipe. Portable hand held oxygen monitors will be used on pipe sizes 2-1/2-inch and larger. Monitors are to read ppm level, percentage monitors are not acceptable. Welding and brazing will be done at less than or equal to 50 ppm oxygen concentrations. Time purging is acceptable on line sizes 2-inches and smaller. Refer to the above Copper Pipe Brazing requirements for time purging and CFH flows.
      3) No welded joint can be less than six inches away from the end of the purge line, which will require, in many instances, that an extension be used.
      4) Verification of all purge lines at the end of each shift. If project only has one shift, reduce purge to a trickle purge for overnight purging or capped under pressure. Inspect each flow meter for proper flow and verify that source of argon will be sufficient until next shift startup.
      5) Maintain installation and purging procedures for all pipe runs until installation is complete and accepted by Owner.
      6) If the system becomes contaminated due to fabrication techniques, prior to Owner's written acceptance, perform a total system re-clean or replacement. Expenses borne by the installing contractor, with no expense to the Owner.

B. Inspection:
   1. Material and workmanship subject to inspection and examination by the Owner.
      a. Copper:
         1) Upon request of the Owner, remove a random piece of installed work, sufficient to establish the quality of materials and workmanship.
         2) If the piece shows evidence of oxidation or contamination, the Owner may require testing of additional samples.
         3) If the additional samples are acceptable, the Owner will pay for the direct labor and materials required for the cutting out and restoration of these samples.
         4) If they are not acceptable, the cost paid for by the contractor.

b. Stainless Steel:
   1) Completed welds subject to inspection wherever practical.
   2) Welds will be inspected, visually by supervisory representatives of the Owner or Architect. Visual weld inspections in accordance with AWS QC 1. Welds falling below the AWS QC 1 standard and deemed unacceptable by the Owner or Representative from a visual inspection, repaired or cut out. At the request of the Owner or Representative; in the event any welder-operator consistently produces unsatisfactory productions welds, refrain from welding and re-qualified, per Section IX of the ASME Boiler and Pressure Vessel Code. Repair and removal of welds or the re-qualification of welder-operators done at the expense of the Mechanical Contractor and not the owner.
   3) Orbital Weld Rejection Criteria:
      a) No visible tacks on the ID or OD of the weld.
      b) No undercut or profile defect causing the wall thickness to fall below that of the parent metal.
      c) Concavity / Convexity exceeds 10 percent of the tube/pipe wall thickness.
      d) Penetration and bead width must be uniform throughout the entire weld, plus or minus 0.008-inch.
      e) Bead meander must not exceed 25 percent of the bead width.
      f) There should be no unusual inclusion or porosity when viewed with the unaided eye.
      g) Misalignment exceeds 10 percent of the wall thickness.
      h) Tube OD color should be at a minimum.
      i) Tube ID color (haloing in heat effected area) should be at a minimum, no color is preferable.
   4) Upon request of the Owner, remove a random piece of installed work, sufficient to establish the quality of materials and workmanship. If the piece shows evidence of weld rejection as stated above, the Owner may require testing of additional samples. If the additional samples are acceptable, the Owner will pay for the direct labor and materials required for the cutting out and restoration of these samples. If they are not acceptable, the cost paid by the contractor.

C. Specific Installation Requirements for Brazing Copper Pipe to Brass Flanges for CDA Piping (QAR Pre-approval Required).
   1. Acceptable fluxes; Stay-Silv, Stay-Brite, or Stay-Clean.
   2. Cut copper pipe square to ensure proper fit.
   3. Clean pipe and flange with emery cloth.
   4. Apply flux to pipe only.
   5. Slide pipe into flange socket, make sure insertion is complete.
   6. Braze pipe/flange assembly once the nitrogen purge and purge block is in place.
   7. Once cooled, perform the following cleaning process. Remove excess flux and thoroughly brush indent groove. Clean the inside of pipe with isopropyl alcohol. Repeat cleaning procedure until pipe interior is clean.
   8. A QC inspector will inspect the connection before the spool is installed. If the connection satisfies QAR acceptance criteria, the inspector will stamp the flange, which authorizes installation to proceed. If a flange not having a QC stamp on it is installed, the connection will be opened up and inspected at the expense of the contractor doing the work.

3.07 SYSTEMS PRESSURE TESTING

A. Test piping as noted below, with no leaks or loss in pressure. Repair or replace defective piping until tests are accomplished successfully. The use of oil pumped air or nitrogen is expressly forbidden. Nitrogen used for testing and purging operations must be from a cryogenic source. Failures on test will require restart and complete time testing after repair.

System	Test Pressure	Test Medium	Test Time
Process Vacuum	10 psig	Nitrogen	12 hours
CDA, IA, RA	150 psig	Nitrogen	24 hours
Hi-Res	150 psig	Water	4 hours
Note: Plastics may be pre-test with 5 psi nitrogen prior to final Hydro-Testing			

B. Repair copper or plastic leaks found be repaired in the following manner:
   1. Brazed joint – Remove/replace fitting and re-braze new joints.
   2. Plastic joint – Remove and install new fitting.

3.08 INSULATION

A. Refer to Section 22 07 00, Insulation for Plumbing for requirements.

3.09 PURITY AND PARTICLE ANALYSIS FOR DRY SIDE CDA, INSTRUMENT AIR AND UTILITY NITROGEN

A. General:
   1. Cycle a volume of gas through the line to maximum pressure (not less than 30 psi.) and then discharge the line through a particle counter.
   2. Maximum flow rate for the gas discharge is 3 cfm.
   3. Cycle line enough times to exchange the total gas volume five times.

B. Take particle measurements and establish a baseline of particle counts that is no more than 5 wpercent of the starting value. If the baseline particle counts do not reach a 5 percent point, then the gas line must be examined for sources of contamination and repaired.

C. Equipment:
   1. PMS Low Pressure Gas Probe with interface.
   2. Two 1/4 turn valves.
   3. One pressure gauge.
   4. One flow meter, 0-4 CFM.
   5. One notebook computer.
   6. One mass flow controller.
   7. Control and processing software.
   8. Misc. hardware.

D. Procedure:
   1. Connect particle counter to gas line.
   2. Charge gas line and adjust flow to 3 cfm using downstream valve.
   3. Close the upstream valve and charge line to max pressure.
   4. Enable the particle counter.
   5. Open the upstream valve and discharge the line until pressure is stable at minimum.
   6. Close the valve and recharge the line to maximum pressure.
   7. Note the particle count and gas volume.
   8. Cycle system five times (or five gas exchanges).
   9. Calculate particle counts (total particles/total gas volume).

E. Test Results:
   1. The required test results are based on particle counts measured at specific particle size classes for the different pipe use categories. Percent of line cleanup is measured for the five cycles.
   2. UN2, IA, and RA:
      a. 100 particles/ft^3 maximum at 0.2um size.
      b. 10 particles/ft^3 maximum at 0.5um size.

c. Final particle count less than 5 percent of the first cycle particle count.

3. Dry Side CDA: 10 particles/ft^3 maximum count at 0.2 um diameter.

END OF SECTION

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SECTION 22 21 13
PIPE AND PIPE FITTINGS PLUMBING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Cast Iron Soil Pipe, Service Weight (No-Hub)
2. Cast Iron Soil Pipe, Service Weight (Hub and Spigot)
3. Ductile Iron Water Pipe
4. Acid Resistant Waste Piping
5. Concrete Pipe
6. Black Steel Pipe, Schedule 40
7. Galvanized Steel Pipe
8. Steel Tubing
9. Copper Pipe
10. Copper, Stainless, and Black Steel Grooved Piping System
11. Copper Pipe, Clean Service
12. PVC Pipe (DWV)
13. ABS Pipe (DWV)
14. CPVC Pipe
15. PVC Pipe
16. Polypropylene Waste and Vent Pipe
17. Double Wall Fiberglass Pipe
18. Polyethylene Pipe
19. Press Fit Pipe and Pipe Fittings
20. PEX Potable Water Tubing
21. Flanged Joints
22. Unions
23. Mechanical Pipe Couplings and Fittings
24. Solder and Brazing
25. Utility Markers
26. Pipe Wrapping
27. Vacuum Cleaning System Tubing
28. Flexible Connector
29. ABS DWV Expansion Joint

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

C. Section 22 05 29, Hangers, Supports, and Anchors for Plumbing

D. Section 22 25 00, Plumbing Water Treatment

E. Section 22 05 23, General Duty Valves for Plumbing

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Piping material and installation to meet requirements of the local plumbing, fire, and building codes and serving utility requirements.
2. Provide chlorination of domestic cold and hot water piping in accordance with County and State health requirements.

B. Grooved Joint Couplings and Fittings:
1. Products of a single manufacturer.
2. Grooving tools of the same manufacturer as the grooved components.

3. Castings used for coupling housings, fittings, valve bodies, etc., date stamped for quality assurance and traceability.

C. Pipe Cleaning: If pipe gets plugged or should foaming of water systems occur, disconnect piping, reclean, and reconnect without additional expense to the Owner.

D. Correct damages to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

E. Products with a wetted surface installed in potable water systems UL classified in accordance with ANSI / NSF-61 for Drinking Water System components, ANSI/NSF-14 for Plastic Piping System Components and certified to the low lead requirements of NSF-372.

1.04 SUBMITTALS

A. Submit the following:
1. List of piping materials indicating the service it is being used for. (Do not submit piping product data).
2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.

B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.

C. Other: Make certified welders' certificates available.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As indicated.

2.02 CAST IRON SOIL PIPE, SERVICE WEIGHT (NO-HUB)

A. General: A code approved hubless system conforming to Cast Iron Soil Pipe Institute Standard 301.

B. Pipe and Fittings:
1. Service weight hubless cast iron conforming to ASTM A 888, marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International.
2. Manufacturers:
a. Tyler
b. AB&I
c. Charlotte

C. Gaskets: Compression type conforming to ASTM C 564.

D. Above Grade Couplings: Band type coupling in conformance with Cast Iron Soil Pipe Institute (CISPI) 310-90, consisting of stainless steel clamp, and corrugated shield assemblies with a neoprene sealing sleeve ANSI A21.6, ANSI A21.10 Fittings.
1. Above Grade – Critical Areas:
a. Stainless steel shield.
b. Neoprene gasket, one piece.
c. Stainless steel screws.
d. Approvals: FM 1680 class I Certified.
e. Based on: Clamp-All HI-TORQ 125.
2. Buried: Husky 28 gauge 304 stainless steel hubless type clamp and orange corrugated shield assemblies (80-inch pound torque) with neoprene sealing gaskets (ASTM-C-564), or Clamp-All (125-inch pound torque), 24 gauge 304 stainless steel hubless type clamp, and shield assemblies with neoprene sealing gaskets (ASTM-C-564).
3. Service:
a. Sanitary, storm, and overflow drain.
b. Vent piping 2 inches and above.

2.03 CAST IRON SOIL PIPE, SERVICE WEIGHT (HUB AND SPIGOT)

A. General: Code approved hub and spigot pipe and fitting system conforming to ASTM A74 marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and listed by NSF International.

B. Gaskets: Compression type gaskets conforming to ASTM C564.

C. Service: Below Grade: Sanitary waste, storm, and overflow drain.

2.04 DUCTILE IRON WATER PIPE

A. Pipe: Ductile iron pipe conforming to ANSI A21.51.

B. Fittings:
   1. Below Grade: Class 150 Boltite mechanical joint type complete with gaskets, bolts, and nuts, or Tyton for joints employing a single gasket for the joint seal with bell-and-spigot pipe.
   2. Above Grade:
      a. Mechanical couplings and fittings as specified herein.
      b. Provide interior pipe coating per ANSI Regulation listed.

C. Service:
   1. Below grade, incoming domestic water main, 4 inches and over.
   2. Above grade, domestic water piping, 6 inches and over.

2.05 ACID RESISTANT WASTE PIPING

A. Pipe: High silicon iron content cast piping, mechanical joint type, extra heavy weight, conforming to ASTM A518.

B. Joints:
   1. Acid resistant mechanical joint meeting the corrosion resistance of the piping including an inner sleeve of non-porous Teflon (PTFE) and outer sleeve of neoprene.
   2. Corrosive solutions come in contact with PTFE sleeve and piping only.

C. Service: Acid waste and vent.

2.06 CONCRETE PIPE

A. Pipe and Fittings:
   1. Non-reinforced concrete sewer pipe conforming to ASTM C 14, Class 2 for 10-inch and under.
   2. Reinforced concrete sewer pipe conforming to ASTM C 76, Class I, Wall B for 12 inches and over.

B. Gaskets: Rubber ring type conforming to C 443.

C. Service:
   1. Sanitary waste beyond 2 feet of building wall.
   2. Storm and overflow drain beyond 2 feet of building wall.

2.07 BLACK STEEL PIPE, SCHEDULE 40

A. General:
   1. Fittings and joints must be UL listed for use with pipe chosen for use.
   2. Listing restrictions and installation procedures per state and local authorities must be followed.

B. Pipe: Schedule 40 conforming to ASTM A 135 or A 53.

C. Fittings:
   1. 150 pound screwed malleable iron on 2 inches and below, Schedule 40 welding fittings conforming to ASTM A 234 for 2-1/2 inches and above or mechanical couplings on select piping as herein specified.
   2. Welded below grade fittings.
   3. Long radius type elbows on pumped systems.

4. Short radius elbows not acceptable for use except as approved on a case by case basis.

D. Service:
1. Compressed air piping, except medical compressed air.
2. Natural gas piping and vent lines.
3. Fuel oil piping, above grade. Socket welded piping in concealed walls.
4. Fuel oil vent, fill, and gauge.

2.08 GALVANIZED STEEL PIPE

A. Pipe: Schedule 40 conforming to ASTM A 135 or A 53.

B. Fittings:
1. 150 pound screwed galvanized malleable iron on 2-inch and below, Victaulic, Gruvlok, Gustin-Bacon, or Mech Line full flow galvanized, grooved end on 2-1/2-inch and above.
2. Provide grooved type gasketed couplings and fittings for pipe 2-1/2-inch and above.

C. Service:
1. Miscellaneous indirect waste piping.
2. Waste and vent piping 1-1/2 inches and under, above grade.
3. Pumped waste (above grade only).

2.09 STEEL TUBING

A. Low Pressure Tubing:
1. Annealed seamless steel tube, minimum 0.035-inch wall thickness.
2. Minimum Size: 5/8-inch OD

B. High Pressure Tubing:
1. Annealed seamless steel tube, minimum 0.083-inch wall thickness.
2. Minimum Size: 5/8-inch OD

C. Service:
1. Low Pressure Tubing: Motor oil piping, hydraulic oil, transmission fluid, and antifreeze.
2. High Pressure Tubing: Grease piping.

2.010 COPPER PIPE

A. Pipe: Hard drawn copper tubing, Class L or K, ASTM B 88.

B. Fittings:
1. Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal.
2. System using mechanically extracted collars in main with branch line inserted to not obstruct flow may be used on domestic water piping above ground, similar to T-drill.

C. Service:
1. Domestic hot and cold water piping below ground (Type K, hard drawn) on piping 3 inches and smaller.
2. Domestic hot and cold water piping above ground (Type L, hard drawn) on piping 4 inches and smaller.
3. Trap priming lines (Type L, annealed).
4. Industrial cold water above grade (Type L) on piping 4-inch and smaller.
5. Pumped waste (DWV).
6. Reclaimed water.
7. Solar hot water.
8. Miscellaneous drains and overflows.

2.011 COPPER, STAINLESS, AND BLACK STEEL GROOVED PIPING SYSTEM

A. Manufacturers:
1. Victaulic
2. Gruvlok

B. Pipe:
   1. Copper tube, ASTM B-88 Type L roll grooved in accordance to Victaulic current listed standards.
   2. No flaring of grooved copper allowed.

C. Mechanical Couplings:
   1. Victaulic Style 607H Installation-Ready (copper) or Style 107H Installation-Ready (steel) or Series 89 (galvanized ductile iron for stainless steel pipe) angle bolt pad rigid couplings for copper, black steel or stainless steel consisting of a ductile iron cast housing, a synthetic rubber gasket of a central cavity pressure-response design with ASTM A449 plated nuts and bolts to secure the unit together.
   2. Coupling Housings: Cast ductile iron conforming to ASTM A-536.

D. Gaskets:
   1. Molded synthetic rubber of elastomers having properties as designated in ASTM D-2000.
   2. UL classified in accordance with ANSI-NSF-61 for potable water service.

E. Flange Adapters: Victaulic Style 641 (copper) , Series 741 (black steel), or Series 741 (DI) and 441 (SS) for Stainless Steel, ductile iron ASTM A-536, engaging directly into roll grooved copper or stainless steel tube and fittings and directly to ANSI Class 125 cast iron and Class 150 steel flanged components.

F. Fittings:
   1. Victaulic full flow copper or stainless steel fittings with grooves designed to accept Victaulic grooved end couplings.
   2. Copper per ANSI B16.22 wrought copper and ASTM B-75 alloy C12200 or Bronze sand casting per ANSI B16.18 and ASTM B 584-87 copper alloy CDA 844.
   3. Stainless Steel Schedule 10 fittings ASTM A403 or factory-fabricated from segmentally welded 316SS.
   4. Victaulic Style 47 dielectric waterway when connecting dissimilar metals.

G. Service: Domestic cold water piping above ground (Type L, hard drawn copper or schedule 10 stainless steel) on piping 2 inches through 4 inches.

2.012 COPPER PIPE, CLEAN SERVICE

A. Pipe: Hard drawn copper tubing, Class L or K, ASTM B-819, prewashed, degreased, and capped at both ends for oxygen service.

B. Fittings:
   1. Wrought copper brazed joint fittings, ANSI B16.50, 150 psi; Chase, Revere, Mueller, or approved equal.
   2. Clean service copper pipe cleaned and suitable for oxygen service and sealed in polyethylene bags.

C. Service:
   1. Oxygen, nitrous oxide, medical air, lab air, and nitrogen, carbon dioxide piping, Type K.
   2. Medical and lab vacuum piping, Type L.

2.013 PVC PIPE (DWV)

A. Pipe: PVC, wall thickness equal to Schedule 40 standard steel pipe, conforming to ASTM D2665-85a.

B. Fittings: PVC building drain, waste, and vent fittings conforming to ASTM D2665-85 and ASTM D3311-82.

C. Solvent Cement: PVC pipe conforming to ASTM D2564-80.

D. Service: Sanitary waste and vent, except not allowed in return air plenums.

2.014 ABS PIPE (DWV)

A. Pipe: ABS, wall thickness equal to schedule 40 standard steel pipe, conforming to ASTM D2661-85a.

B. Fittings: ABS waste and vent fittings conforming to ASTM D2661-85a and ASTM D3311-82.

C. Solvent Cement: ABS pipe conforming to the requirement of ASTM D2235-81.

D. Service: Sanitary waste and vent, storm and overflow, except not allowed in return air plenums.

2.015 CPVC PIPE

A. Pipe:
   1. CPVC pipe compound meets cell class 24448 as defined by ASTM D1784 and meets or exceeds requirements of ASTM F-441.
   2. Certified NSF International for use with potable water.

B. Fittings:
   1. CPVC fitting compound meets cell class 23447 as defined by ASTM D1784.
   2. Meet or exceed the requirements of ASTM F-441.

C. Solvent Cement:
   1. CPVC pipe conforming to the requirements of ASTM F493.
   2. Certified by NSF International for use with potable water.

D. Service: Domestic cold, hot, and re-circulating hot water systems above grade, except not allowed in return air plenums.

2.016 PVC PIPE

A. Pipe: Schedule 80 PVC, normal impact, Type 1, ASTM D 1785.

B. Fittings: Schedule 80 PVC, deep socket, solvent welded, ASTM D2467.

C. Service:
   1. Process grey water not concealed in walls.
   2. Deionized water.
   3. Except not allowed in return air plenums.

2.017 POLYPROPYLENE WASTE AND VENT PIPE

A. Pipe:
   1. Schedule 40 flame retardant polypropylene conforming to ASTM D635, Enfield Industrial Enfusion, R&G Sloan Fuseal II, or Orion Proxylene.
   2. DWV pattern fittings.

B. Fittings:
   1. Flame retardant polypropylene fusion sealed slip socket type.
   2. Method of fusion utilizing an electrical fusion coil, compression clamp and a power unit.

C. Service: Lab waste and vent.

2.018 DOUBLE WALL FIBERGLASS PIPE

A. Pipe: Fiberglass reinforced epoxy, U.L. listed secondary containment piping system, A.O. Smith Red Thread II, or approved equal.

B. Fittings: Two piece secondary containment fittings per manufacturers standard product line.

C. Service: Underground fuel oil supply and return piping.

2.019 POLYETHYLENE PIPE

A. Pipe: Polyethylene pipe and tube PE 3406 conforming to ASTM D2513-80a.

B. Fittings:
   1. Provide copper alloy, PE 3306, PE 3406, stainless steel or other listed materials.
   2. Mechanical connectors for PE pipe and tubing and for transition fittings approved compression type couplings or other special listed joints.

C. Storage:
   1. Do not store unprotected pipe in direct sunlight.
   2. Store in a way to protect it from mechanical damage.

D. Service: Buried natural gas piping.

2.020 PRESS FIT PIPE AND PIPE FITTINGS

A. Manufacturers:
   1. Victaulic Vic-Press
   2. Viega ProPress
   3. Other Manufacturers: Submit substitution request.

B. Pipe:
   1. 1/2-inch to 2-inches nominal diameter.
      a. Black Steel:
         1) Conforming to ASTM A53 or A135.
      b. Type 304 Stainless Steel:
         1) Conforming to ASTM A-269; Schedule 10S.
      c. Type 316 Stainless Steel: ‘
         1) Conforming to ASTM A-312; Schedule 10S.
      d. Type L Copper:
         1) Conforming to ASTM B-88.

C. Couplings and Fittings:
   1. Produced from the same material as pipe by same manufacturer of pipe.
   2. Couplings precision cold drawn with self-contained factory installed O-ring HNBR sealing element.
   3. Fittings used with pipe fabricated from same material as pipe. Elbows on pumped systems to be long radius type.

D. Service:
   1. Compressed air mains (Schedule 40 steel) or (Schedule 10S stainless steel), except medical compressed air and oil free air.
   2. Pumped sewage.
   3. Domestic hot and cold water piping above ground (Type L copper, hard drawn) or (Schedule 10S stainless steel) on piping 2-inches and smaller.
   4. Trap priming lines (Type L copper, annealed).
   5. Industrial cold water above grade (Type L copper) or (Schedule 10S stainless steel) on piping 2-inches and smaller.

2.021 PEX POTABLE WATER TUBING

A. Manufacturers:
   1. Uponor (aka Wirsbo)
   2. Other Manufacturers: Submit substitution request.

B. Regulatory Listings: Submit appropriate NSF International, UL, Warnock Hesey, or CSA listings as proof of compliance with local building and plumbing codes.

C. PEX tubing and components installed in full compliance with local jurisdictional codes, standards, and requirements.

D. Submit listings that indicated that the PEX tubing system has been certified to ANSI/NSF Standards 14 and 61.

E. Quality Assurance:
   1. Installer Qualifications: Installer experienced in performing work of this Section who has specialized in installation of work similar to that required for this project.
   2. Provide in writing to the Owner that the PEX tubing and components furnished under this Section conforms to the material and mechanical requirements specified herein.

3. Provide letters of certification indicating: Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed trades person.

F. Materials:
1. Tube Materials:
   a. Cross-linked polyethylene (PEX) manufactured by PEX-A or Engle method.
   b. Provide blue colored PEX for cold water systems and red colored PEX for hot water systems for pipe size 1/2-inch thru 1 inch.
2. Tubing Type:
   a. PEX tubing manufactured in accordance with ASTM F876, ASTM F877 and CAN/CDA-B137.5.
   b. Listed to ASTM by an independent third party agency.
      1) PEX tubing to have Standard Grade hydrostatic design and pressure ratings of 200 degrees F at 80 psi and 180 degrees F at 100 psi. Temperature and pressure ratings issued by the Plastic Pipe Institute (PPI) report TR-4/06.
      2) Minimum bend radius for cold bending of the PEX tubing not less than 6 times the outside diameter. Bends with the radius less than stated requires the use of a bend support as supplied by tube manufacturer.
3. PEX-a Fittings: elbows, adapters, couplings, plugs, tees and multi-port tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fitting manufactured from the following material types:
   a. UNS No. C69300 Lead-free (LF) Brass.
   b. 20 percent glass-filled polysulfone as specified in ASTM D 6394.
   c. Unreinforced polysulfone (Group 01, Class 1, Grade 2) as specified in ASTM D 6394.
   d. Polyphenylsulfone (group 03, class 1, grade 2) as specified in ASTM D 6394.
   e. Blend of polyphenylsulfone (55-80%) and unreinforced polysulfone (rem.) as specified in ASTM D 6394.
   f. Reinforcing cold-expansion rings manufactured from the same source as PEX-a piping manufacturer and marked F1960.
4. Multi-Port Tees: Multiple-outlet fitting complying with ASTM F 877; with ASTM F 1960 inlets and outlets.
   a. Engineered polymer branch multi-port tee.
   b. Engineered polymer flow-through multi-port tee.
   c. Engineered polymer commercial branch multi-port tee.
   d. Engineered polymer commercial branch multi-port elbow.
   e. Engineered polymer commercial flow-through multi-port tee.
5. Manifolds: Multiple-outlet assembly complying with ASTM F 877; with ASTM F 1960 outlets.
   a. Engineered polymer valved manifold.
   b. Engineered polymer valve less manifold.
   c. Lead - free copper branch manifold.
   d. Lead-free copper valved manifold.
6. PEX-to-Metal Transition Fittings:
   a. Manufacturers: Provide fittings from the same manufacturer of the piping.
   b. Threaded Brass to PEX-a Transition: one-piece brass fitting with male or female threaded adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
   c. Brass Sweat to PEX-a Transition: one-piece brass fitting with sweat adapter and ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
   d. PEX-a to Flange Transition: two-piece brass fitting with lead-free ProPEX adapter and steel flange conforming to ASME B 16.5.
   e. PEX-to-Thermoplastic Transition Fittings: CPVC to PEX-a Transition: Thermoplastic fitting with one spigot or socket end and one ASTM F 1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.

G. Accessories:
   1. Wall Penetration Brackets: Brackets designed for wall membrane penetrations supplied by PEX tubing manufacturer; Uponor Drop Ear Bend Support.
   2. Concrete Tube Support Brackets: Brackets to hold PEX tubing in place in structural concrete slabs rigid PVC construction and be designed for that purpose.
   3. Uponor Stand-Up bracket.

H. Service:
   1. Domestic hot and cold-water piping above grade on piping 3 inches and smaller.
   2. Industrial cold water above grade on piping 3 inches and smaller.
   3. Reclaimed cold water above grade on piping 3 inches and smaller.
   4. Trap priming lines below grade.

2.022 FLANGED JOINTS

A. Cast iron or steel for screwed piping and forged steel welding neck for welded line sizes.

B. Pressure rating and drilling to match apparatus, valve, or fitting to which they are attached.

C. ANSI B16.1; 150 pounds for system pressures to 150 psig; 300 pounds for system pressures 150 psig to 400 psig.

D. Gaskets
   1. Flanged services, except steam and pumped condensate, Garlock 3700 or equal, 1/8-inch thick, non-metallic type.
   2. Steam and pumped condensate Flexitaulic Style CG or equal, 1/8-inch thick, semi-metallic type.

E. Make joint using American Standard hexagon head bolts, lock washers, and nuts (per ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer, and American Standard hexagon head nuts (per ASTM A307 GR.B) for service pressures 150 psig to 400 psig.

F. Use length of bolt required for full nut engagement.

G. Provide electro-cad plated bolts and nuts on cold and chilled water lines.

2.023 UNIONS

A. 150 psi malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing.
   1. Unions or flanges for servicing or disconnect are not required in installations using grooved mechanical joint couplings. Couplings serve as disconnect points.

B. Dielectric fittings nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F1545. Fittings suitable for the pressure and temperature to be encountered.

2.024 MECHANICAL PIPE COUPLINGS AND FITTINGS

A. Manufacturers:
   1. Victaulic
   2. Anvil Gruvlok 7401, 7001
   3. Other Manufacturers: Submit substitution request.

B. Coupling: Ductile iron conforming to ASTM A 536, Grade 65-45-12, rust inhibiting paint.

C. Fittings:
   1. Ductile iron conforming to ASTM A 536, Grade 65-45-12.
   2. Elbows long radius type.

D. Bolts and Nuts: Zinc electroplated track head bolts conforming to ASTM A 183.

E. Gasket:
   1. Grade E EPDM.
   2. Temperature Range: -30 degrees F to 230 degrees F

F. Service: Compressed air mains.

2.025 SOLDER AND BRAZING

A. Brazed Joints:
   1. Wrought Copper Piping Fittings: Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
   2. Applied locations:
      a. Below grade piping.
      b. Above grade piping larger than 2-inches for the following services: Industrial cold water, domestic hot and cold water, and pumped waste.
      c. Oxygen, nitrous oxide, carbon dioxide, medical vacuum, lab vacuum and lab air. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
      d. Joints in Domestic Hot and Cold Water Piping: Use mechanically extracted collars. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.
      e. Solar hot water.

B. Soldered Joints:
   1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
   2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
   3. Applied locations: Above grade piping 2-inch and smaller for the following services: Industrial cold water, domestic hot and cold water, pumped waste, trap priming lines.

2.026 UTILITY MARKERS

A. Provide plastic tape utility markers over buried piping. Provide identification on tape.

B. Material to be Brady Identoline plastic tape, 6-inch, Seton, or as approved.

2.027 PIPE WRAPPING

A. For below ground steel piping and fittings, provide complete covering of Scotchrap 51, 20 mil thickness, protective tape applied over Scotchrap pipe primer applied at 1 gal/800 SF of pipe surface.

B. Approved, pipe may be furnished with factory applied jacket of X-tru-coat with Scotchrap as previously specified for field joints.

2.028 VACUUM CLEANING SYSTEM TUBING

A. Pipe and Fittings:
   1. 16 gauge galvanized steel tubing.
   2. Fittings specifically designed for vacuum cleaning service with long sweep elbows and branches and expanded socket type ends (similar to U.S. Turbine or approved equal).

B. Service: Cleanup vacuum piping from vacuum unit to outlet nozzles.

2.029 FLEXIBLE CONNECTOR

A. Expansion Joint/Seismic Connector:
   1. T304 stainless steel hose and braid, Schedule 40 radius elbows and 180° bend, flange or weld end Schedule 40 fittings. ASA certified when used for natural gas service. Metraflex Metaloop only.
   2. Accept differential support displacement without damaging pipe, equipment connections, or support connections.
   3. In steel piping systems, three Victaulic flexible couplings may be used in lieu of a flexible connector for vibration attenuation and stress relief at equipment connections. Place couplings in close proximity to the vibration source.

B. Service:
   1. Compressed air piping.
   2. Natural gas piping and vent lines.
   3. Miscellaneous drains and overflows.

4. Domestic hot and cold water piping.
5. Industrial cold water piping.
6. Fuel oil piping.
7. Fuel oil vent, fill and gauge.

2.030 ABS DWV EXPANSION JOINT

A. Expansion Joint:
   1. DWV expansion/compression joint made from ABS. Certified by NSF International. UPC approved. Canplas.
   2. See ABS Pipe (DWV) piping specifications for required pressure and temperature rating.

B. Service: Sanitary waste and vent, storm and overflow piping above grade.

PART 3 EXECUTION

3.01 PREPARATION

A. Measurements, Lines and Levels:
   1. Check dimension at the building site and establish lines and levels for work specified in this Section.
   2. Establish inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
   3. Use established grid and area lines for locating trenches in relation to building and boundaries.

3.02 EXCAVATION AND BACKFILL

A. General:
   1. Perform necessary excavation and backfill required for the installation of mechanical work in accord with Division 02, Existing Conditions
   2. Repair pipelines or other work damaged during excavation and backfilling.

B. Excavation:
   1. Excavate trenches to the necessary depth and width, removing rocks, roots, and stumps.
   2. Include additional excavation to facilitate utility crossovers, additional offsets, etc.
   3. Excavation material is unclassified. Width of trench adequate for proper installation of piping.
   4. Widen trench if not wide enough for a proper installation.

C. Bedding:
   1. Cast iron, steel, and copper piping full bedded on sand.
   2. Place a minimum 4-inch deep layer on the leveled trench bottom for this purpose.
   3. Remove the sand to the necessary depth for piping bells and couplings to maintain contact of the pipe on the sand for its entire length.
   4. Lay other piping on a smooth level trench bottom so that contact is made for its entire length.

D. Backfill:
   1. Place in layers not exceeding 8 inches deep, and compact to 95 percent of standard proctor maximum density at optimum moisture content.
   2. Earth backfill free of rocks over 2 inches in diameter and foreign matter.
   3. Disposal of excess material as directed.
      a. Interior: Backfill under interior slabs bank sand or pea gravel.
      b. Exterior:
         1) Excavated material may be used outside of buildings at the Contractor’s option.
         2) First 4-inches sand, and final 12-inch layer course soil.

3.03 PIPING INSTALLATION

A. Install unions in non-flanged piping connections to apparatus and adjacent to screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.

B. Mechanical Pipe Couplings and Fittings:
   1. Grooved joint couplings, fittings, valves, and specialties the products of a single manufacturer. Grooving tools of the same manufacturer as the grooved components.
   2. Flexible couplings to be used only when expansion, contraction, deflection or noise and vibration is to be dampened, as detailed or specified.
   3. On systems using galvanized pipe and fittings, fittings galvanized at factory.
   4. Before assembly of couplings, lightly coat pipe ends and outside of gaskets with approved lubricant.
   5. Pipe grooving in accordance with manufacturer's specifications contained in latest published literature.
   6. Mold and produce gaskets by coupling manufacturer, and suitable for the intended service.
   7. The coupling manufacturer's factory trained representative provided on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products. Periodically visit the project site to ensure best practices in grooved installation are being followed. A distributor's representative is not considered qualified to conduct the training or field visits.

C. Press Fit Systems:
   1. Pipe square cut, deburred, cleaned, and properly marked to ensure non-leak O-ring seal in accordance with manufacturers specifications contained in latest published literature.
   2. Before assembly, check pipe ends and fittings for insertion mark. Lightly coat O-rings with approved lubricant.
   3. Assemble pipe couplings and fittings using only by approved Pressfit PFT-510 tool equipped with the proper size PressJaw in accordance with manufacturer. Fittings that connect with-out the use of a press tool are not acceptable.
   4. Stainless steel products should be handled only by non-contaminating apparatus.

D. Install piping as to vent and drain. Install according to manufacturer's recommendations.

E. Support piping independently at apparatus so that its weight not carried by the equipment.

F. Run piping clear of tube cleaning or removal/replacement access area on heat exchangers, water heaters, etc.

G. Utility Marking:
   1. Installed over the entire length of the underground piping utilities.
   2. Install plastic tape along both sides and the center line of the trenches at the elevation of approximately 12-inches above the top of utility.

H. Underground Water System:
   1. Prior to testing pipe provide concrete thrust blocks at changes in direction.
   2. Block size as required for types of fittings involved.

I. Dielectric Fittings:
   1. Provide dielectric couplings, unions, or flanges between dissimilar metals.
   2. Provide dielectric couplings as required to isolate cathodically protected piping and equipment.

J. No-Hub Couplings: Install per manufacturer's instructions.

K. Copper Grooved Piping System: Install in strict accordance with latest manufacturer's published literature.

L. PEX System:
   1. Installation complies with manufacturer's product data, including product technical bulletins, installation instructions, and product carton instructions for installation.

2. PEX tubing passing through metal studs provided with grommets or sleeves at the penetration.
3. Protect PEX tubing with sleeves where abrasion may occur.
4. Use strike protectors where PEX tubing has the potential for being struck with a screw or nail.

3.04 PIPING JOINTS

A. Pipe and fittings joined using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes. Cleaning, cutting, reaming, grooving, etc. done with proper tools and equipment. Hacksaw pipe cutting prohibited. Peening of welds to stop leaks not permitted.

B. Purge oxygen, nitrous oxide, nitrogen, medical air, lab vacuum, lab air, nitrogen, and carbon dioxide piping with nitrogen continuously during the piping installation, and seal each branch outlet with Visqueen and tape or similar method to assure continued cleanliness of interior of piping until system is completed.

C. Copper Piping:
   1. Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished.
   2. Joints uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.

D. No couplings installed in floor or wall sleeves.

E. Steel Piping:
   1. Screwed Joints:
      a. Pipes cut evenly with pipe cutter reamed to full inside diameter with burrs and cuttings removed.
      b. Joints made up with Teflon liquid dope or Teflon tape applied to male threads only, leaving two threads bare.
      c. Joints tightened so that not more than two threads are left showing.
      d. Junctions between galvanized steel waste pipe and bell of cast iron pipe made with tapped spigot or half coupling on steel pipe to form spigot end and caulked.
   2. Flanged Joints:
      a. Pressure rating of flanges match valve or fitting joined.
      b. Joint gaskets coated with graphite and oil.

F. Welded Joints:
   1. Preparation for Welding: Bevel piping on both ends before welding:
      a. Use following weld spacing on buttwelds:

Nominal Pipe Wall Thickness	Spacing	Bevel
1/4-inch or less	1/8-inch	37-1/2
Over 1/4-inch, less than 3/4-inch	3/16-inch	27-1/2

      b. Before welding, remove corrosion products and foreign material from surfaces.
   2. Welded Joints:
      a. Use arc-welding process using certified welders.
      b. Port openings of fittings must match the inside diameter of the pipe to which they are welded.
      c. Use full radius welding elbows for turns, use welding tees for tees.
      d. Reducing fittings must be used for size reduction.
      e. Weldolets may be used for branches up through one-half the pipe size of the main to which they are attached.
      f. Nipples are not allowed.
   3. Welding Operation:
      a. After deposition, clean each layer of weld metal to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer.

b. Weld reinforcement no less than 1/16-inch not more than 1/8-inch above normal surface of jointed sections. Reinforcement crowned at center and taper on each side to surfaces being joined. Exposed surface of weld present professional appearance and be free of depressions below surface of jointed members.
c. Do not weld when temperature of base metal is lower than 0 degrees F. Material to be welded during freezing temperatures made warm and dry before welding is started. Metal warm to the hand or approximately 60 degrees F.

G. Flexible Connector: Provide where indicated on the Drawings.

H. Ductile Iron Pipe: Install per manufacturer's instructions.

I. Concrete Pipe: Install per manufacturer's instructions.

J. PVC Piping:
1. Socket weld joints with solvent cement and application method recommended by manufacturer.
2. Use power saw and miter box to cut PVC pipe, except DI piping must be cut with a wheel cutter specifically made for plastics.
3. Allow proper curing time based on temperature range during cure period before pressure testing.

K. ABS Piping:
1. Socket weld joints with solvent cement and application method recommended by manufacturer, use power saw and miter box to cut ABS pipe.
2. Allow proper curing time based on temperature range during cure period before pressure testing.

L. CPVC Piping:
1. Socket weld joints with solvent cement and application method recommended by manufacturer, use power saw and miter box to cut CPVC pipe.
2. Allow proper curing time based on temperature range.

M. Double Wall Fiberglass Pipe:
1. Install per manufacturer's instructions.
2. Seal containment system after fuel lines have been tested.
3. Refer to Section 22 05 90, Pressure Testing for Plumbing Systems for testing requirements.

N. Lab Waste and Vent Pipe: Follow manufacturer's recommendations and instructions for producing joint fusion.

O. Above Grade No-Hub Couplings: Install in accordance with manufacturer recommendations.

P. Above Grade No-Hub Couplings – Critical Areas:
1. Install in accordance with manufacturer recommendations.
2. Existing Piping: Remove existing couplings and replace with new.

3.05 ABS DWV EXPANSION JOINT

A. ABS DWV Expansion Joint:
1. Install per manufacturer's installation instructions.
2. Determine quantities and locations required.

3.06 INSTALLATION, PIPE WRAP

A. Apply per manufacturer's written instructions.

B. Apply wrapping to fittings in field after installation.

3.07 ADJUSTING AND CLEANING

A. General:
1. Clean interior of piping before installation.
2. Flush sediment out of piping systems after installation before connecting plumbing fixtures to the piping.

3. When placing the water systems in service during construction, each system cleaned in accordance with Section 22 25 00, Plumbing Water Treatment prior to being placed in service.
4. Clean strainers prior to placing in service.

3.08 INSTALLATION, NATURAL GAS PIPING

A. Install piping where shown on Drawings.

B. Black Steel Pipe:
1. Arc-weld joints by certified welders as outlined above.
2. On piping below grade install protective pipe wrap after testing and prior to backfilling in accordance with the manufacturer's recommendations. Overlap one-half spiral lap for double thickness.
3. Piping installed under building floor slabs in vented sleeve per code.

C. Polyethylene Pipe:
1. Thermal Expansion:
a. Snaking:
1) Pipe and tubing to be snaked in the trench bottom with enough slack to provide for thermal expansion and contraction before stabilizing.
2) Normal slack created by residual coiling is generally sufficient for this purpose.
b. If pipe has been allowed to straighten before it is placed in the trench, 6 inches per 100-feet of pipe length allowed for this purpose.
c. Stabilizing:
1) Pipe and tubing temperature to be stabilized by backfilling and leaving joints exposed so they can be examined during the pressure test.
2) Allow to stand overnight.
2. Joints:
a. Heat Fused Joints: Heat fused joints to be made as recommended by the manufacturer.
b. Mechanical Joints:
1) Make in an approved manner with tools recommended by the joint manufacturer.
2) Make with listed compression type couplings, or other listed special fittings.
c. Joints to Other Materials:
1) Listed plastic to steel transition fittings to be installed on each end of the plastic piping system.
2) Transition fittings to be installed outside of building walls with metallic piping extending into the building a sufficient distance to permit the use of backup wrenches.
d. Threaded joints or joints made with adhesives or solvent are prohibited.
3. Pipe temperatures to be stabilized before testing.
4. Install pipe and tubing only outside the foundation of building or structure or parts thereof.
5. Provide 18 gauge bare copper tracer wire over entire length of pipe.
6. Installation acceptable to the serving gas supplier.

3.09 MEDICAL GAS PIPE CLEANING

A. Provide system installation in accordance with latest NFPA 99 edition, per Section 5.1.10, level 1 distribution.

END OF SECTION

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SECTION 22 30 00
PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Water Heaters
   2. Backflow Preventers
   3. Utility Vaults
   4. Oil/Water Separators
   5. Catch Basin
   6. Heat Trace Cable
   7. Domestic Water Expansion Tank
   8. Acid Neutralization Systems
   9. pH Monitoring System
   10. Fuel Oil Fill Stations

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

C. Section 22 40 00, Plumbing Fixtures

D. Section 23 51 00, Breechings, Chimneys and Stacks

1.03 QUALITY ASSURANCE

A. Regulatory Requirements: Water heaters to meet state energy code requirements.

1.04 SUBMITTALS

A. Submit the following:
   1. Product data for each item specified.
   2. Operating and Maintenance Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Water Heaters:
   1. Electric Water Heater:
      a. State Industries, Rudd
      b. Rheem
      c. A.O. Smith
      d. Bradford-White
      e. Other Manufacturers: Submit substitution request.

2.02 WATER HEATERS

A. Electric Water Heater:
   1. Construct heater of heavy gauge steel, fluorocarbon polymer, epoxy, or glass lined, 150 psi working pressure (ASME rated for 125 gallon size and above).
   2. Equip heater with sacrificial magnesium anode unless fluorocarbon polymer lined.
   3. Heating elements of the inconel sheath rod type.
   4. One external adjusting thermostat for each element.
   5. Immersion thermostats to switch magnetic contactors through a staged sequence control (60 KW and larger).
   6. Insulate tank with foam insulation to comply with ASHRAE 90 standards and local codes, with a baked enamel steel jacket.
   7. Manual reset high limit thermostat, ASME rated temperature and pressure relief valve and drain valve.

8. Heater UL listed, prewired, and factory tested.
9. See Drawings for size and capacity.

B. DOMESTIC WATER EXPANSION TANK

C. Diaphragm type of welded steel, constructed and stamped in accordance with ASME code for 150 psi working pressure.

D. Heavy-duty butyl diaphragm meets FDA requirements for potable water supply.

E. Support with steel legs or bases for vertical installation or steel saddles for horizontal installation.

F. Pre-charged with compressed air to minimum fill pressures as indicated on the Drawings.

PART 3 EXECUTION

3.01 WATER HEATER INSTALLATION

A. Install per manufacturer's installation instructions and in accordance with all applicable codes.

B. Provide pressure/temperature relief valve on storage tanks. Provide piping from relief valve to floor drain utilizing a 1-inch air gap at discharge point.

C. Support:
1. Install water heater oriented so that controls and devices needing service and maintenance have adequate access.
2. Install water heaters level.
3. Provide required strapping to structure and floor in accordance with code requirements.

D. Water Piping:
1. Provide hot and cold water piping to units with shutoff valves, unions, and specialties as detailed on the Drawings.
2. Provide recirculating water line to unit with shutoff valve, check valve, and union.

END OF SECTION

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Fixture Trim
   2. Plumbing Fixtures
   3. Emergency Fixtures
   4. Drainage Products
   5. Laboratory Fixture Fittings

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 22, Plumbing

1.03 QUALITY ASSURANCE

A. Water Closets: Maximum Performance (MaP) score of no less than 800

B. Faucets: Certify to NSF/ANSI 61 and California AB1953

C. Electric Water Coolers and Drinking Fountains: Certified to NSF/ANSI 61 and California AB1953

D. Emergency Eyewash and Emergency Shower Equipment: Comply with ANSI Standard Z358.1

1.04 SUBMITTALS

A. Submit the following:
   1. Product data for each item specified.
   2. Operating and Maintenance Data:
      a. Electric Water Coolers
      b. Whirlpool Baths
      c. Hot Water Dispensers
      d. Garbage Disposals
      e. Sensor Operated Faucets
      f. Sensor Operated Flush Valves.
   3. Mounting heights for fixtures.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers are stated for each fixture specified. The following manufacturers are also acceptable, except when indicated only.

B. Fixture Trim:
   1. Supply Stops:
      a. Chicago
      b. NPT McGuire (LK series)
      c. Brasscraft (SCR series)
   2. Support Rims:
      a. Hudee
   3. Vacuum Breakers:
      a. Chicago Faucet
      b. A.W. Cash
      c. Febco, chrome plated

C. Drainage Products and Carrier Products:
   1. J.R. Smith
   2. Josam

3. Sioux Chief
4. Zurn
5. Wade
6. Watts Drainage
7. Woodford
8. Mifab

D. Fixtures:
1. American Standard
2. Kohler
3. Sloan
4. Toto

E. Seats:
1. Olsonite
2. Church
3. Beneke
4. Bemis

F. Electric Water Coolers:
1. Elkay
2. Halsey Taylor
3. Oasis
4. Sunroc
5. Haws

G. Mixing Valves:
1. Powers
2. Leonard
3. Symmons
4. Chicago

H. Emergency Fixtures:
1. Haws
2. Bradley
3. Speakman
4. Encon

I. Emergency Fixture Mixing Valves:
1. Leonard
2. Bradley
3. Lawler
4. Powers

J. Stainless Steel Products:
1. Elkay
2. Just
3. Franke

K. Mop Sinks:
1. Fiat
2. Williams
3. Mustee

L. Faucets:
1. Chicago
2. Delta Commercial
3. Kohler
4. Symmons
5. Moen Commercial

M. Metering Faucets:
   1. Chicago
   2. Symmons

N. Disposals and Hot Water Dispenser:
   1. In-Sink-Erator

O. Flush Valves:
   1. Sloan
   2. Zurn

P. Sensor Operated Flush Valves:
   1. Sloan
   2. Zurn

Q. Sensor Operated Faucets:
   1. Sloan
   2. Chicago
   3. Delta Commercial
   4. Moen Commercial

R. Shock Arrestors:
   1. PPP
   2. J.R. Smith

S. Trap Primer Stations:
   1. PPP

T. Exposed Waste and Supply Piping Insulation Kits:
   1. Truebro
   2. McGuire

U. Other Manufacturers: Submit substitution request.

2.02 FIXTURE TRIM

A. Supply Stops: Chicago cast brass rigid riser supplies with loose key angle stops, wall flanges, NPT female inlet, chrome plate finish; equivalent NPT McGuire (LK series), Brasscraft (SCR series), or NPT stops by fixture supplier.

B. Traps:
   1. For floor drains, provide coated cast iron P-trap; recessed, screw jointed or bell and spigot.
   2. For other fixtures, provide 17 gauge, chrome plated cast brass P-Traps with solder bushings, and clean-out.

C. Support Rims: Hudee stainless steel rims, if sink not furnished with integral rim.

D. Vacuum Breakers:
   1. Chicago Faucet
   2. A.W. Cash
   3. Febco, chrome plated

2.03 PLUMBING FIXTURES

A. WC-1 Water Closet:
   1. See Campus Standards

B. WC-2 Water Closet (ADA): Same as WC-1, except mounted at ADA mounting height.

C. L-1 Lavatory:
   1. See Campus Standards

D. WF-1 Lavatory:
   1. See Campus Standards

E. MS-1 Mop Sink:
   1. See Campus Standards

F. DRAINAGE PRODUCTS

G. HB-1 Hose Bibb: Chicago 952 Series, chrome-plated, removable key, 3/4-inch hose thread, integral vacuum breaker.

H. WH-1 Wall Hydrant: J.R. Smith 5609 Series, bronze finish, removable key, 3/4-inch hose thread, integral vacuum breaker, freeze proof.

I. GH-1 Ground Hydrant: J.R. Smith 5810 Series, bronze hydrant in rough bronze box, hinged locking cover, 3/4-inch hose thread, removable key, integral vacuum breaker, with 1/8-inch drain hole for box and valve.

J. WB-1 Wall Box Hydrant: J.R. Smith 5509 Series, bronze finish, removable key, 3/4-inch hose connection, integral vacuum breaker, freeze proof, in locking stainless steel recessed box.

K. WB-2 Wall Box Hydrant: J.R. Smith 5500 series, bronze finish, hot and cold water control box, 3/4-inch hose thread, integral vacuum breaker, removable key handle, freeze proof.

L. WSCB-1 Water Supply Control Box (for Garbage Can Wash):
   1. J.R. Smith 3380 series, recessed water supply control box in type 304 stainless steel with a number 4 satin finish, cylinder type key lock, cold and hot water screwdriver stops, flow control valve, and atmospheric vacuum breaker.
   2. [Unit to be used in conjunction with J.R. Smith Fig. 3370 garbage can washing floor drain.]

M. PH-1 Non-Freeze Sanitary Post Hydrant:
   1. J.R. Smith 5904 Series, 3/4-inch hose thread, nozzle with venture adapter, freeze proof, flow wheel lock handle, drain-down tubing, stainless steel sealed canister (for drain down).

N. RD-1 Roof Drain (Large Area): J.R. Smith 1010 Series, 16-inch low profile diameter dome, cast iron body with combined flashing clamp and gravel stop, no-hub outlet, under deck clamp.

O. OD-1 Overflow Roof Drain (Large Area Overflow): J.R. Smith 1080 Series, 16-inch low profile diameter dome, 2-inch water dam, cast iron body with combined flashing clamp and gravel stop, no-hub outlet and under deck clamp.

P. RD-2 Roof Drain (Small Area): J.R. Smith1330 Series, 8-1/2-inch low profile diameter dome, cast iron body with combined flashing clamp and gravel stop, no-hub outlet and under deck clamp.

Q. OD-2 Overflow Roof Drain (Small Area Overflow): J.R. Smith 1330 Series, 8-1/2-inch low profile diameter dome, 2-inch high solid water dam, cast iron body with combined flashing clamp and gravel stop, no-hub outlet and under deck clamp.

R. RD-3 Roof Drain (Eco-Roof): J.R. Smith 1011 Series, 16-inch low profile dome, cast iron body with combined flashing clamp and gravel stop, no-hub outlet, under deck clamp, 1/16-inch thick perforated stainless steel gravel stop with 3/8-inch openings and stainless steel mesh top.

S. OD-3 Overflow Roof Drain (Eco-Roof): J.R. Smith 1011 Series, 16-inch low profile dome, 2-inch high solid water dam, cast iron body with combined flashing clamp and gravel stop, no-hub outlet, under deck clamp, 1/16-inch thick perforated stainless steel gravel stop with 3/8-inch openings and stainless steel mesh top.

T. RD-4 Roof Drain (Deck Area where Waterproof Covering is to be Applied): J.R. Smith DX-2565 Series, cast iron wide flange body with nickel bronze grate, DX2565-R membrane clamp, vandal resistant, sediment bucket, no-hub outlet, under deck clamp.

U. CR-1 Condensate Receiver: J.R. Smith 3980-R-C, acid resistant coated interior, with no-hub outlet, under deck clamp, sump receiver, 4-inch water dam, and dome strainer.

V. AD-1 Area Drain: J.R. Smith 2142 Series, cast iron body and 12-inch round heavy duty vandal-proof ductile iron tractor grate, no-hub outlet, and sediment bucket.

W. FD-1 Floor Drain: J.R. Smith 2005 Series, round nickel bronze vandal resistant grate, cast iron body with flashing collar and adjustable strainer head and no-hub outlet.

X. FD-2 Floor Drain (Unfinished Areas): J.R. Smith 2110 Series, round cast iron grate, cast iron body, no-hub outlet, sediment bucket.

Y. FD-3 Floor Drain (Unfinished Areas): J.R. Smith 3710 Series, round cast iron grate, cast iron body, sediment bucket, no-hub outlet, and integral 4-inch diameter funnel.

Z. FD-4 Floor Drain (Finished Areas - Kitchens): J.R. Smith 2010 Series, vandal-proof, square nickel bronze hinged grate, sediment bucket, cast iron body with flashing collar, adjustable strainer head and no-hub outlet

AA. FD-5 Floor Drain (Finished Areas - Indirect Waste): J.R. Smith 2005 Series, vandal-proof, round nickel bronze grate, cast iron body, no-hub outlet, and oval funnel.

BB. FD-6 Floor Drain (Acid Resistant): Orion AWFDSTD corrosion resistant floor drain manufactured from fire retardant polypropylene material conforming to ASTM D4101, vandal-proof.

CC. FD-7 Floor Drain (Acid Resistant): Orion AWFDSTD corrosion resistant floor drain manufactured from fire retardant polypropylene material conforming to ASTM D4101, vandal-proof with sediment bucket.

DD. FD-8 Floor Drain (Garbage Can Wash Drain):
1. J.R. Smith 3370 Series, acid resisting coated interior, nickel bronze grate, free-standing sediment bucket lined with 1/4-inch stainless steel mesh screen, no-hub outlet, and bronze adjustable nozzle assembly.
2. [Unit to be used in conjunction with WSCB-1 J.R. Smith Fig. 3380 water supply box for garbage can wash.]

EE. FD-9 Floor Drain (Wood Deck): Sioux Chief 822 series adjustable floor drain with deck flange and nickel bronze grate, no-hub outlet.

FF. FS-1 Floor Sink (Finished Areas - Kitchens): J.R. Smith 3101-12 Series, acid resistant coated floor sink, vandal-proof 8-1/2-inch by 8-1/2-inch nickel bronze 1/2 grate and sediment bucket, no-hub outlet and flashing collar.

GG. FS-2 Floor Sink (Finished Areas - Kitchens): Same as FS-1, except with 3/4 grate.

HH. FS-3 Floor Sink (Finished Areas - Kitchens): Same as FS-1, except with 2-1/2-inch square center hole grate.

II. FS-4 Floor Sink (Finished Areas - Kitchens): Same as FS-1, except no grate.

JJ. FS-5 Floor Sink (mechanical room indirect waste): J.R. Smith 3041 Series floor sink with 8-inch deep receptor, basket strainer, 1/2 cast iron grate, no-hub outlet and flashing collar..

KK. WCO Wall Cleanout: J.R. Smith 4530 Series, round stainless steel vandal resistant cover and screw.

LL. WCO Wall Cleanout (Acid Resistant): Orion COT, corrosion resistant polypropylene cleanout tee, CPC polypropylene cleanout plug, J.R. Smith 2720 Series chrome plated round frame with vandal-proof wall cover.

MM. FCO Floor Cleanout: J.R. Smith 4020 Series, round vandal resistant, nickel bronze top.

NN. FCO Floor Cleanout (Acid Resistant):
1. Orion corrosion resistant floor cleanout, manufactured from fire retardant polypropylene material conforming to ASTM D4101, with round nickel bronze cover. AWCO (Acid Waste Cleanout) cast in cover.

OO. CTG Cleanout to Grade: J.R. Smith 4220 Series, round, extra heavy duty cast iron top set in 12-inch by 12-inch by 4-inch deep concrete pad, vandal resistant.

PP. DSN-1 Downspout Nozzle: J.R. Smith 1770 Series in nickel bronze.

QQ. DSN-2 Downspout Nozzle: J.R. Smith 1775 Series in nickel bronze, hinged perforated cover.

RR. DSB-1 Downspout Boot: J.R. Smith 1787 Series, 4-inch round downspout connection.

SS. DSB-2 Downspout Boot: J.R. Smith 1785 Series, 4-inch by 3-inch rectangular downspout connection.

TT. Trap Priming Valves:
1. Precision Plumbing Products Prime-time electronic trap priming manifold including but not limited to: atmospheric vacuum breaker, pre-set 24 hour clock, manual over ride, 120V slow closing solenoid valve, calibrated manifold for equal water distribution.
2. Components pre-installed in recessed steel cabinet with SS access door.

UU. Water Hammer Arrester: Precision Plumbing Products Model SC (Maintenance-Free).

VV. Grease Interceptor:
1. Schier PATG Series for recessed (flush) or floor-mounted installation, unit manufactured in compliance with ASME Standard A112.14.3, internal flow control fitting, extension sections as required based on installed depth. 1/4-inch thick steel tread plate cover.
2. See schedule on Drawings for capacity of unit.

WW. Oil/Water Interceptor:
1. J.R. Smith 8500 Series floor mounted installation, duco coated inside and out, flow control fitting, gravity drain off, sediment bucket.
2. See Schedule on Drawings for basis of design and capacity of unit.

2.04 LABORATORY FIXTURE FITTINGS

A. SF-1 Supply Faucet: Chicago 930 series cold and hot water sink faucet with 5-3/8-inch rigid/swing gooseneck spout, vacuum breaker, serrated nozzle, ceramic cartridges and cross handles.

B. SF-2 Supply Faucet (ADA): Chicago 930-series cold and hot water sink faucet with 5 3/8-inch rigid/swing gooseneck spout, vacuum breaker, serrated nozzle, ceramic cartridges, and 4-inch wrist blade handles.

C. AO-1 Air Outlet: Chicago 986 series, single outlet wall fitting with lever handle with air service button, integral check valve, and serrated outlet.

D. AO-2 Air Outlet: Chicago 987 series double outlet wall fitting with two lever handles with air service buttons, integral check valves, and serrated outlets.

E. AO-3 Air Outlet (Shop Air): Norgren B72G series general purpose filter/regulator with 3/8-inch port, 0-60 psig operation range.

F. GO-1 Gas Outlet: Chicago 986 series, single outlet wall fitting with lever handle with “gas” service button, integral check valve, and serrated outlet.

G. GO-2: Gas Outlet: Chicago 987 series double outlet wall fitting with two lever handles with gas service buttons, integral check valve, and serrated outlets.

H. AGO-1 Air and Gas Outlet: Chicago 982 series deck mounted turret with two 90 degree outlets, divided interior for one lever handle air valve with integral check valve and serrated outlet, one lever handle gas valve with integral check valve and serrated outlet.

PART 3 EXECUTION

3.01 FIXTURE TRIM

A. Provide plumbing fixture trim where applicable on fixtures, including but not limited to supply stops, traps, support rims, flush valve, and vacuum breakers.

B. Provide rough-in and final piping connection to fixtures. Carefully review all construction documents to assure that all fixtures are provided with necessary services for a complete operating system.

C. Rigidly secure rough-in piping, carriers and supports, and other service piping to structure.

3.02 PLUMBING FIXTURES

A. Americans with Disabilities Act:
   1. Those fixtures indicated by ADA complies with and be installed in accordance with Americans with Disabilities Act Guidelines (ADAAG). Where applicable building code requirements are more stringent than ADAAG guidelines, building code requirements followed.
   2. Water Closets:
      a. Mounting height of ADA water closet 17-inches to 19-inches from floor to top of the toilet seat.
      b. Mount flush valve for ADA water closets on wide side of enclosure.
   3. Lavatories:
      a. Mounting height of ADA lavatories at a maximum height of 34 inches from floor to rim.
      b. Provide insulation kits on exposed hot water and waste piping beneath ADA lavatories.
   4. Sinks: Provide insulation kits on exposed hot water and waste piping beneath ADA sinks.
   5. Urinals: Mounting height of ADA water closet at a maximum height of 17-inches from floor to top rim.

B. Fixture Mounting Heights: Fixtures standard rough-in catalogued heights unless shown otherwise on the Architectural Drawings.

C. Showers:
   1. Piping from shower mixing valve to shower head rigid pipe. PEX piping not allowed.
   2. Shower Head Mounting Heights: Mount so that face of head is at 6-feet-6-inches above finished floor and not to conflict with shower enclosure.

D. Water Supplies: When both hot and cold water to a fixture is required, connect the hot on the left and the cold on the right.

E. Floor Mounted Supports and Chair Carriers:
   1. Secure floor mounted supports and chair carriers to slab with a minimum of 1/2-inch bolts.
   2. Install supports and carriers per manufacturer's installation instructions.

F. Lavatories, Urinals and Water Closets with Hard-Wired Electronic Sensors:
   1. Install sensors, wiring and piping as recommended by manufacturer.
   2. Provide vandalproof screws on wiring boxes for lavatories and sensor boxes.
   3. Mount lavatory wiring box on bottom of countertop for total concealment. Coordinate with Division 26 for plug-in transformer and receptacle locations.
   4. Provide one 24V transformer for any combination of 10 water closets or urinals installed side by side, and one transformer for every 6 lavatories installed side by side.

G. Lavatories:
   1. Public Toilet Room: Grid strainers.
   2. Private Toilet Room: Pop-up waste assemblies.
   3. Those lavatories indicated as ADA are ADA compatible. Coordinate with Architect to verify if all wall hung lavatories are to be installed at ADA height.

H. Waterless Urinal:
   1. Install in strict accordance with manufacturer's instructions.
   2. Install a sanitary tee with wall cleanout located below each waterless urinal. This sanitary tee/cleanout would be for inspection/cleaning of the waste pipe leaving the unit.
   3. Waterless urinals installed level with the drain line.
   4. Assure that there is proper connection made on the short coupling with O-ring from unit to waste piping.
   5. Water supply roughed-in within chase to accommodate possible future changes to a conventional type urinal.

I. Floor Drain and Floor Sinks:
   1. Set top flush with finished floor.

2. Provide flashing clamp for all drain bodies installed in floors provided with waterproof membranes.

J. Cleanout:
1. Where shown or required.
2. Cover set flush with finished surface.

K. Roof and Area Drains:
1. Provide sump receivers for all drains except poured in place installations.
2. Provide extension section as required to compensate for the specified insulation thickness above the roof slab or deck.

L. Water Hammer Arresters: Provide where shown and where recommended by Plumbing Drainage Institute (PDI).

M. Water Coolers and Drinking Fountains:
1. Water-bearing materials comply with the Safe Drinking Water Act of 1986 and the Lead Contamination Control Act of 1988. The waterway system of the unit manufactured of copper components and other completely lead-free materials.
2. Water cooler refrigerants will be non-CFC.
3. Provide fixture manufacturer's wall mounting plate or floor mounted support for all wall-hung water coolers or drinking fountains.

N. Mixing Valves: Provide piping connections per manufacturer's installation instructions.

O. Water closets equipped with a dual flush devices marked with the reduced flush volume and the designation ASME A112.19.14 to signify compliance with the standard.

P. Wall hung lavatories with pop-up waste assemblies: Verify there is no vertical pull rod assembly conflict with lavatory backsplash prior to submitting product data.

3.03 PRIMING VALVES

A. All floor drains, floor sinks, and similar traps primed. Use minimum 3/8-inch type K annealed copper tubing. Primer line to be continuous and without joints.

B. Where priming valves are installed in finished rooms, conceal in wall and provide access panel.

C. Coordinate locations of electronic trap primer stations with electrical contractor for 120V service.

3.04 KITCHEN EQUIPMENT

A. General:
1. Kitchen equipment is supplied and set in place by Kitchen Supplier.
2. Obtain drawings before any rough-in is started.
3. Complete installation and furnish equipment required or scheduled below to give complete working installation.
4. Symbol numbers are indicated by (_____) symbol with number inside.
5. See plumbing fixtures for supply types and traps.

3.05 HOSPITAL EQUIPMENT

A. General:
1. Contractor to rough-in and connect items described below.
2. Obtain drawings from supplier or hospital of equipment before roughing-in equipment.
3. Verify stud locations and coordinate setting of supports for equipment to be moved and reinstalled, verify rough-ins required.

B. Schedule:
1. Symbols indicated on drawings in (_____) reflect Hospital Equipment List.
2. Owner Furnished, Contractor Installed and Owner Furnished Contractor Rough-in.

3.06 LAB FURNISHING COORDINATION

A. General:
1. Lab Furnishings specified in Division 11, Equipment.

2. Obtain drawings before any rough-in is started.
3. Complete plumbing piping installation and furnish all trim required to give complete working installation.
4. Make final connections to lab casework plumbing fittings and sinks.
5. See plumbing floor plans and riser diagrams for plumbing piping serving lab casework.
6. Reference lab casework connection schedule for plumbing rough-in sizes.
7. Reference lab furnishing plans and Division 11, Equipment for requirements at lab casework.

END OF SECTION

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SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. The intent of Division 23, HVAC Specifications and the accompanying Drawings is to provide a complete and workable facility with complete systems as shown, specified and required by applicable codes. Include work specified in Division 23, HVAC and shown on the accompanying Drawings, including appurtenances, connections, etc., in the finished job.

B. The Drawings that accompany the Division 23, HVAC Specifications are diagrammatic. They do not show every offset, bend, tee, or elbow which may be required to install work in the space provided and avoid conflicts. Offsets and transitions assumed at a minimum at each duct crossing, structural penetrations through shear walls or beams, structural grids where ceiling heights are restricted, and at piping mains. Follow the Drawing as closely as is practical to do so and install additional bends, offsets and elbows where required by local conditions from measurements taken at the Building, subject to approval, and without additional cost to the Owner. The right is reserved to make any reasonable changes in outlet location prior to roughing-in, without cost impact.

C. The General and Supplemental Conditions apply to this Division, including but not limited to:
   1. Drawings and specifications.
   2. Public ordinances, permits.
   3. Include payments and fees required by governing authorities for work of this Division.

D. Division 01, General Requirements, General Requirements, applies to this Division.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Products and equipment prohibited from containing pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products or equipment within this specification contain these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
   2. General: Work and materials conforms to the local and State codes, and Federal, State and other applicable laws and regulations.
   3. Contractor responsible for obtaining and payment for permits, licenses, and inspection certificates required in accordance with provisions of Contract Documents.

B. New materials and equipment. Work of good quality, free of faults and defects and in conformance with the Contract Documents.

C. Apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. The entire mechanical system and apparatus operates at full capacity without objectionable noise or vibration.

E. Install equipment level and true. Housekeeping pads and curbs account for floor or roof slope.

F. Materials and Equipment:
   1. Each piece of equipment furnished meet detailed requirements of the Drawings and Specifications and suitable for the installation shown. Equipment not meeting requirements will not be acceptable, even though specified by name along with other manufacturers.

2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer. Component parts of the entire system need not be products of same manufacturer.
3. Furnish materials and equipment of size, make, type, and quality herein specified.
4. Equipment scheduled by performance or model number considered the basis of the design. If other specified manufacturer's equipment is provided in lieu of the basis of design equipment the contractor is responsible for changes and costs which may be necessary to accommodate this equipment, including different sizes and locations for connections, different electrical characteristics, different dimensions, different access requirements, or any other differences which impact the project.

G. Workmanship:
1. General: Install materials in a neat and professional manner.
2. Manufacturer's Instructions:
   a. Follow manufacturer's directions where they cover points not specifically indicated.
   b. If conflict with the Drawings and Division 23, HVAC Specifications, obtain clarification before starting work.

H. Cutting and Patching:
1. Cutting, patching, and repairing for the proper installation and completion of the work specified in this Division including plastering, masonry work, concrete work, carpentry work, and painting performed by skilled craftsmen of each respective trade in conformance with the appropriate Division of Work.
2. Additional openings required in building construction made by drilling or cutting. Use of jackhammer is specifically prohibited.
3. Fill holes which are cut oversize so that a tight fit is obtained around the sleeves passing through.
4. Do no pierce beams or columns without permission of Architect and then only as directed.
5. Restore new or existing work cut or damaged to its original condition. Where alterations disturb lawns, paving, walks, etc., surfaces repaired, refinished, and left in condition existing prior to commencement of work.

1.04 SUBMITTALS

A. Shop Drawings:
1. The Contract Drawings indicate the general layout of the piping, ductwork, and various items of equipment. Coordination with other trades and with field conditions will be required. For this purpose, prepare Shop Drawings of piping, ductwork, and equipment installations. Shop Drawings new drawings prepared by Contractor and not reproductions or tracings of Architect's Drawings. Overlay drawings with shop drawings of other trades and check for conflicts. Drawings the same size as Architect's Drawings with title block similar to Contract Drawings and identifying Architect's Drawing number or any reference drawings. Drawings fully dimensioned including both plan and elevation dimensions. Shop drawings cannot be used to make scope changes.
2. Prepare in two-dimensional format.
3. Include but are not limited to:
   a. Complete floor plans with sheet metal and HVAC piping to a minimum of 1/4-inch equals 1-foot scale.
   b. Sheet metal and HVAC piping of mechanical and fan rooms to a minimum of 1/2-inch equals 1-foot scale.
   c. Sections of congested areas to a minimum of 1/2-inch equals 1-foot scale.
   d. Controls and Instrumentation: Scale and drawing sizes to suit controls supplier.
   e. Fabricated Equipment: Scale and drawing sizes to suit contractor except equipment not less than 1/4-inch equals 1-foot scale.
   f. Superplot plans of above ground work with a colored overlay of trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2-inch equals 1-foot scale.

g. Superplot plans of below ground work with a colored overlay of trades including, but not limited to, structural footings and foundation, HVAC piping, civil piping, plumbing piping, and power conduit to a minimum of 1/2-inch equals 1-foot scale.
h. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4-inch equals 1-foot scale.
i. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1-foot scale.
j. Fabrication drawings of radiant ceiling panels, architectural metal ceiling, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.

4. Submit shop drawings for review prior to beginning fabrication. Additional shop drawings may be requested when it appears that coordination issues are not being resolved in the field or when there is a question as to whether contract documents are being complied with or the design intent is being met.

B. Product Data:
1. In general, submit product data for review on scheduled pieces of equipment, on equipment requiring electrical connections or connections by other trades, and as required by each specification section or by Drawing notes. Include manufacturer's detailed shop drawings, specifications, and data sheets. Data sheets include capacities, RPM, BHP, pressure drop, design and operating pressures, temperatures, and similar data. Manufacturer's abbreviations or codes are not acceptable.
2. List the name of the motor manufacturer and service factor for each piece of equipment.
3. Indicate equipment operating weights including bases and weight distribution at support points.
4. In the case of equipment such as wiring devices, time switches, valves, etc., specified by specific catalog number, a statement of conformance will suffice.

C. Submission Requirements:
1. Shop Drawings and Product Data:
a. Refer to Division 01, General Requirements for additional requirements related to submittals.
b. Submit copies of shop drawings and product data for Work of Division 23, HVAC in a 3-ring loose leaf binder with each item filed under a tab and labeled with its respective specification section number, Article and paragraph, and mark if applicable.
c. Submit electronic copies of shop drawings and product data for Work of Division 23, HVAC in PDF format with each item filed under a folder and labeled with its respective specification section number, Article and paragraph and mark if applicable.
d. Include a complete index in the original submittal. Indicate both original items submitted and note stragglers that will be submitted at a later date to avoid delay in submitting.
e. The bulk of the shop drawings and product data, excepting Controls and Instrumentation, included with the original submittal. Controls and Instrumentation submittals may lag but complete when submitted. Partial submittals will not be accepted. Other stragglers submitted after return of the original binder includes a tab similar to that originally submitted. Upon receipt of the returned late submittal, insert them in the previously submitted binder.

D. Contractor Responsibilities:
1. Submit submittals one time and are in proper order.
2. Ensure that equipment will fit in the space provided.
3. Assure that deviations from Drawings and Specifications are specifically noted in the submittals. Failure to comply will void review automatically.

1.05 AS-BUILT DRAWINGS

A. Provide 2D model and record drawings at the end of the project on USB Drive.

B. 2D model in the following format:
   1. AutoCAD
   2. Record Drawings: Provide hard copies and pdf format.
   3. Drawings include the following:
      a. Project Specific Titleblock.
      b. Notations reflecting the as built conditions of any additions to or variations from the construction documents provided as part of the BIM coordination, RFIs, ASIs, Owner Changes, and Field Coordination.

1.06 OPERATING AND MAINTENANCE MANUAL, PARTS LISTS, AND OWNER'S INSTRUCTIONS

A. Refer to Division 01, General Requirements for additional requirements.

B. Submit three bound copies of manufacturer's operation and maintenance instruction manuals and parts lists for each piece of equipment or item requiring servicing. Literature on 8-1/2-inch by 11-inch sheets or catalogs suitable for side binding. Submit data when the work is substantially complete, packaged separately, and clearly identified in durable 3-ring binder. Include name and contact information for location of source parts and service for each piece of equipment. Clearly mark and label in each submittal, the piece of equipment provided with the proper nameplate and model number identified. Provide wiring diagrams for electrically powered equipment.

C. Instruct Owner thoroughly in proper operation of equipment and systems, in accordance with manufacturer's instruction manuals. Operating instructions cover phases of control.

D. Furnish competent engineer knowledgeable in this building system for minimum of five 8-hour days to instruct Owner in operation and maintenance of systems and equipment. Keep a log of this instruction including dates, times, subjects, and those present and present such log when requested by Architect.

1.07 PROJECT CONDITIONS

A. Existing Conditions:
   1. Prior to bidding, verify and become familiar with existing conditions by visiting the site, and include factors which may affect the execution of this Work.
   2. Include related costs in the initial bid proposal.

B. Coordinate exact requirements governed by actual job conditions. Check information and report discrepancies before fabricating work. Report changes in time to avoid unnecessary work.

C. Coordinate shutdown and start-up of existing, temporary, and new systems and utilities. Notify Owner, the City, and Utility Company.

1.08 WARRANTY

A. Provide a written guaranty covering the work of this Division (for a period of one calendar year from the date of acceptance by the Owner) as required by the General Conditions.

B. Provide manufacturer's written warranties for material and equipment furnished under this Division insuring parts and labor for a period of one year from the date of Owner acceptance of Work of this Division.

C. Correct warranty items promptly upon notification.

1.09 PROVISIONS FOR LARGE EQUIPMENT

A. Make provisions for the necessary openings in building to allow for admittance of equipment.

1.010 TEST REPORTS AND CERTIFICATES

A. Submit one copy of test reports and certificates specified herein to the Architect.

1.011 SUBSTITUTIONS

A. Submit requests for product substitutions in accordance with the Instructions to Bidders and the General and Supplemental Conditions.

PART 2 PRODUCTS

2.01 ACCESS PANELS

A. Furnish under this Division as specified in another Division of work.

2.02 PIPE AND DUCT SLEEVES

A. Interior Wall and Floor Sleeves: 18 gauge galvanized steel, or another pre-approved system.

B. Interior Wall and Floor Sleeves (fire rated): Fire rated and water tight system approved by Authority Having Jurisdiction and Owners Insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping material, size and service.

C. Exterior Wall Sleeves: Cast iron

D. On Grade Floor Sleeves: Same as exterior wall sleeves.

E. Water Tight Sleeves: Combination steel pipe sleeves with water stop and anchor plate; Link Seal Model WS, mated with synthetic rubber links interlocked with bolts and nuts; Link Seal Model LS.

2.03 FLOOR, WALL AND CEILING PLATES

A. Furnish stamped split type plates as follows:
   1. Floor Plates: Cast brass, chromium plated.
   2. Wall and Ceiling Plates: Spun aluminum.

2.04 MACHINERY GUARDS

A. Furnish guards for protection on rotating and moving parts of equipment. Provide guards for metal fan drives and motor pulleys, regardless of being enclosed in a metal cabinet.

B. Design guards so as not to restrict air flow at fan inlets resulting in reduced capacity.

C. Provide shaft holes in guards for easy use of tachometers at pulley centers. Guards easily removable for pulley adjustment or removal and changing of belts.

D. Guards meet OSHA requirements including back plates.

E. Provide inlet and outlet screens on fans in plenums or where exposed to personnel.

2.05 ELECTRICAL EQUIPMENT

A. General: Equipment and installed work as specified under Division 26, Electrical.

B. Coordinate with the electrical Drawings and electrical contractor for minimum electrical equipment bracing requirements based on the available fault current rating at the bus of the panelboard or switchboard serving the piece of equipment. Provide equipment with a Short Circuit Current Rating (SCCR) that meets the bracing requirement.

C. Motors – AC Induction:
   1. Furnish as integral part of driven equipment.
   2. Drip proof induction type with ball bearings unless noted otherwise.
   3. Motors 1 hp and above premium energy efficient type, except for emergency equipment motors.
   4. Built to NEMA Standards for the service intended.
   5. Rated for voltage specified, suitable for operation within the range of 10 percent above to 10 percent below the specified voltage.
   6. Energy Efficient Motors:
      a. Baldor
      b. Westinghouse
      c. General Electric
      d. Or approved equal.

7. Motors meet the efficiency standards identified in the table below as determined using the IEEE Method B test at full load.

MINIMUM MOTOR EFFICIENCIES					
		RPM IEEE 112B Efficiency			
HP	KW	900	1200	1800	3600
1	0.75	--	82.5	85.5	80.0
1.5	1.15	--	86.5	86.5	85.5
2	1.53	--	87.5	86.5	86.5
3	2.3	84.0	89.5	89.5	88.5
5	3.8	85.5	89.5	89.5	89.5
7.5	5.6	87.5	91.7	91.7	91.0
10	7.5	88.5	91.7	91.7	91.7
15	7.5	88.5	91.7	92.4	91.7
20	15.9	90.2	92.4	93.0	92.4
25	18.8	91.0	93.0	93.6	93.0
30	22.5	91.0	93.6	94.1	93.0
40	30.0	91.7	94.1	94.5	93.6
50	37.5	92.4	94.1	94.5	94.1
60	45.0	93.0	94.5	95.0	94.1
75	56.3	93.0	95.0	95.4	94.5
100	75.0	93.0	95.4	95.4	95.0
125	93.8	94.5	95.4	95.4	95.4
150	112.5	94.5	95.8	95.8	95.4
200	150.0	94.5	95.8	96.2	95.8
250	187.5	94.5	95.1	96.2	95.1
300	225.0	94.5	95.3	96.2	95.3
350	225.0	94.5	95.3	96.2	95.3
400	300.0	94.5	95.4	96.2	95.4
450	337.5	94.5	95.5	96.2	95.5
500	375.0	94.5	95.6	96.2	95.6

8. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
9. Refer to individual product sections for additional motor requirements.
10. Furnish motors on belt drive equipment of nominal nameplate horsepower not less than 120 percent of equipment brake horsepower required for performance specified.
11. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Hermetically sealed motors have quick trip devices.
12. Motors controlled by variable frequency drives inverter duty rated and have Class F insulation or better. Withstand repeated voltage peaks of 1600V with rise times of 0.1 microseconds and greater in accordance with NEMA Standard MG1 Part 31.
13. Motors served from variable frequency drives equipped with shaft grounding system which provide a path for current to flow between the shaft and motor frame. SGS or equal.
14. Motors located in environment air plenums not tied to air handling functions totally enclosed type motors.
15. Motors – Electronic Commutation (EC):
16. Furnished as integral part of driven equipment.
17. Permanently lubricated with ball bearings unless noted otherwise.
18. Internal motor circuitry converts AC power supplied to the motor to DC power to operate the motor.
19. Speed controllable down to 20 percent of full speed.
20. Motor efficiency at a minimum of 85 percent at all speeds.

21. Refer to Equipment Schedules on the Drawings for motor horsepower, voltage, and phase.
22. Refer to individual product sections for additional motor requirements.
23. Built-in thermal overload protection, or be protected externally with separate thermal overload devices with low voltage release or lockout. Quick trip devices hermetically sealed motors.
24. Motors located in environment air plenums not tied to air handling functions totally enclosed type motors.

D. Starters: Provided under Division 26, Electrical, suitable for performing the control functions required, with the exception of self-contained equipment and where the starters are furnished as part of the control package.

E. Equipment Wiring:
1. Interconnecting wiring within or on a piece of mechanical equipment provided with the equipment unless shown otherwise.
2. This does not include the wiring of motors, starters and controllers provided under Division 26, Electrical.

F. Control Wiring: Control wiring for mechanical equipment provided under Section 23 09 00, Instrumentation and Controls for HVAC.

G. Codes: Electrical equipment and products bear the UL label as required by governing codes and ordinances.

PART 3 EXECUTION

3.01 ACCESS PANELS

A. Install in accord with manufacturer's recommendations, coordinated with architectural features.

B. Provide 2-hour fire rated doors where required bearing the UL label.

C. Furnish 18-inch by 18-inch panels for ceilings and for access to equipment in soffits and shafts, and 12-inch by 12-inch for walls unless indicated otherwise.

D. Furnish where indicated and where required to access valves, fire/smoke dampers, trap primers, shock arresters, and other appurtenances requiring operation, service or maintenance. Submit proposed locations for review prior to installation.

3.02 SLEEVES

A. Interior Floor and Wall Sleeves:
1. Provide sleeves large enough to provide 3/4-inch clearances around pipe or ductwork.
2. Where pipe or ductwork is insulated, insulation passes continuously through sleeve with 3/4-inch clearance between insulation and sleeve.
3. Penetrations through mechanical room and fan room floors watertight by packing with safing insulation and sealing with Tremco Dymeric Sealant or approved system.

B. Sleeves through Rated Floors and Walls: Similar to interior sleeves except install fire rated system approved by Authority Having Jurisdiction and Owners insurance underwriter, with rating equal to floor or wall penetration, and designed specifically for the floor or wall construction, piping or duct material, size and service.

C. Sleeves specified or indicated at fire damper penetrations take precedence over this article.

D. Exterior Wall Sleeves Below Grade:
1. Provide water tight sleeves. Install at pipes entering building below grade and where shown.
2. Adjust to provide positive hydrostatic seal.
3. Follow manufacturer's procedure for installing and tightening seal.
4. Secure sleeves against displacement.

E. On Grade Floor Sleeves: Same as below grade exterior wall sleeves, caulked from inside.

F. Exterior Wall Sleeves Above Grade: Similar to interior wall sleeves except caulk outside with Tremco Dymeric Sealant.

G. Layout work prior to concrete forming. Do cutting and patching required. Reinforce sleeves to prevent collapse during forming and pouring.

H. Floor sleeves maintain a water barrier by providing a water tight seal or they extend 1-inch above finished floor except through mechanical equipment room floors and shafts where sleeves extend 2-inches above finished floor level. Sleeves through roof extend 8-inches above roof. Wall sleeves flush with face of wall unless otherwise indicated.

I. Do not support pipes by resting pipe clamps on floor sleeves. Supplementary members provided so pipes are floor supported.

J. Special sleeves detailed on drawings take precedence over this section.

3.03 CLEANING

A. General: Clean mechanical equipment, piping and ductwork of stampings and markings (except those required by codes), iron cuttings, and other refuse.

B. Painted Surfaces: Clean scratched or marred painted surfaces of rust or other foreign matter and paint with matching color industrial enamel, except as otherwise noted.

C. Additional requirements are specified under specific Sections of this Division.

3.04 EQUIPMENT PROTECTION

A. Keep pipe, ductwork, and conduit openings closed by means of plugs or caps to prevent the entrance of foreign matter. Protect piping, conduit, ductwork, equipment, and apparatus against dirty water, chemical or mechanical damage both before and after installation. Restore damaged or contaminated fixtures, equipment, or apparatus to original conditions or replace at no cost to the Owner.

B. Protect bright finished shafts, bearing housings, and similar items until in service. No rust will be permitted.

C. Cover or otherwise suitably protect equipment and materials stored on the job site.

3.05 ACCESSIBILITY

A. General: Locate valves, thermometers, cleanout fittings and other indicating equipment or specialties requiring frequent reading, adjustments, inspection, repairs, and removal or replacement conveniently and accessibly with reference to the finished building.

B. Thermometers and Gauges: Install thermometers and gauges so as to be easily read from the floors, platforms, and walkways.

3.06 FLOOR, WALL, AND CEILING PLATES

A. Install on piping and ductwork passing through finished walls, floors, ceilings, partitions, and plaster furrings. Plates completely cover opening around pipe and duct.

B. Secure wall and ceiling plates to pipe, insulation, or structure.

C. Plates not penetrate insulation vapor barriers.

D. Plates not required in mechanical rooms or unfinished spaces.

3.07 PAINTING

A. General:
   1. Coordinate painting of mechanical equipment and items with products and methods in conformance with the appropriate Division of Work, Painting.
   2. Exposed work under this Division receives either a factory painted finish or a field prime coat finish, except:
      a. Exposed copper piping.
      b. Aluminum jacketed outdoor insulated piping.

B. Equipment Rooms and Finished Areas:
   1. Insulation: Not painted.

2. Hangers, Uninsulated Piping, Miscellaneous Iron Work, Structural Steel Stands, Uninsulated Tanks, and Equipment Bases: Paint one coat of black enamel.
3. Steel Valve Bodies and Bonnets: One coat of black enamel.
4. Brass Valve Bodies: Not painted.
5. Equipment:
   a. One coat of grey machinery enamel.
   b. Do not paint nameplates.
6. Grilles, Diffusers, Registers: Paint sheet metal and visible ductwork behind grilles, diffusers, and registers flat black.

C. Concealed Spaces (above ceilings, not visible):
1. Insulation: Not painted.
2. Do not paint the following:
   a. Hangers
   b. Uninsulated Piping
   c. Miscellaneous Iron Work
   d. Valve Bodies and Bonnets

D. Exterior Steel: Wire brush and apply two coats of rust-inhibiting primer and one coat of grey exterior machinery enamel.

E. Roof Mounted Equipment:
1. Paint two coats of exterior machinery enamel.
2. Color as selected by Architect.
3. Where factory standard finish is indicated in the equipment specification, it is assumed that the standard finish is painted.

F. Exterior Black Steel Pipe:
1. Wire brush and apply two coats of rust-inhibiting primer and one coat of exterior enamel.
2. Painting schemes comply with ANSI A13.1.

3.08 ADJUSTING AND CLEANING

A. Before operating any equipment or systems, make thorough check to determine that systems have been flushed and cleaned as required and equipment has been properly installed, lubricated, and serviced. Check factory instructions to see that installations have been made accordingly and that recommended lubricants have been used.

B. Use particular care in lubricating bearings to avoid damage by over-lubrication and blowing out seals. Check equipment for damage that may have occurred during shipment, after delivery, or during installation. Repair damaged equipment as approved or replace with new equipment.

3.09 ELECTRICAL EQUIPMENT

A. Ductwork or piping for mechanical systems not serving electrical space not installed in any switchgear room, transformer vault, telephone room, or electric closet except as indicated.

B. Ductwork or piping for mechanical systems not to pass over switchboards or electrical panelboards. Where conflicts exist, bring to attention of Architect.

3.010 EQUIPMENT CONNECTIONS

A. Make final connections to equipment specified in sections other than Division 23, HVAC of the specifications and Owner furnished equipment in accordance with manufacturer's instructions and shop drawings furnished and as indicated.

B. Piping:
1. Connections include steam supply, steam vent, and condensate.
2. Provide valves and specialties as specified and as detailed on the Drawings. Provide increasers, reducers, and any other fittings required for complete installation.
3. Independently support piping connections supported to prevent undue strain on equipment.

C. Ductwork: Make exhaust connections to fume hoods, emergency generator radiators, and any other processing, laboratory, or kitchen equipment in strict accordance with manufacturer's instructions.

D. Refer to Division 11, Equipment for requirements.

END OF SECTION

SECTION 23 05 14

VARIABLE FREQUENCY DRIVES FOR HVAC EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Variable Frequency Drives

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 09 00, Instrumentation and Controls for HVAC

1.03 SUBMITTALS

A. Submit the following:
   1. Product data on variable frequency drives and related components.
   2. Startup log/check list showing successful operation.
   3. Operation and maintenance data.

1.04 WARRANTIES

A. Provide 24-month warranty from date of shipment to include full replacement covering parts and labor.

PART 2 PRODUCTS

2.01 VARIABLE FREQUENCY DRIVES

A. Manufacturers:
   1. ABB
   2. Other Manufacturers: Submit substitution request.

B. General Description:
   1. Variable Frequency AC Motor Drive (VFD):
      a. Pulse width modulated (PWM) inverter type.
      b. Designed to convert 60 Hz input power to adjustable frequency output power to provide positive speed control to standard induction motors.
      c. Dedicated variable torque design for specific use with centrifugal loads.
   2. Provide completely solid state variable frequency power and logic unit.
   3. Speed control to be stepless throughout the range under variable torque load on continuous basis. Speed controlled by remote building energy management system providing 4-20MA input signal to drive and remote start/stop signal. Coordinate with Section 23 09 00, Instrumentation.
   4. Provide adjustable frequency control with diode bridge/capacity input designed to provide high, constant power factor of 0.95 regardless of load or speed and eliminate SCR line noise.
   5. Equipment will be designed and manufactured in accordance with applicable current NEMA and IEEE recommendations and be designed for installation per NEC. Equipment will be UL listed and bear the UL label.
   6. Control suitable for operation in ambient temperatures of 32 degrees F to 104 degrees F.
   7. Factory tested with an AC induction motor 100 percent loaded and temperature cycled within an environmental chamber at 104 degrees F.

C. Self-Protection and Reliability Features:
   1. Adjustable current limit to 60 percent to 110 percent of drive rating.
   2. Adjustable instantaneous overcurrent trip.
   3. Under voltage trip.
   4. Over temperature trip.

5. Short circuit protection phase to phase and phase to ground faults phase rotation insensitive.
6. Momentary power loss, more than 17 milliseconds.
7. Transient protection against normal transients and surges in incoming power line.
8. Orderly shutdown in event of any of above conditions, drive designed to shut down safely without component failure.
9. Provide visual indication and manual reset.

D. Standard Features:
1. Drive Logic: Microprocessor based
2. Control Logic: Isolated from power circuitry.
3. Standalone operation to facilitate start up and troubleshooting procedures.
4. UL 508C listed for drives serving a single motor or UL 508A listed for drives serving multiple motors, for use on distribution systems with 22,000 AIC.
5. Output voltages equal to applied input voltage.
6. Isolated signal inputs.
7. Frequency Stability. Output frequency will be held to +0.1 percent of maximum frequency regardless of load, +10 percent input voltage change or temperature changes within ambient specification.
8. Built-in digital display indicates output frequency, voltage, and current and provide indication of over current, over voltage, current limit, ground fault, over temperature, input power on, minimum or maximum speed adjustment, power on, fault condition. Display on panel face.
9. Start/Stop Control - Controlled decelerated stop.
10. Primary and secondary fused for a control circuit transformer.
11. Minimum and maximum speed control.
12. Adjustable Accel/Decel - independently adjustable 10-100 second.
13. Hand-Off auto switches.
14. Programmable Auto Restart - after power outage.
15. Provide fused disconnect, including auxiliary contacts to isolate control circuit when disconnect is in “off” position, except fused disconnects not required where packaged equipment is provided with a single point connection with single point disconnect and internal overcurrent protection for VFD and motors.
16. Remote contacts for fault, and on/off status.
17. Adjustable motor output voltage.
18. Analog output voltage of 0-10 VDC, -20 MA proportional to control output frequency.
19. Provide a NEMA 1 enclosure for indoor applications and NEMA 3R enclosure for outdoor applications to isolate each motor starter and control section with its associated disconnect switch.
20. Manual speed control for each motor.
21. Provide RF, and EMI, noise suppression network to limit RF and EM interference.
22. Provide isolated analog output signals for volts, amps, and frequency, from each VFD for connection to the building energy management system.
23. Provide line (input) reactors.
24. Provide output filters for VFD’s located more than 25 conductor feet from the motor they serve. Output reactors permit VFD’s to be located up to 350-feet from the motors they serve.
25. Design VFD to catch spinning load in forward and reverse direction.
26. Harmonic Calculations: Perform on manufacturer supplied Harmonic Analysis program to provide conformance with IEEE 519-1992.

E. Communications:
   1. Provide factory installed communication chip for direct network connection to DDC Control System specified in Section 23 09 00, Instrumentation and Controls for HVAC. Interface allows for control and interface functions specified herein and in Section 23 09 00, Instrumentation and Controls for HVAC. Interface control functions and information includes, but not be limited to the following:
      a. Start/Stop, also provide hardwire connection for this control point.
      b. Change Directions
      c. Drive Fault
      d. Drive Fault Codes
      e. Reset Drive
      f. Percent Output
      g. Speed, also provide hardwire connection for this control point.
      h. Power
      i. Drive Temp
      j. KWH
      k. Run Time
      l. Run Status, also provide hardwire connection for this control point.
   2. Provide isolated analog output signals for volts, amps and frequency from each VFD for connection to the DDC Control System specified in Section 23 09 00, Instrumentation and Controls for HVAC.
   3. Provide RS485 communications port and programming software capability.

PART 3 EXECUTION

3.01 VARIABLE FREQUENCY DRIVE INSTALLATION

A. Install VFD in accordance with manufacturer's written installation instructions.

B. Install on strut support stand.

C. Provide one drive for each motor as scheduled.

3.02 START UP

A. General: Comply with manufacturer's instructions for startup.

B. Provide under direct supervision of the manufacturer's representative with factory trained personnel.

3.03 FIELD QUALITY CONTROL

A. Prior to installation, manufacturer's representative coordinate variable speed drive control interface with the controls contractor and verify that intended installation (controls, wiring, etc.) complies with the manufacturer's recommendations.

B. Field Test: Except where initial variable speed drive operation clearly shows the performance meets or exceeds the requirements, test to show compliance. Tests performed by the manufacturer's representative in the presence of the Engineer.

END OF SECTION

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SECTION 23 05 18
HVAC EXPANSION COMPENSATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. The provisions of Division 23, Heating, Ventilation and Air Conditioning (HVAC) Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.

1.02 SUMMARY

A. This Section includes Design-Build work.

B. This Section includes:
   1. Expansion Joints and Compensators
   2. Expansion Loops/Seismic Expansion Joints

1.03 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 29, Hangers, Supports and Anchors for HVAC

D. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment

E. Section 23 21 13, Pipe and Pipe Fittings HVAC

1.04 QUALITY ASSURANCE

A. Design expansion joints, pipe guides, and related supports, braces, and anchorages to building structure to absorb thermal expansion and contraction of piping and terminal movement, as well as to resist the static and dynamic loads due to fluid flow at design conditions, hydraulic testing pressures, and seismic forces.

B. Expansion Joints, Guides, and Related Supports, Braces, and Anchorage to Building Structure: Provide design and details bearing the seal of a professional engineer registered in the State having jurisdiction.

C. Use expansion joints in straight lengths of rigid pipe anchored and guided in accordance with best practices recommendations of ASHRAE and ASME B31.9.

D. Avoid use of expansion joints in conjunction with U-bends or other piping systems with inherent flexibility, such as piping with flexible mechanical couplings.
   1. If expansion joints are used in piping with bends, conduct thorough analysis of pipe stresses and deflections with extra care and attention paid to radial thrust capacity of pipe guides, braces, and anchors.

E. Design to include:
   1. Pipe stress analysis indicating loads, deflections, and pipe stress at critical points throughout the piping systems under the following conditions:
      a. At hydraulic design test pressure and ambient water temperature.
      b. At design operating temperature, pressure, and flow.
      c. At design occasional seismic loads where required by the building occupancy and risk category as defined in the state and local code or by the authority having jurisdiction.
      d. Model number, size, location, and details of expansion joints, compensator guides, supports, braces, and anchorage to building structure, with substantiating calculations that the components and building can accept the calculated loads and deflections.
      e. Detailed shop drawings stamped and signed by a registered professional engineer.
      f. Structural details and calculations stamped and signed by a registered professional structural engineer.

g. Expansion Joints to be designed and manufactured to the current Expansion Joint Manufacturers Association (EJMA) standards. Manufacturer of expansion joints to be certified by EJMA.

1.05 SUBMITTALS

A. Submit the following:
1. Product Data
2. Shop Drawings showing details of construction, dimensions, arrangement of components, and isolation.
3. Structural Details and Calculations: Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
4. Specified testing requirements.
5. Operating and Maintenance Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Expansion Joints and Compensators:
1. Flexonics
2. Keflex
3. Hyspan
4. Metraflex
5. Other Manufacturers: Submit substitution request.

B. Expansion Loops/Seismic Expansion Joints:
1. Metraflex Metraloop
2. Other Manufacturers: Submit substitution request.

2.02 EXPANSION JOINTS AND COMPENSATORS

A. Expansion compensators to be of the packless, externally pressurized type to allow for axial movement constructed of stainless steel bellows, stainless steel shroud, integral guide rings, internal liner, limit stops, with drain port and plug.

B. All materials of construction and pressure ratings shall be appropriate for the application as specified for each piping material and service.

2.03 EXPANSION LOOPS/SEISMIC EXPANSION JOINTS

A. Flexible stainless steel hose and braid connector.

B. Connector shall accept differential support displacement without damaging pipe, equipment connections, or support connections.

C. All materials of construction and pressure ratings shall be appropriate for the application as specified for each piping material and service.

PART 3 EXECUTION

3.01 EXPANSION JOINTS AND COMPENSATORS

A. Install piping risers in wood structures to compensate for 1/2-inch of shrinkage per floor. Contractor is responsible to determine quantities and locations required.

B. Install in piping to compensate for thermal expansion and contraction. Responsible to determine quantities and locations required.

C. Install in other locations indicated on the drawings.

D. Provide and install pipe alignment guides as recommended by the expansion joint manufacturer with the first guide no more than 4 pipe diameters away from the expansion joint or compensator and second guide no more than 14 pipe diameters from first guide.

E. Install per manufacturer’s installation instructions.

3.02 EXPANSION LOOP / SEISMIC EXPANSION JOINT

A. Install at building seismic expansion joints.

B. Install in piping to compensate for thermal expansion and contraction. Contractor is responsible to determine quantities and locations required.

C. Install in other locations indicated on the drawings.

D. Install per manufacturer's installation instructions.

END OF SECTION

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SECTION 23 05 19
METERS AND GAUGES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Thermometers - Water
   2. Pressure Gauges - General
   3. Differential Pressure Gauges
   4. Water Meter

1.02 RELATED SECTION

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

A. Submit the following:
   1. Products listed in this Section.
   2. Water flow meters, include graph of output signal vs. gpm for each device.
   3. Operating and Maintenance Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Thermometers - Water:
   1. Ashcroft
   2. Weiss
   3. Trerice
   4. Marsh
   5. Weksler
   6. Tel-Tru
   7. Other Manufacturers: Submit substitution request.

B. Pressure Gauges - General:
   1. Marsh
   2. Ashcroft
   3. Weiss
   4. Trerice
   5. Weksler
   6. Tel-Tru
   7. Other Manufacturers: Submit substitution request.

C. Differential Pressure Gauges:
   1. Between Rooms: Dwyer magnahelic Model 2000-00, 0-0.25 inches of water range.
   2. Across Filters: Dwyer magnahelic Model 2002-AF, 0-2.0 inches of water range with air filter gauge accessory package.

D. Water Meter:
   1. Hersey
   2. Badger
   3. Sparling.
   4. Other Manufacturers: Submit substitution request.

2.02 THERMOMETERS - WATER

A. Direct mounted 4-1/2-inch dial type, stainless steel case, separable sockets, stem length to penetrate minimum of 1/2 pipe diameter, adjustable face, extension necks where required to clear insulation, accuracy of 1 percent of range.

B. Range:

HVAC Systems	Temperature	Graduations
Chilled Water	25-125 degrees F	1 degrees F
Condenser Water	25-125 degrees F	1 degrees F
Heating Water	30-240 degrees F	2 degrees F
Heat Recovery Water	30-240 degrees F	2 degrees F
Steam (<60 psig)	100-350 degrees F	5 degrees F

2.03 PRESSURE GAUGES - GENERAL

A. Description: 4-1/2-inch dial, molded black polypropylene turret case.

B. Range:

HVAC Systems	Pressure	Graduations
Chilled Water	0-100 psi	1 psi
Heating Water	0-100 psi	1 psi
Condenser Water	0-100* psi	1 psi
Steam	0-30 psi	0.2 psi
*Provide compound gauge where shown on inlet side of condenser water pump on opening piping systems (30-inches Hg – 15 psi.) Other ranges may be listed on Drawings in which case they take precedence.		

2.04 DIFFERENTIAL PRESSURE GAUGES

A. Description: Surface mounted diaphragm-actuated dial type with zero pointer adjustment. Provide 4-inch minimum dial diameter with black figures on a white background.

B. Tubing: Copper; polytube may be used if concealed inside walls.

2.05 WATER METER

A. Description:
1. Disc type meter, bronze split casing, magnetic drive.
2. Heavy duty gear train, completely sealed, circular meter, totalize in cubic feet with sweep hand.
3. Comply with AWWA performance standards.

PART 3 EXECUTION

3.01 INSTALLATION - GENERAL

A. Provide meters and gauges where shown on Drawings.

B. Install gauges and meters as required and as recommended by equipment manufacturer or their representative.

C. Extend connections, wells, cocks, or gauges to a minimum of 1-inch beyond insulation thickness of the various systems.

D. Locate gauges so that they may be conveniently read at eye level or easily viewed and read from the floor or from the most likely viewing area, i.e., platform, catwalk, etc.

E. Install instruments over 6-feet-6-inches above floor, to be viewed from the floor, with face at 30 degrees to horizontal.

3.02 INSTALLATION - PRESSURE GAUGES

A. Provide instrument gauge cock at inlets. Provide protective siphon on steam gauges.

B. Locate pressure gauge taps for measuring pressure drop or increase across pumps, coils, condensers, etc., as close to the device as possible.

END OF SECTION

SECTION 23 05 23

GENERAL DUTY VALVES AND SPECIALITES FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Gate Valves
2. Globe Valves
3. Check Valves
4. Ball Valves
5. Butterfly Valves
6. Balancing Valve
7. Automatic Flow Control Valves
8. Pressure Independent Control Valve
9. Specialty Valves
10. System Specialties
11. Diaphrgm Expansion Tank System
12. Bladder Expansion Tank Sytem
13. Water Buffer Tank
14. Air Separator – High Efficiency Coalescing
15. N-Line Air Purger
16. Pressure Reducing Valve (Closed Hydronic System Feed)
17. Water Relief Valves
18. Strainers
19. Suction Diffusers
20. Water Filters

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

A. Submit product data.

B. Submit balancing valve schedule with manufacturer, model, size, flow rate and pressure drop.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. General: Where only NIBCO figure numbers are listed, equivalent products by those specified below are acceptable.

B. Gate Valves:
1. Apollo
2. Victaulic
3. Crane
4. Kennedy
5. Stockham
6. Milwaukee
7. Walworth
8. Hammond

C. Globe Check:
1. Apollo
2. Victaulic
3. Crane
4. Kennedy

5. Stockham
6. Milwaukee
7. Walworth
8. Hammond

D. Check Valves:
1. Mueller
2. Metraflex
3. Victaulic
4. Bell and Gossett
5. Milwaukee
6. Gruvlok.

E. Ball Valves:
1. Gruvlok
2. Apollo
3. Crane
4. Hammond
5. Milwaukee
6. Victaulic

F. Butterfly Valves:
1. Apollo
2. Victaulic
3. Gruvlok
4. Crane
5. Walworth
6. Milwaukee
7. Metraflex

G. Balancing Valve:
1. DeZurik
2. Homestead
3. Bell and Gossett
4. Armstrong
5. Walworth
6. Taco
7. Wheatley
8. Tour & Andersson
9. Victaulic
10. Gruvlok
11. NIBCO

H. Specialty Valves

I. System Specialties:
1. Manual Air Vents:
   a. Coin type
   b. Dole 9
   c. Or approved equal.
2. Automatic Air Vents:
   a. Hoffman 78
   b. Amtrol
   c. Armstrong
   d. Spirax-Sarco Engineering
   e. Spirotherm Spirotop
   f. Other Manufacturers: Submit substitution request.

3. Pressure/Temperature Test Plug:
    a. Peterson Engineering, Inc.
    b. Universal Lancaster
    c. Sisco
    d. Trerice
    e. Other Manufacturers: Submit substitution request.

J. Integrated Coil Piping Connector:
1. Griswold Controls
2. HCi

K. Diaphragm Expansion Tank System:
1. Amtrol
2. Bell & Gossett
3. Armstrong
4. Wheatley
5. Taco
6. Other Manufacturers: Submit substitution request.

L. Bladder Expansion Tank System:
1. Amtrol, Bell & Gossett
2. Armstrong
3. Wheatley
4. Taco
5. Other Manufacturers: Submit substitution request.

M. Water Buffer Tank:
1. Cemline
2. Taco
3. Bell & Gossett
4. Amtrol
5. Wessels Company
6. Bradford-White
7. A.O. Smith
8. Other Manufacturers: Submit substitution request.

N. Air Separator – High Efficiency Coalescing :
1. Spirotherm Spirovent
2. CALEFFI
3. Other Manufacturers: Submit substitution request.

O. N-Line Air Purger:
1. American Air Purger Model 720 eliminator.
2. Other Manufacturers: Submit substitution request.

P. Pressure Reducing Valve (Closed Hydronic System Feed) :
1. Bell & Gossett
2. Armstrong
3. Taco
4. Amtrol
5. Cash Acme
6. Other Manufacturers: Submit substitution request.

Q. Water Relief Valves:
1. Consolidated
2. Kunkle Valve
3. B&G, Armstrong
4. Cash Acme
5. Other Manufacturers: Submit substitution request.

R. Strainers:
   1. General:
      a. NIBCO
      b. Armstrong
      c. McAlear Mfg. Co.
      d. Sarco, Inc.
      e. Steamflo
      f. Mueller
      g. R.P. & C. Company
      h. Titan Flow Control
      i. Other Manufacturers: Submit substitution request.
   2. Grooved Coupling Systems:
      a. Gruvlok
      b. Victaulic

S. Suction Diffusers:
   1. General:
      a. Bell & Gossett
      b. Armstrong
      c. Taco
      d. Amtrol
      e. Wheatley
      f. Paco
      g. Mueller
      h. Other Manufacturers: Submit substitution request.
   2. Grooved Piping Systems:
      a. Gruvlok
      b. Victaulic

T. Triple Duty Valve
   1. General:
      a. B&G Triple Duty Valve
      b. Armstrong
      c. Amtrol
      d. Wheatley
      e. Paco
      f. Mueller
      g. Taco
      h. Other Manufacturers: Submit substitution request.
   2. Grooved Piping Systems:
      a. Gruvlok
      b. Victaulic

U. Water Filters:
   1. Pall
   2. Millipore
   3. Other Manufacturers: Submit substitution request.

V. Differential Pressure Regulator Valve:
   1. Jordan Mark 67D
   2. Hoffman
   3. Clayton
   4. Other Manufacturers: Submit substitution request.

W. Other Manufacturers: Submit substitution request.

X. Use one manufacturer on valves.

Y. Threaded, flanged, soldered, or grooved valve ends, as applicable to piping system. Refer to Section 23 21 13, Pipe and Pipe Fittings HVAC for allowable fittings.

2.02 GATE VALVES

A. Bronze Gate: Bronze body, bronze trim, bronze screwed bonnet; solid wedge, 150 psi steam rating (use bonnet on steam service), 300 psi WOG, NIBCO 134.

B. Iron Gate, OS&Y: Iron body, bronze trim, OS&Y pattern, solid wedge, 150 psi rating; NIBCO 637.

2.03 GLOBE VALVES

A. Bronze Globe and Angle Globe: Bronze body, bronze mounted, renewable composition disc, 150 psi rating; NIBCO 235 or 335.

B. Iron Globe: Iron body, bronze mounted, OS&Y pattern, renewable composition disc, 125 psi rating; NIBCO 718-B.

2.04 CHECK VALVES

A. Horizontal Bronze Swing Check: Bronze body, bronze mounted, regrinding bronze disc, 150 psi steam rating, 300 psi WOG; NIBCO 433-Y.

B. Horizontal Iron Swing Check: Iron body, bronze mounted, regrinding bronze disc and seat ring, 125 psi rating; NIBCO 918.

C. Vertical and Silent Check Valves:
   1. 250 pounds WOG, iron body, stainless steel trim, globe type with flanged ends; NIBCO 960.
   2. 300 psig CWP, ductile iron body, stainless steel spring, and shaft. Victaulic Series 716.
   3. 230 psig CWP, AGS grooved end ductile iron body, stainless steel spring, shaft, and disc, EPDM seat. Victaulic Series W715.

D. Vertical and Silent Check Valves: 250-lb. WOG, iron body, stainless steel trim, wafer type; NIBCO W-960.

E. Iron Swing Check with Lever and Spring: Iron body, bronze fitted, with adjustable lever and spring; NIBCO F-918-BL&S.

2.05 BALL VALVES

A. Bronze Ball: Bronze cast body or forged brass, chrome-plated full port ball, with handle, Teflon seat, 300 psi WOG, 150 psi steam; NIBCO 585-70 or Victaulic Series 589.

B. PVC Ball: PVC Body, trunnion mounted, Teflon seat, Viton seals, socket type connection; True Blue GSR Asahi.

2.06 BUTTERFLY VALVES

A. Ductile iron body, electroless-nickel chrome plated disc and stainless steel shaft (shaft offset from the disc centerline to provide complete 360-degree circumferential seating), with lever handle and locking feature on valves 6-inches and less, gear operator on valves 8-inches and over; stem neck length to accommodate insulation where applicable, pressure responsive EPDM liner, 300 psi water; Victaulic MasterSeal, NIBCO 2000, NIBCO 4765.

B. Copper Grooved Piping System Butterfly Valve: Nylon coated or Cast bronze body per Copper Development Agency-836, ductile iron disc encapsulated with EPDM coating, lever handle up to 6-inches, gear operator on valves 8-inches and greater, stem length to accommodate insulation, 300 psi water; Victaulic Series 608, per ASTM A-584.
   1. Grooved ends manufactured to copper-tubing sizes. Flaring tube or fitting ends to accommodate alternate sized couplings is not permitted.

2.07 BALANCING VALVE

A. Calibrated:
   1. Y-pattern globe style design. Valve to perform the following functions: Precision flow measurement, precision flow balancing, memory stops, positive shut-off to a minimum of 250 psi, drain port suitable for hose bibb fitting. Threaded or solder ends for 1/2-inch through 2-inches. 1/2-inch valve capable of balance to 0.5 GPM. Grooved or flanged ends for 2-1/2-inches through 12-inches. Tour & Andersson, Armstrong CBV, Gruvlok GBV, NIBCO CBV 1710, 737.
   2. Size balancing valves based on the published performance curve characteristics for the scheduled flow rate for each location to ensure proper operation at design conditions.

2.08 SPECIALTY VALVES

A. Gauge Cocks: Brass, tee handle, male to female, 200 psi working pressure, 1/4 inch; Conbraco 41 series.

B. Drain Valves: Bronze globe valve or full port ball valve, garden hose end, cap, and chain 3/4 inch size.

2.09 SYSTEM SPECIALTIES

A. Automatic Air Vents: Water main type, cast brass body, built-in check valve, 1/8-inch I.P.S. top tapping for moisture discharge, 3/4-inch size, 150 psi operating pressure.

B. Temperature and Pressure Test Plugs:
   1. General: 1/2-inch N.P.T. fitting to receive either a temperature or pressure probe 1/8-inch O.D., fitted with a color coded and marked cap with gasket.
   2. Material: Solid brass with valve core of NORDEL.
   3. Rating: Minimum 300 psig at 275 degrees F.
   4. Gauges and Thermometers: Supply Owner with two pressure gauge adapters with 1/8-inch O.D. probe and two five-inch stem pocket test thermometers 25 degrees - 125 degrees F for chilled water, 40 degrees -240 degrees F for heating water.

2.010 DIAPHRAGM EXPANSION TANK SYSTEM

A. Expansion Tank:
   1. Diaphragm type of welded steel, constructed and stamped in accordance with ASME Code for 125 psi working pressure.
   2. Support with steel legs or bases for vertical installation or steel saddles for horizontal installation.
   3. Precharge with compressed air to minimum fill pressures.

2.011 BLADDER EXPANSION TANK SYSTEM

A. Expansion Tank:
   1. Bladder type of welded steel, constructed and stamped in accordance with ASME Code for 125 psi working pressure.
   2. Support with steel legs or bases for vertical installation or steel saddles for horizontal installation.
   3. Precharge with compressed air to minimum fill pressures as indicated.
   4. Replaceable bladder.

2.012 WATER BUFFER TANK

A. Vertical tank constructed of heavy gauge carbon steel with internal baffle, welded support stand and drain and vent connections.

B. Rated for 125 psig working pressure in accordance with ASME Boiler and Pressure Vessel Code Section VIII, Division 1.

C. Flanged inlet and outlet pipe connections.

D. Capacity and connection sizes per schedule on Drawings.

2.013 AIR SEPARATOR – HIGH EFFICIENCY COALESCING

A. Turbulence suppressive type air eliminator to separate microbubbles and to remove stationary air pockets through absorption. Brass or steel body with centerlined inlet and outlet for in-line piping. Valved side tap to bleed large amounts of air during system fill.

B. Integrated brass venting mechanism on top. Blowdown connection port at bottom.

C. Maximum working pressure, 150 psi. Maximum working temperature 250 degrees F. Maximum allowable water velocity, 4ft/second. Maximum pressure drop 0.5-feet.

D. Air elimination efficiency of 100 percent free air, 100 percent entrained air, 99.6 percent dissolved air.

2.014 IN-LINE AIR PURGER

A. Description: Fabricated steel air purger with [flanged] [screwed] inlet and outlet, disked air entrapment head, purger, and drain coupling.

B. Eliminator:
1. Use the same manufacturer capable of eliminating air as fast as it can be separated.
2. Design so air cannot be drawn into the system if negative pressures occur.

C. Size: Purger to be line size.

2.015 PRESSURE REDUCING VALVE (CLOSED HYDRONIC SYSTEM FEED)

A. Description: Self-filling type with low inlet pressure check valve, removable strainer, adjustable range, and set point as indicated on the Drawings.

B. Construction:
1. Iron body for steel piping installation, brass body for copper piping installation.
2. Brass working parts.

C. Size: 3/4-inch unless shown otherwise.

2.016 WATER RELIEF VALVES

A. Bronze or steel body, stainless steel or bronze, pressure settings to 160 psi at 250 degrees F, conforming to Section IV of ASME Code, size per manufacturer's recommendations based on Code, setting as indicated; Kunkle Model 537.

2.017 STRAINERS

A. Wye Pattern:
1. Bronze: Bronze body, 250 psi, 1/16-inch perforated type 304 stainless screen.
2. Ductile Iron: Ductile iron body, 300 psi, 1/16 or 1/8-inch 304 stainless steel screen.
3. Cast Iron: Cast iron body, 125 psi, 1/16-inch perforated type 304 stainless screen.
4. Cast Iron, High Pressure: Cast iron body, 250 psi, 1/16-inch perforated type 304 stainless screen.

B. Basket Pattern: Semi-steel body, 125 psi WOG, flanged, 1/8-inch perforated type 304 stainless steel screen, closed bottom basket, clamped, or bolted cover.

2.018 SUCTION DIFFUSERS

A. Description:
1. Angle type body with inlet straightening vanes and combination orifice cylinder-diffuser-strainer with 3/16-inch diameter openings.
2. Provide inlet vane length equal to 2-1/2 times pump connection diameter.
3. Provide adjustable support foot to carry the weight of suction piping, drain plug, and pressure gauge tap.

B. Construction:
1. Cast iron body rated for 175 psig operating pressure at 300 degrees F.
2. Provide steel inlet vanes on closed systems, stainless steel on open systems and domestic water systems.

3. Provide steel orifice cylinders on closed systems, stainless steel on open systems and domestic water systems.
4. Provide bronze mesh start-up strainers on closed systems and domestic water systems, none on open systems.

C. Selection:
1. Outlet Size: Match pump inlet size.
2. Inlet Size:
a. Match pipe size upstream.
b. Maximum of 2 psi drop without start-up strainer.

2.019 WATER FILTERS

A. Chilled Water:
1. Housing:
a. Carbon steel housing suitable for holding 2 filter elements with quick release stainless steel clamp, Viton O-ring and cartridge seals, Viton couplers, and ductile iron head.
b. Unit rated for 150 psig operation.
c. Manufacturer: Pall MCD.
2. Filter Cartridge:
a. Industrial style filter cartridge constructed for pure cellulose medium without binders.
b. Pleated to provide high surface area with the corrugated medium supported by a perforated pure polypropylene core without filler or reinforcement to withstand 75 psi differential at 70 degrees F in normal outside to inside flow direction.
c. Outer support cage of pure polypropylene around the entire cartridge to provide high structural strength.
d. Nominal filtration rating of 98 percent on particles 10 micrometers and larger.
e. Manufacturer: Pall DE.

B. Heating Water:
1. Housing:
a. Carbon steel housing suitable for holding two filter elements with quick release EPR O-ring and cartridge seals suitable for operation at 300 degrees F.
b. Element seal by tie rod and seal nut onto element gasket.
c. Unit rated for 150 psig operation.
d. Manufacturer: Pall MCC.
2. Filter Cartridge:
a. Industrial style filter cartridge constructed of epoxy resin-impregnated cellulose medium.
b. Pleated to provide high surface area with the corrugated medium supported by a perforated 300 series stainless steel core and end caps.
c. Filter able to withstand 75 psi differential pressure in normal outside to inside flow direction.
d. Nominal filtration rating of 98 percent on particles 10 micrometers and larger.
e. Manufacturer: Pall Corporation Epocel Series

C. Condenser Water:
1. Housing:
a. 316 stainless steel housing, maximum 150 psi rating, SMC polyester lid with galvanized steel nuts and bolts, nitrile rubber seals, in-line arrangement, TurboClean flush assembly, ASA flange fitting connection points.
b. Manufacturer: Amirad
2. Filter Cartridge:
a. Nominal 100 micron filter rating, weave wire screen design, 316 stainless steel, nitrile rubber seals, maximum 1 psi pressure drop.
b. Manufacturer: Amirad

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide valves at connections to equipment where shown or required for equipment isolation.

B. Install valves and strainers in accessible locations and same size as connected piping (not the size of the equipment connection), except balancing valves sized by contractor to properly balance the flow.

C. Provide separate support for valves where necessary.

D. Provide drain valves in low points in the piping system, at coils and equipment, and as indicated.

3.02 APPLIED LOCATIONS HVAC VALVES

A. Piping 2-inches and Smaller:

System	Valve Types				
	Gate	Globe	Swing Check	Ball	Butterfly
Heating Water	At Boiler Only	Bronze	Bronze	Bronze	Not Allowed

B. Piping 2-1/2-inches and Larger:

System	Valve Types				
	Gate	Globe	Check	Ball	Butterfly
Heating Water	Iron	Iron	Iron, Swing	Not Allowed	Ductile Iron

C. Calibrated y-pattern globe balancing valves 1/2-inch through 12-inches, on water coils and in piping systems in accordance with manufacturer's recommendations.

D. Provide gauge cock for pressure gauges.

E. Provide gate valves with pressure type packing glands for heating water boiler shutoff applications. Meet requirements of ASME Boiler and Pressure Vessel Code, Section IV, Article 7 for Stop Valves.

3.03 VALVE IDENTIFICATION

A. General: Identify valves to indicate their function and system served.

B. See Section 23 05 53, Identification for HVAC Piping and Equipment.

3.04 INSTALLATION

A. Manual Air Vents:
   1. Install at high points where automatic air vents are not used, where noted, and where required for proper venting of system.
   2. Install in accordance with manufacturer's recommendations.

B. Automatic Air Vents:
   1. Install automatic air vents at high points where air can collect in water systems where indicated. Route drain lines from vent to nearest floor drain.
   2. Install 3/4-inch globe shut-off valve ahead of air vent. Install ball valve where bucket drainage is required.

C. Grooved Mechanical Pipe Valve End Connections:
   1. Refer to Section 23 21 13, Pipe and Pipe Fittings HVAC for allowed service installations.
   2. Install in accordance with the manufacturer's published installation instructions.
   3. Mold and produce gaskets by the coupling manufacturer, and suitable for the intended service.
   4. The coupling manufacturer's factory trained representative:
      a. Provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products.

b. Periodically visit the project site to ensure best practices in grooved installation are being followed.
c. A distributor's representative is not considered qualified to conduct the training or field visits.

D. Test Plugs: Install where indicated and in accordance with the manufacturer's recommendations.

E. Coil Connectors:
1. Applied Locations: Integrated coil connectors are prohibited except where specifically indicated below or on the drawings.
2. Make connections in accordance with Section 23 21 13, Pipe and Pipe Fittings HVAC.

F. Expansion Tanks:
1. Support with steel rods and brackets from structure or from structural steel stand as required.
2. Pipe valve drain to over floor drain.

G. Water Buffer Tank:
1. Install as shown on Drawings and in accordance with the manufacturer's recommendations.
2. Insulate per Section 23 07 00, Insulation for HVAC.
3. Pipe valve drain to over floor drain.

H. Air Separator:
1. Install as shown on Drawings and in accordance with the manufacturer's recommendations.
2. Suspend from structure with steel rods or brackets or support from steel stand as required.
3. Bleed system air at start-up according to manufacturer's recommendations.

I. In-Line Air Purger:
1. Install purger and eliminator as shown on Drawings and in accordance with the manufacturer's printed recommendations.
2. Support separately from structure with spring isolators as required.
3. Install bronze globe shut-off valve between the purger and eliminator.
4. Pipe discharge to nearest floor drain using Schedule 40 galvanized steel pipe.

J. Pressure Reducing Valves:
1. Install where indicated and in accordance with manufacturer's recommendations with 3 valve bypass.

K. Water Relief Valves:
1. Install where indicated, and in accordance with manufacturer's instructions.
2. Pipe discharge to nearest floor drain using Schedule 40 steel pipe.

L. Strainer:
1. Provide valved blow off for each strainer of same size as plugs with maximum size of 1-1/2 inches.
2. Pipe blow off full size and terminate over floor drains except finned tube, reheat coils, fan coils, terminal units, and unit heaters.
3. Applied Locations HVAC:
a. Cast iron wye, chilled, heating, and heat recovery water, low pressure steam, low pressure condensate.
b. Bronze wye, in piping 2-inch and smaller, medium, and high pressure steam and condensate.
c. Cast iron, high pressure wye, in piping 2-1/2-inch and larger, medium, and high pressure steam and condensate.
d. Basket, in piping 2-1/2-inch and larger, condenser water inlet to pumps.

M. Suction Diffusers:
   1. Install on inlets of pumps where indicated in accordance with manufacturer's recommendations.
   2. Support suction diffuser and piping from same surface as pump base is supported unless shown otherwise. Adjust foot so that pump inlet does not carry piping weight.
   3. Pipe pressure gauges to gauge port, and blow down to drain with ball shut-off valve.
   4. After operating pumps for seven days, clean strainer and remove start-up strainer.

N. Water Filters:
   1. Install per manufacturer's recommendations where shown.
   2. After system is accepted by Owner, provide one set of filters for each filter station.

O. Differential Pressure Regulating Valve: Install per manufacturer's recommendations where shown on plans.

END OF SECTION

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SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. The provisions of Division 23, Heating, Ventilation and Air Conditioning (HVAC) Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.

1.02 SUMMARY

A. This Section includes Design-Build work.

B. This Section includes:
1. Supports
2. Anchors
3. Pipe Rollers
4. Insulation Protection Shields
5. Insulation Protection Saddles
6. Building Attachments
7. Roof Mounted Equipment Support
8. Roof Curbs

1.03 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment

D. Section 23 07 00, Insulation for HVAC

E. Section 23 21 13, Pipe and Pipe Fittings HVAC

1.04 QUALITY ASSURANCE

A. Provide pipe and equipment hangers and supports in accordance with the following:
1. Design supports, anchorages, and seismic restraints for equipment, and supports and seismic restraints for conduit, piping, and ductwork when not shown on the Drawings.
2. Hangers, supports and sway braces to be fabricated in accordance with ANSI B31.1 and MSS SP-58 and SP-89.
3. Use components for intended design purpose only. Do not use for rigging or erection purposes.
4. Seismic restraints and anchorages shall resist seismic forces as specified in the state and local code or by the authority having jurisdiction for the seismic zone in which the project is constructed.
5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.
6. Seismic Restraints:
   a. Shall not introduce stresses in the piping caused by thermal expansion or contraction.
   b. Shall not exceed forces or design limits of the piping per ASME B31.9.
   c. Provide in accordance with the latest edition of the SMACNA, Seismic Restraint Manual Guidelines for Mechanical Systems" for the Seismic Hazard Level corresponding to the seismic zone in which the project is constructed.
   d. Provide in accordance with the local applicable codes.
   e. Follow provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

7. Piping Connections to Equipment:
    a. Shall not introduce twisting, torsion, or lateral forces or moments on the equipment.
    b. Shall be supported and isolated in a manner not to exceed the equipment's point of connection load limitations.

B. Engineered Support Systems: Provide design services for the following support systems:
1. Supports and seismic restraints for suspended piping, ductwork, and equipment.
2. Support frames such as pipe racks or stanchions for piping, ductwork, and equipment which provide support from below.
3. Equipment, ductwork, and piping support frame anchorage to supporting slab or structure.

1.05 SUBMITTALS

A. Submit the following:
1. Shop Drawings of contractor fabricated support structures.
2. Structural Details and Calculations:
    a. Submit structural details and calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads.
    b. Details and calculations to bear the seal of a professional engineer registered in the state having jurisdiction.
3. No other submittals required under this section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Supports:
1. Unistrut
2. Superstrut
3. Powerstrut
4. Kinline
5. B-Line Systems
6. AnvilStrut

B. Pipe Hangers:
1. Anvil
2. Superstrut
3. B-Line Systems
4. Tolco
5. ERICO
6. Pipe Shields Inc.
7. Rilco

C. Pipe Rollers
1. Anvil
2. Super Strut
3. B-Line Systems
4. Tolco
5. ERICO

D. Insulation Protection Shields
1. Anvil
2. Super Strut
3. B-Line Systems
4. Tolco
5. ERICO

E. Insulation Protection Saddles
1. Anvil
2. Super Strut

3. B-Line Systems
4. Tolco
5. ERICO

F. Pipe Guides
1. Anvil
2. B-Line Systems
3. Pipe Shields Inc.
4. Rilco
5. Hyspan

G. Pipe Anchors
1. Anvil
2. B-Line Systems
3. Pipe Shields Inc.
4. Rilco

H. Building Attachments
1. Anvil
2. Elcen
3. Superstrut
4. B-Line Systems
5. Tolco
6. ERICO

I. Roof Mounted Equipment Support
1. Thybar
2. Greenheck
3. Twin City

J. Roof Curbs
1. Thybar
2. Greenheck
3. Twin City

2.02 SUPPORTS

A. Fabricate support members from welded standard structural shapes, pipe, and plate to carry the necessary rollers, hangers, and accessories as required. Support piping less than 4-inch pipe size from or by prefabricated roll-formed channels with necessary accessories to adequately support piping system.

B. Supports and Accessories: Preformed roll-formed channels and accessories with matching compatible accessories as shown, as specified, and as required.

C. Dissimilar Metal Protection: Hydra-Zorb cushions or Cush-a-strip.

D. Clamps: Super Strut Series 700 through 702 or AnvilStrut Series 1000 through 1200.

2.03 PIPE HANGERS

A. Uninsulated Horizontal Copper Piping:
1. 2-inch and Smaller: Anvil CT-65, CT-69.
2. Larger than 2-inch:
a. Anvil 260 field or factory copper plated, plastic coated or other recognized industry methods.
b. Electricians' tape is unacceptable.

B. Insulated Horizontal Copper Pipe with Hangers Inside of Insulation: Same as Uninsulated Horizontal Copper Pipe.

C. Insulated Horizontal Copper Pipe with Hangers Outside of Insulation:
1. 2-inch and Smaller: Anvil 65, 104 or 260.
2. Larger than 2-inch: Anvil 260.

D. Other Uninsulated Horizontal Pipe:
   1. 2-inch and Smaller: Anvil 65, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

E. Other Insulated Horizontal Pipe with Hangers Inside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 104, 260 or 300.
   2. Larger than 2-inch: Anvil 260.

F. Other Insulated Horizontal Pipe with Hangers Outside of Insulation:
   1. 2-inch and Smaller: Anvil 65, 104 or 260.
   2. Larger than 2-inch: Anvil 260.

G. Riser Clamps Copper Pipe:
   1. 4-inch and Smaller: Anvil CT-121, CT-261.
   2. Larger than 4-inch: Anvil 261.

H. Riser Clamps Other Piping: Anvil 261.

2.04 PIPE ROLLERS

A. Cast Iron roll and sockets, steel roll rod.
   1. Anvil 171, 175, 177, 178, 181, or 274 as required.
   2. Size for pipe plus insulation for insulated pipe.

2.05 INSULATION PROTECTION SHIELDS

A. Galvanized carbon steel.
   1. Anvil 167.

2.06 INSULATION PROTECTION SADDLES

A. Carbon steel.
   1. Anvil 160 series.
   2. Saddles for copper pipe: Factory copper plated.

2.07 PIPE GUIDES

A. Spider type alignment guide.
   1. Anvil 255, 256, 257 & 436
   2. Steel Piping:
      a. Carbon steel housing
      b. Carbon steel spider clamp
   3. Copper Piping:
      a. Carbon steel housing
      b. Factory copper plated steel spider clamp

2.08 PIPE ANCHORS

A. Uninsulated Pipe
   1. Pipe Shields Inc. C1000

B. Insulated Pipe
   1. Pipe Shields Inc. C3000 through C4300 series

C. Pipe Stanchions
   1. Anvil 62

2.09 BUILDING ATTACHMENTS

A. Beam Hangers:
   1. On piping 6-inch and smaller: Anvil 86 with retaining clip Fig. 89.
   2. On piping larger than 6-inch: Anvil 228, or 292.

B. Inserts:
   1. Anvil 152 malleable iron or 281 steel inserts.
   2. Inserts sized for required rod to support load being carried.

C. Expansion Plugs: Similar and equal to Phillips “red-head” self-drilling flush shell selected for safety factor of 4.

D. Powder actuated fasteners with silencers as approved by Architect.

2.010 ROOF MOUNTED EQUIPMENT SUPPORT

A. Continuous welded aluminum or galvanized steel construction.

B. Pressure treated wood nailer strip mechanically fastened with corrosion resistant fasteners.

C. Engineered to support gravity and seismic loads of equipment.

D. Suitable for use on insulated or non-insulated roof decks.

E. Account for roof slope and roof insulation thickness to provide level mounting service for equipment.

F. Curb height no less than 8 inches from roof membrane.

2.011 ROOF CURBS

A. Continuous welded aluminum or galvanized steel construction.

B. Pressure treated wood nailer strip mechanically fastened with corrosion resistant fasteners.

C. Engineered to support gravity and seismic loads of entire unit.

D. Suitable for use on insulated or non-insulated roof decks.

E. Account for roof slope and roof insulation thickness to provide level mounting service for equipment.

F. Curb height no less than 8 inches from roof membrane.

G. Provide minimum 1-1/2 inch thick 3 pounds per cubic foot density rigid fiberglass insulation with encapsulated top and bottom.

H. Spring isolated roof curbs where fans and compressors are not internally isolated.

I. Security bars on 6-inch centers.

J. Seismic/wind restraint brackets.

PART 3 EXECUTION

3.01 HANGERS AND SUPPORTS

A. General:
   1. Install support systems as detailed and in accordance with manufacturer’s recommendations. Provide pipe racks, pipe stands, trapeze hangers, etc., as required, and as detailed on the Drawings.
   2. Provide adjustable hangers for pipes complete with inserts, adjusters, bolts, nuts, swivels, all-thread rods, etc., except where specified otherwise.
   3. Arrange for grouping of parallel runs of horizontal piping to be supported together on trapeze type hangers where possible. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping and do not support piping from other piping.
   4. Except as otherwise indicated for exposed continuous pipe runs, install hangers, and supports of same type and style as installed for adjacent similar piping.
   5. Support piping within 2-feet of each change of direction on both sides of fitting.

B. Insulated Piping Systems:
   1. Refer to Section 23 07 00, Insulation for HVAC for insulation requirements.
   2. Insulated Piping Systems with Vapor Barrier Insulation:
      a. Install hangers outside of insulation.
      b. On piping 1-1/2-inch and larger, provide insulation protection shields at each support location.

3. Other insulated Piping Systems with Non-Vapor Barrier Insulation:
    a. At the contractor's option, hangers may be installed inside or outside of insulation for piping 2-inch and smaller.
    b. If hangers are installed outside of insulation, provide insulation protection shields at support locations on piping 1-1/2-inch and larger.
    c. On piping larger than 2-inch, provide insulation saddles at each support location.
4. Insulation Protection:
    a. Band insulation protection shields firmly to insulation to prevent slippage.
    b. Tack weld insulation protection saddles to steel pipe. Braze saddles to copper pipe.

C. Vertical Piping:
1. Support Spacing: Provide support at minimum spacing in accordance with state and local codes.
2. Support with U-clamps fastened to wall to hold piping away from wall unless otherwise approved.
3. Provide mid-story vertical guide support where floor to floor distances exceed spacing as required by state and local codes. Riser clamps on steel pipe to be directly welded to pipe. Riser clamps on copper pipe to be installed directly under fitting.
4. Risers that are not subject to thermal change to be supported at each floor of penetration.
5. Risers that are subject to thermal change require engineered supports. Size supports to carry forces exerted by piping system when in operation. Riser supports follow the provisions described in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

D. Horizontal Piping:
1. Trapeze Hangers:
    a. Multiple pipe runs where indicated supported on channels with rust resistant finish.
    b. Provide necessary rods and supporting steel.
2. Support Spacing:
    a. Provide support at maximum spacing in accordance with state and local codes and any applicable manufacturer requirements.
    b. Support piping within 2-feet of each change in direction.
    c. Provide piping with acoustical lagging wrap supported a maximum of 5-feet on center. Install hangers outside of acoustical lagging.

E. Building Attachments:
1. Fastening or attaching to steel deck (without concrete fill) is prohibited. It will be necessary to support piping from structural members, beams, joists, or provide intermediate angle iron supporting members between joists. Supports may be attached to concrete filled steel deck with load limitations shown on the structural drawings or otherwise obtained from the structural engineer.
2. Provide horizontal bracing on horizontal runs 1-1/2-inch and larger and exceeding 50-feet in length at 75-foot intervals and as required to provide stabilized piping systems.
3. Provide additional structural steel angles, channels, or other members required to support piping where structures do not occur as required for proper support.
4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at joist panel points.

F. Roof Mounted Equipment Supports:
1. Select appropriate model for insulated or uninsulated roof deck.
2. Install per manufacturer's instructions.
3. Account for roof slope to provide level mounting service for equipment.

G. Roof Curbs:
1. Select appropriate model for insulated or uninsulated roof deck.
2. Install per manufacturer's instructions.
3. Account for roof slope to provide level mounting service for equipment.

4. Coordinate dimensions with installed HVAC unit.

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SECTION 23 05 48

VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. The provisions of Division 23, Heating, Ventilation and Air Conditioning (HVAC) Section 23 05 00, Common Work Results for HVAC, apply to work specified in this Section.

1.02 SUMMARY

A. This Section includes:
1. Neoprene Waffle Pad
2. Restrained Neoprene Mount
3. Spring Isolators
4. Springs with Restraints
5. Base with Springs
6. Inertia Base
7. Isolating Spring Hangers
8. Isolating Neoprene Hangers
9. Rooftop Air Handling Unit Isolation Curb
10. Isolating Sleeves
11. Seismic Restraints
12. Flexible Sphere Connector
13. Flexible Hose Connector

B. Isolation of mechanical equipment as indicated on the Drawings and specified herein.

C. Seismic restraint of equipment, piping, and ductwork.

1.03 RELATED SECTIONS:

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 18, HVAC Expansion Compensation

D. Section 23 05 29, Hangers, Supports and Anchors for HVAC

E. Section 23 31 01, HVAC Ducts and Casing-Low Pressure

F. Section 23 31 02, HVAC Ducts and Casing-Medium Pressure

1.04 QUALITY ASSURANCE

A. Single manufacturer select and furnish isolation required, except packaged equipment with integral isolators meeting all the isolation and seismic requirements of this Specification.

B. System of vibration isolators and seismic controls designed, detailed, and bear the seal of a professional engineer registered in the State having jurisdiction.

C. Isolation performance requirements are indicated in the specifications. Deflections indicated are nominal static deflections for specific equipment supported.

D. Isolator Stability and Rated Capacity:
1. Spring diameters not less than 0.8 of the compressed height of the spring at rated load.
2. Springs have a minimum additional travel to solid equal to 50 percent of the rated deflection.

E. Seismic Restraints:
1. Restraint of equipment, piping, and ductwork to be in accordance with the current state and local Building Code.
2. Calculations in accordance with current state and local Building Code.

1.05 SUBMITTALS

A. Submit the following:
   1. Submit Shop Drawings showing complete details of construction for steel and concrete bases including:
      a. Equipment mounting holes.
      b. Dimensions
      c. Isolation selected for each support point.
      d. Details of mounting brackets for isolator.
      e. Weight distribution for each isolator.
      f. Code number assigned to each isolator.
   2. Submit product data and calculation sheets for isolators, showing:
      a. Size, type, load rating, and rated deflection of each required isolator.
      b. Percent of vibration transmitted based on the lowest disturbing frequency of the equipment.
   3. Structural Details and Calculations substantiating that building structure, anchorages, and fabricated steel braces can safely withstand maximum calculated loads stamped and signed by a registered structural engineer.
   4. Installation report as specified in PART 3 of this Section.
   5. Operation and maintenance data.

1.06 EQUIPMENT VIBRATION ISOLATION

A. Provide a balanced set of vibration isolators for each piece of equipment listed in the Equipment Schedules.

B. Isolation work to include, but not necessarily be limited to, the following:
   1. Isolation support of motor-driven equipment.
   2. Inertia base frames in conjunction with isolation.
   3. Isolation support of air-handling housings.
   4. Isolation support of piping, piping risers, and ductwork.
   5. Penetration isolation of pipework, ductwork, and conduits through walls, floors, or ceilings.
   6. Flexible connections of ductwork and piping to equipment.

C. Each piece of rotating equipment must meet a reasonable criterion for maximum vibration levels at each bearing, while in operation. The criteria for varying operating speeds are given as follows:
   1. Rotating equipment operating at peak vibration velocities must not exceed 0.08-inch/second.
   2. If it is discovered that the operating vibration velocities exceed this criteria, the equipment repaired or replaced at no expense to the owner until approval of the equipment is given by the Engineer.

D. Provide components or materials not specially mentioned herein, but necessary to the proper vibration isolation of the equipment.

1.07 CONTRACTOR RESPONSIBILITY

A. Vibration isolation devices, including auxiliary steel bases and pouring forms, design and furnish by a single manufacturer or supplier.

B. Adequately restrain all equipment, piping, and ductwork to resist seismic forces. Design and select restraint devices to meet seismic requirements as defined in the latest issue of the International Building Code under Earthquake Loads and applicable state and local codes.

C. Have the following responsibilities:
   1. Selection, installation, adjustment, and performance of vibration isolators which will meet the requirements given on the plans or in the Specifications.
   2. Provide Engineering drawings, details, supervision, and instruction to assure proper installation and performance.

3. Provide whatever assistance necessary to ensure correct installation and adjustment of the isolators.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Type 1 – Neoprene Waffle Pad:
   1. Mason Type Super W or Super WM and HG Grommet
   2. Kinetics Corporation.

B. Type 2 – Restrained Neoprene Mount:
   1. Mason Type BR

C. Type 3 – Spring Isolators:
   1. Mason Type SLF
   2. Amber-Booth Type SW
   3. Kinetics Corporation
   4. Vibrex

D. Type 4 – Springs with Restraints:
   1. Mason Type SSLR or SLRS with seismic restraints
   2. Kinetics Corporation Model FYS
   3. Vibrex

E. Type 5 – Base with Springs:
   1. Mason WFSL
   2. Kinetics Corporation
   3. Vibrex

F. Type 6 – Inertia Base:
   1. Mason BMK or KSL
   2. Kinetics Corporation
   3. Vibrex

G. Type 7 – Isolating Spring Hangers:
   1. Mason 30N, similar Amber-Booth
   2. Consolidated Kinetics
   3. Vibrex

H. Type 8 – Isolating Neoprene Hangers:
   1. Mason HD
   2. Consolidated Kinetics
   3. Vibrex

I. Type 9 – Rooftop Air Handling Unit Isolation Curb:
   1. Mason RSC, similar Amber-Booth
   2. Kinetics Corporation
   3. Vibrex

J. Isolating Sleeves:
   1. Potter-Roemer PR isolators
   2. Grinnell Semco Trisolators

K. Flexible Sphere Connector:
   1. Mason Type SFU, SFDEJ, or SFEJ

L. Flexible Hose Connector:
   1. Mason Type FFL, MN, CPS or CPSB
   2. HCi
   3. Metraflex

2.02 TYPE 1 - NEOPRENE WAFFLE PAD

A. 3/4-inch thick neoprene waffle pads with pattern repeating on 1/2-inch centers.

B. Select Duro rating for recommended deflection at average load rating.

C. Include load distribution steel plate as required.

D. Include anchor bolt grommet as required.

2.03 TYPE 2 - RESTRAINED NEOPRENE MOUNT

A. Bridge-bearing neoprene mountings directional seismic capability.

B. Provide minimum deflection of 0.2-inch.

C. Ductile iron casting containing two separated and opposing molded neoprene elements.

D. Elements prevent the central threaded sleeve and attachment bolt from contacting the casting during normal operation.

E. Shock absorbing neoprene materials compounded to bridge-bearing specifications.

2.04 TYPE 3 – SPRING ISOLATORS

A. Free standing springs without housings.

B. Provide minimum deflection of 1-inch.

C. 1/4-inch thick molded neoprene cup with steel reinforcement washer or neoprene acoustical friction pads between base plate and support.

D. Mounting: Leveling bolts with height saving brackets.

E. Springs mounted outboard of channels.

F. Attach baseplate screws using neoprene bushings and washers.

G. Diameter not less than 0.8 of the compressed height of the spring at rated load.

H. Additional travel to solid equal to 50 percent of the rated deflection.

I. Submittals to include the following:
   1. Spring Diameters
   2. Deflection
   3. Compressed Spring Height
   4. Solid Spring Height

2.05 TYPE 4 - SPRINGS WITH RESTRAINTS

A. Same as springs except housing with seismic restraints to be added.

B. Seismic restraint with molded directional neoprene bushings an integral part of isolator.

C. Seismic restraint selected for minimum safety factor of 2 from ultimate seismic capacity.

D. Spring mount must have neoprene cup or pad inside the seismic housing to allow anchoring of the housing baseplate without short circuiting pad.

E. A minimum clearance of 1/4-inch shall be maintained around restraining bolts and between the housing and the spring so as not to interfere with the spring action.

F. Restraining Bolts: Neoprene bushing between the bolt and the housing.

G. Limit stops out of contact during normal operation.

2.06 TYPE 5 - BASE WITH SPRINGS

A. Steel base with wide flange beams and springs.

B. Provide minimum clearance of 1-inch.

C. Depth of base equal to 10 percent of the span between supports, 6-inch minimum.

D. Provide external height saving brackets.

2.07 TYPE 6 – INERTIA BASE

A. Steel Inertia Base with 1/2-inch square bar reinforcing, for field grout.

B. Provide minimum clearance of 1-inch.

C. Bases must be sized to fit stanchions for pump elbows or suction diffusers.

D. Depth of base equal to 8 percent of the span between supports, 6-inch minimum.

E. Provide integral height saving brackets and steel templates with anchor bolts sleeves.

2.08 TYPE 7 - ISOLATING SPRING HANGERS

A. Combination rubber-in shear and steel spring isolators installed on the hanger rods.

B. Provide minimum deflection of 1-inch.

C. Isolators shall have the proper deflection to allow the piping to deflect as a unit with the equipment isolators.

D. Neoprene element and the cup shall have neoprene bushing bushings projecting through the steel box.

E. Hangers designed for 30 degree angular movement.

F. Minimum Deflection: 1-inch

2.09 TYPE 8 – ISOLATING NEOPRENE HANGERS

A. Double deflection neoprene hangers.

B. Provide minimum static deflection of 0.35-inch.

C. Provide projecting bushing to prevent steel to steel contact.

2.010 TYPE 9 – ROOFTOP AIR HANDLING UNIT ISOLATION CURB

A. Rooftop unit spring isolation curb.

B. Provide minimum deflection of 2-inches.

C. Steel springs shall be laterally stable and rest on 1/4-inch thick neoprene acoustical pads.

D. Hardware shall be plated and the springs provided with a rust resistance finish.

E. Curb waterproofing shall consist of a continuous flexible flashing attached over the lower curb waterproofing.

F. All spring locations shall have accessibility to adjust springs.

G. Curb provides continuous support for equipment and be constructed to resiliently resist wind and seismic forces.

H. Construction of curb must not enable rigid connection between vibrating equipment and building structure.

I. Provide provisions for sloped roof, plenum curb, tall curb, and duct openings where required by installation conditions.

2.011 ISOLATING SLEEVES

A. Provide for piping through walls and floors of penthouses and chiller room. Size for piping as required.

2.012 SEISMIC RESTRAINTS

A. General Requirements:
   1. Provided for equipment, piping and ductwork, both supported and suspended.
   2. Bracing of piping shall be in accordance with state and local code requirements and ASCE 7 Seismic Design Requirements for Nonstructural Components, whichever is most stringent.
   3. Bracing of ductwork shall be in accordance with the state and local code requirements, ASCE 7 Seismic Design Requirements for Nonstructural Components, and with the provisions set forth in the SMACNA seismic restraint manual.
   4. The structural requirements for the restraints, including their attachment to the building structure, shall be reviewed and approved by the Structural Engineer.
   5. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

B. Supported Equipment:
   1. All-directional Seismic Rubbers: Interlocking steel members restrained by a one-piece molded neoprene bushing of bridge bearing neoprene.
   2. Replaceable bushing and minimum of 1/4-inch thick. Rated loadings not to exceed 1000 psi.
   3. An air gap of 1/4-inch shall be incorporated in the snubber design in all directions before contact is made between the rigid and resilient surfaces.
   4. Snubber End Caps:
      a. Removable to allow inspection of internal clearances.
      b. Rotated neoprene bushings be rotated to ensure no short circuits exist before systems are activated.
   5. Snubber: Mason Industries, Inc. Type Z-1225

C. Bracing of Pipes:
   1. Provide seismic bracing of piping as detailed below to meet the building code requirements:
      a. Exception: Piping suspended by individual hangers need not be braced where the following criteria are met.
         1) Distance between the top of the pipe to the bottom of the support structure is 12-inches or less.
         2) Seismic braces are not required on high deformability piping when the Ip=1.0 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 3-inch diameter or less.
         3) Seismic braces are not required on high deformability piping when the Ip=1.5 and provisions are made to avoid impact with larger pipe or mechanical components or to protect the pipe in the event of such impact and the nominal pipe size is 1-inch diameter or less.
   2. Seismic braces for pipes on trapeze hangers may be used.
   3. Provide flexibility in joints where pipes pass through building seismic joints or expansion joints, or where pipes connect to equipment.
   4. Cast iron pipe of all types, glass pipe, and any other pipe joined with a shield and clamp assembly, where the top of the pipe is 12-inches or more from the supporting structure, shall be braced on each side of a change in direction of 90 degrees or more. Riser joints on unsupported sections of piping shall be braced or stabilized between floors.
   5. Vertical risers shall be laterally supported with a riser clamp at each floor. For buildings greater than six stories high or for piping subject to thermal change all risers shall be engineered individually.

D. Bracing of Ductwork:
   1. Brace rectangular ducts with cross sectional areas of 6 square feet and larger. Brace flat oval ducts in the same manner as rectangular ducts. Brace round ducts with diameters of 28-inches and larger. Brace flat oval ducts the same as rectangular ducts of the same nominal size.
   2. Exception: No bracing is required if the duct is suspended by hangers 12-inches or less in length, as measured from the top of the duct to the bottom of the support where the hanger is attached.
   3. Transverse bracing shall occur at the interval specified in the SMACNA tables or at both ends if the duct run is less than the specified interval. Transverse bracing shall be installed at each duct turn and at each end of a duct run, with a minimum of one brace at each end.
   4. Longitudinal bracing shall occur at the interval specified in the SMACNA tables with at least one brace per duct run. Transverse bracing for one duct section may also act as longitudinal bracing for a duct section connected perpendicular to it if the bracing is installed within four feet of the intersection of the ducts and if the bracing is sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.

5. Install duct flex connections at equipment connections to accept expected differential displacement and protect the equipment connection from damage.

E. Suspended Equipment and Piping and Ductwork:
   1. Seismic cable restraints shall consist of galvanized steel aircraft cables sized to resist seismic loads with a minimum safety factor of two and arranged to provide all-directional restraint.
   2. Cable must be pre-stretched to achieve a certified minimum modulus of elasticity. Cable end connections shall be steel assemblies that swivel to final installation angle and utilize two clamping bolts to provide proper cable engagement.
   3. Cable assemblies shall be type SCB at the ceiling and at the clevis bolt, SCBH between the hanger rod and the clevis or SCBV if clamped to a beam, all as manufactured by Mason Industries, Inc.
   4. Steel angles or strut, sized to prevent buckling, shall be clamped to pipe or equipment rods utilizing a minimum of three ductile iron clamps at each restraint location when required. Welding of a minimum of three ductile iron clamps at each restraint location when required. Welding of support rods is not acceptable. Rod clamp assemblies shall be type SRC or UCC as manufactured by Mason Industries, Inc.
   5. Pipe clevis cross-bolt braces are required in all restraint locations. They shall be special purpose preformed channels deep enough to be held in place by bolts passing over the cross bolt. Clevis cross brace shall be type CCB as manufactured by Mason Industries, Inc.

2.013 FLEXIBLE SPHERE CONNECTOR

A. Flexible EPDM pipe connectors shall be manufactured of multiple plies of Kevlar tire cord fabric and EPDM; both molded and cured in hydraulic rubber presses. No steel wire or rings shall be used as pressure reinforcement.

B. Connectors up to and including 2-inch diameter may have a single sphere and threaded ends. Connectors 2-1/2-inch and larger shall be manufactured with twin spheres up to 12-inches and a single sphere on larger sizes and floating steel flanges recessed to lock the connectors raised face EPDM flanges.

C. Connectors shall be rated a minimum of 150 psi at 220 degrees F. Connections shall be pre-extended as recommended by the manufacturer to prevent additional elongation under pressure.

D. Provide expansion joint control rods and install per the manufacturers installation recommendations.

2.014 FLEXIBLE HOSE CONNECTOR

A. Flexible stainless steel hoses shall be manufactured using type 304 stainless steel hose and braid with one fixed and one floating raised face carbon steel plate flange.

B. Sizes 2-1/2-inch and Smaller:
   1. Threaded male nipples or copper sweat ends.
   2. Grooved ends are acceptable in all sizes in grooved piping systems.
   3. Weld ends are not acceptable.
   4. Copper sweat end hoses for water service shall be all copper or bronze construction.

C. Hose shall have close pitch annular corrugations for maximum flexibility and low stiffness. Tested hose stiffness at various pressures must be included in the submittals.

D. Hose shall be capable of continuous operation at 150 psi and system test pressure when installed in piping systems.

E. Hose shall be the same size as the pipe it connects and have pipe thread connectors on both ends with male or female end adapters as required.

PART 3 EXECUTION

3.01 GENERAL

A. Do not install any equipment or pipe which makes rigid contact with the building.

B. The installation or use of vibration isolators must not cause any change of position of equipment or piping which would result in stresses in piping connections or misalignment of shafts or bearings. In order to meet this objective, equipment and piping shall be maintained in a rigid position during installation. The load shall not be transferred to the isolator until the installation is complete and under full operational load.

C. Correct, at no additional cost, all installations which are defective in workmanship or materials.

3.02 PREPARATION

A. Treat all isolators, including springs, hardware, and housing, with a corrosion protective coating of epoxy powder or electro galvanizing.

B. Coat steel frames exposed to weather with a rustproof metal primer.

C. Provide hot dipped galvanizing on steel frames as indicated on the plans for corrosion protection in severe conditions.

3.03 INSTALLATION

A. General:
   1. Install isolation where indicated on the Drawings by type and location and where indicated below.
   2. The assigned code number shall be marked on the isolators and bases to assure placement in the proper location.
   3. Anchor isolator seismic housing baseplate to floor.
   4. Rubber grommets and washers shall be provided to isolate the bolt from the building structure. Under no circumstances shall the isolation efficiency be destroyed when bolting the isolators to the building structure.

B. Type 1 – Neoprene Waffle Pad:

C. Type 2 – Restrained Neoprene Mount:
   1. Service:
      a. Roof Exhaust Fans

D. Type 5 – Base with Springs:
   1. Service:
      a. Centrifugal Fans
      b. Vane Axial Fans
      c. Mixed Flow Fans
      d. Plug Fans
      e. Air Cooled Condensing Unit
      f. Air to Air Energy Recovery Units Mounted to Building Structure

E. Type 7 – Isolating Spring Hangers:
   1. Service:
      a. In-Line Circulating Pumps
      b. Piping rigidly connected to rotating equipment
      c. Propeller Fans
      d. Small Cabinet Fans
      e. Inline Centrifugal Fans
      f. Gas Fired Unit Heaters
      g. Fan Coil Units
      h. Split-System Air Conditioning Unit
      i. Split-System Heat Pump
      j. Unit Heaters

F. Type 8 – Isolating Neoprene Hanger:
   1. Service:
      a. In-Line Circulating Pumps
      b. Split-System Air Conditioning Unit
      c. Split-System Heat Pump
      d. Unit Heaters

G. Type 9 – Rooftop Air Handling Unit Isolation Curb:
   1. Service:
      a. Rooftop Mounted Air Handling Units
      b. Rooftop Mounted Energy Recovery Units

H. Flexible Connectors:
   1. Mechanical Couplings: Provide three or more flexible couplings as vibration isolation as indicated on the drawings and for the following services: Heating Water

3.04 SEISMIC RESTRAINTS

A. General:
   1. Install and adjust seismic restraints so that the equipment, piping, and ductwork support is not degraded by the restraints.
   2. Restraints must not short circuit vibration isolation systems or transmit objectionable vibration or noise.

B. Supported Equipment:
   1. Each vibration isolation frame for supported equipment shall have a minimum of four seismic snubbers mounted as close as possible to the vibration isolators and/or the frame extremities.
   2. Care must be taken so that the 1/4-inch air gap in the seismic restraint snubber is preserved on all sides in order that the vibration isolation potential of the isolator is not compromised. This requires that the final snubber adjustment be completed after the vibration isolators are properly installed and the installation approved.

C. Bracing of Pipes:
   1. Branch lines may not be used to brace main lines.
   2. Transverse bracing shall be at 40-feet maximum, except where a lesser spacing is indicated in the SMACNA Seismic Restraint Manual for bracing of pipes.
   3. Longitudinal bracing shall be at 80-feet maximum except where a lesser spacing is indicated in the tables. In pipes where thermal expansion is a consideration, an anchor point may be used as the specified longitudinal brace provided that it has a capacity to resist both the seismic load and the additional force induced by expansion and contraction.
   4. Fuel oil, gas, cast iron pipe of all types, glass pipe and any other pipes joined with four band shield and clamp assembly shall be braced at 1/2 the spacings shown above.
   5. A rigid piping system shall not be braced to dissimilar parts of the building or to two dissimilar building systems that may respond differently during an earthquake.
   6. Transverse bracing for one pipe section may also act as longitudinal bracing for a pipe section of the same size connected perpendicular to it if the bracing is installed within 24-inches of the elbow or tee.
   7. Branch lines may not be used to restrain main lines.
   8. Where thermal expansion is a consideration, guides and anchors may be used as transverse and longitudinal restraints provided they have a capacity equal to or greater than the restraint loads in addition to the loads induced by expansion or contraction.
   9. Subject to confirmation by field inspection, seismic bracing is not required on piping when the piping is supported by rod hangers and the hangers in the entire run are 12-inches or less in length from the top of the pipe to the supporting structure, hangers are detailed to avoid bending of the hangers and their attachments and provisions are made for piping to accommodate expected deflections.

D. Bracing of Ductwork:
   1. Transverse restraints shall occur at 30-foot intervals or at both ends of the duct run if less than the specified interval. Transverse restraints shall be installed at each duct turn and at each end of a duct run.
   2. Longitudinal restraints shall occur at 60-foot intervals with at least one restraint per duct run. Transverse restraints for one duct section may also act as a longitudinal restraint for a duct section connected perpendicular to it if the restraints are installed within 4-feet of the intersection of the ducts and if the restraints are sized for the larger duct. Duct joints shall conform to SMACNA duct construction standards.
   3. Hanger straps must be positively attached to the duct within 2-inches of the top of the duct with a minimum of two number 10 sheet metal screws.
   4. A group of ducts may be combined in a larger frame so that the combined weights and dimensions of the ducts are less than or equal to the maximum weight and dimensions of the duct for which bracing details are selected.
   5. Walls, including gypsum board nonbearing partitions, which have ducts running through them, may replace a typical transverse brace. Provide solid blocking around duct penetrations at stud wall construction.
   6. Unbraced ducts shall be installed with a 6-inch minimum clearance to vertical ceiling hanger wires.

E. Suspended Equipment, Piping, and Ductwork Cable Method:
   1. The cables shall be adjusted to a degree of slackness approved by the Structural Engineer.
   2. The uplift and downward restraint nuts and Mason type RW neoprene covered steel rebound washers for the Type 6 hangers adjusted so there is a maximum 1/4-inch clearance.
   3. C-clamps for attachment to the bottom of I-beams must incorporate a restraining strap.

3.05 FIELD QUALITY CONTROL

A. Installation Report: Isolation manufacturer's representative shall confirm that all isolation is installed correctly and submit report stating that isolators are installed as shown on Shop Drawings, isolators are free to work properly, and that installed deflections are as scheduled and as specified.

END OF SECTION

SECTION 22 05 53

IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Valve Identification
   2. Piping Markers
   3. Equipment Identification
   4. Concealed Equipment Identification

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

A. Submit the following:
   1. Valve Tag Directory: Submit for approval prior to fabrication of valve tags.
   2. Equipment Nameplate Directory: Submit for approval prior to fabrication.
   3. Operating and Maintenance Data: Include a copy of valve tag and equipment nameplate directories in each set of Operating and Maintenance manuals.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Piping Markers:
   1. W.H. Brady
   2. Seton
   3. Marking Systems, Inc. (MSI)
   4. Other Manufacturers: Submit substitution request.

B. Concealed Equipment Identification:
   1. W.H. Brady
   2. Seton
   3. Other Manufacturers: Submit substitution request.

2.02 VALVE IDENTIFICATION

A. Valve Tags:
   1. General: Identify valves with metal tags, legends to be stamped or embossed. Indicate the function of the valve and its normal operating position; i.e.,

56 HW	(NUMBER AND CONTENT OF PIPE)
ISOLATION	(VALVE FUNCTION)
NO	(NORMAL OPERATION POSITION)

   2. Size: Valve tags 2-inch diameter with 1/4-inch high letters.
   3. Material: Use 0.04-inch brass tags.
   4. Automatic Valves and Regulating Valves:
      a. Use 1/16-inch thick laminated 3-ply plastic, center ply white, outer ply red, lamicoid, or equal.
      b. Form letters by exposing center ply.
   5. Buildings Systems: Contact the Owner for coordination with existing building tagging system and supplementary information required for any specific system before valve tagging begins.

B. Valve Tag Directory:
   1. Tag Number
   2. Location
   3. Exposed or Concealed

4. Service
5. Valve Size
6. Valve Manufacturer
7. Valve Model Number
8. Normal Operating Position of Valve

2.03 PIPING MARKERS

A. Label pipes with all-vinyl, self-sticking labels or letters.

B. For pipe covering sizes up to and including 3/4-inch outside diameter, select labels with 1/2-inch letters.

C. For sizes from 3/4 to 2-inch outside diameter, 3/4-inch letters, above 2-inches outside diameter, 2-inch letters.

D. Identify pipe markers and color coded as follows with black directional arrows.

HVAC SERVICE	PIPE MARKER *	BACKGROUND COLOR
HEATING WATER	HEATING WATER SUPPLY	YELLOW OR GREEN
	HEATING WATER RETURN	YELLOW
REFRIGERANT SUCTION	REFRIGERANT SUCTION	YELLOW
REFRIGERANT LIQUID	REFRIGERANT LIQUID	GREEN
REFRIGERANT HOT GAS	REFRIGERANT HOT GAS	YELLOW
REFRIGERANT RELIEF VENT	REFRIGERANT RELIEF VENT	GREEN
* Directional arrow applied adjacent to pipe marker indicating direction of flow.		

2.04 EQUIPMENT IDENTIFICATION

A. Nameplates:
1. Tag pumps, air handling supply units, fans, terminal units, converters, and miscellaneous items of mechanical equipment with engraved nameplates.
2. 1/16-inch thick, 3-inch by 5-inch laminated 3-ply plastic, center ply white, outer ply black. Form letters by exposing center ply.
3. Identify unit with equipment tag as shown on Drawings and area served.
4. Permanently identify access points to fire dampers, smoke dampers, and combination fire and smoke dampers on the exterior of the duct by a label with letters 1/2-inch in height reading the following:
   a. Fire Damper
   b. Smoke Damper
   c. Fire/Smoke Damper
5. Label constructed from same material as equipment nameplates.

B. Equipment Nameplate Directory:
1. List Pumps
2. Air Handlers
3. Terminal Units
4. Other Equipment Nameplates

C. Include Owner and Contractor furnished equipment.

D. List the following on the nameplate:
1. Designation
2. Model Number
3. Location of Equipment
4. Area Served or Function
5. Disconnect Location
6. Normal Position of HOA Switch

2.05 CONCEALED EQUIPMENT IDENTIFICATION

A. Adhesive Laminated Tape:
   1. 3/4 width transparent clear tape with black lettering.
   2. Lettering in all caps Helvetica font 24 point.

PART 3 EXECUTION

3.01 VALVE IDENTIFICATION

A. Valve Tags:
   1. Attach to valve with a brass chain.
   2. Valve tag numbers continuous throughout the building for each system.
   3. Obtain a list for each system involved from the Owner.

B. Valve Tag Directory: Post final copy in Operation and Maintenance Manual.

3.02 PIPING MARKERS

A. Unless recommendations of ANSI A13.1, 1981 are more stringent, apply labels or letters after completion of pipe cleaning, insulation, painting, or other similar work, as follows:
   1. Every 20-feet along continuous exposed lines.
   2. Every 10-feet along continuous concealed lines.
   3. Adjacent to each valve and stub out for future.
   4. Where pipe passes through a wall, into and out of concealed spaces.
   5. On each riser.
   6. On each leg of a T.
   7. Locate conspicuously where visible.

B. Apply labels or letters to lower quarters of the pipe on horizontal runs where view is not obstructed or on the upper quarters when pipe is normally viewed from above.

C. Apply arrow labels indicating direction of flow.

D. Arrows the same color and sizes as identification labels.

3.03 EQUIPMENT IDENTIFICATION

A. Nameplates: Attach to prominent area of equipment, either with sheet metal screws, brass chain, or contact cement as applicable.

B. Nameplate Directory: Post final copy in Operation and Maintenance Manual.

3.04 CONCEALED EQUIPMENT IDENTIFICATION

A. Where valves or equipment are located above ceilings or behind walls provide adhesive tape indicating the item (valve tag, equipment tag, etc.) at the access location (T-bar ceiling grid, access door, etc.).

B. Applicable equipment includes, but is not limited to, the following:
   1. Terminal Units
   2. Fan Coil Units
   3. Fans
   4. Isolation Valves
   5. Fire Smoke Dampers
   6. Pumps
   7. Control Valves

END OF SECTION

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SECTION 23 05 90
PRESSURE TESTING FOR HVAC SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Pressure Testing of Piping and Ductwork Systems

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

A. Code Compliance: Perform required tests in the presence of the authority having jurisdiction.

B. Owner Witness: Perform tests in the presence of the Owner's representative.

C. Engineer Witness: The Engineer or Engineer's representative reserves the right to observe tests or selected tests to assure compliance with the specifications.

D. Simultaneous Testing: Test observations by the authority having jurisdiction, the Owner's representative, and the Engineer's representative need not occur simultaneously.

1.04 SUBMITTALS

A. Submit the following:
   1. Test Reports:
      a. Submit certificate of completion, inspection and test by authority having jurisdiction on required piping systems.
      b. Submit certificate of test approval by Owner's representative on all systems.
      c. For ductwork testing, submit the Test Report.
      d. Test report shall contain description of the testing procedure and results, including recommendation for any remedial actions needed.
      e. The Engineer's representative will record witnessed tests.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 GENERAL

A. Piping:
   1. Test prior to concealment, insulation being applied, and connection to equipment, fixtures, or specialties.
   2. Conduct tests with all valves but those used to isolate the test section 10 percent closed.

B. Ductwork: Test prior to connection to equipment and before applying insulation.

C. Leaks: Repair all leaks and retest until stipulated results are achieved.

D. Notification:
   1. Advise the Engineer 72 hours in advance of each test.
   2. Failure to so notify will require test to be rescheduled.

E. Testing Equipment: Provide all necessary pumps, gauges, connections, and similar items required to perform the tests.

3.02 TESTING REQUIREMENTS

A. Medium Pressure Ductwork:
   1. Test all ductwork systems at 4-inch static pressure, using a Pacific Air Products Port-O-Lab or Rolok, or a McGill Airflow LEAK DETECTIVE testing machine or approved equivalent.
   2. All ductwork testing shall be conducted in accordance with latest published version of the SMACNA HVAC Air Duct Leakage Test Manual.

3. Prior to testing verify that all medium pressure ductwork has been sealed to meet the SMACNA Seal Class A. for all joints, seams and at al duct wall penetrations.
4. Medium pressure ductwork leakage shall be less than or meet the requirement of the following SMACNA Leakage Classes:
   a. Rectangular Metal – Class 6
   b. Round or Flat Oval – Class 3
5. Maximum allowable leakage is defined as Cubic Feet per Minute (CFM) air leakage per 100 square feet SURFACE AREA of duct section tested.
6. Test all medium pressure ductwork.

B. Low Pressure Ductwork:
1. Test all ductwork systems at 2-inch static pressure, using a Pacific Air Products Port-O-Lab or Rolok, or a McGill Airflow leak detective testing machine or approved equivalent.
2. All ductwork testing shall be conducted in accordance with latest published version of the SMACNA HVAC Air Duct Leakage Test Manual.
3. Prior to testing verify that all low pressure ductwork has been sealed to meet the SMACNA Seal Class C. for all joints.
4. Low pressure ductwork leakage shall be less than or meet the requirement of the following SMACNA Leakage Classes:
   a. Rectangular Metal – Class 24
   b. Round or Flat Oval – Class 12
5. Maximum allowable leakage is defined as CFM air leakage per 100 SF surface area of duct section tested.
6. All low pressure ductworks shall be tested.

C. Ductwork for Smoke Control Systems:
1. Ducts shall be leak tested to 1.5 times the maximum design pressure.
2. Leakage shall not exceed 5 percent of design flow.

D. Piping - General: Test all piping as noted below, with no leaks or loss in pressure for time indicated. Repair or replace defective piping until tests are completed successfully:

HVAC Systems	Test Pressure	Test Medium	Test Duration
Refrigerant piping – R410A	450 psig**	Nitrogen	24 hours
Refrigerant piping – R134A	450 psig**	Nitrogen	24 hours
Refrigerant piping – R407C	450 psig**	Nitrogen	24 hours
Heating water	150 psig	Water	4 hours
* The outer casing field welds at piping closures shall be field tested for leaks. Pressurize with compressed air at 15 psig and apply a soap solution and check for leaks. ** Or as recommended by equipment manufacturer.			

END OF SECTION

SECTION 23 05 93

TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Testing and Balancing of Air Systems
   2. Testing and Balancing of Hydronic Systems
   3. Testing and Balancing of Miscellaneous Mechanical Equipment
   4. Related Sections

B. Division 01, General Requirements

C. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

D. Section 23 08 00, Commissioning for HVAC

E. Section 23 09 00, Instrumentation and Controls for HVAC

1.02 QUALITY ASSURANCE

A. Acceptable Testing and Balancing Firms:
   1. Neudorfer Engineers, Inc.
   2. Northwest Engineering Services
   3. Other Firms: Submit substitution requests prior to bid date.
   4. Certification: The firm shall be Certified by National Environmental Balancing Bureau (NEBB).

B. Industrial Standards: Testing and Balancing shall conform to NEBB, American Society of Heating, Refrigerating, and Air Conditioning Engineers (ASHRAE), and American National Standards Institute (ANSI) as follows:
   1. NEBB: Comply with Procedural Standards for Testing, Adjusting Balancing of Environmental Systems.
   2. ASHRAE: Comply with recommendations pertaining to measurements, instruments, and testing, adjusting and balancing.
   3. ANSI:
      a. S1.4 Specifications for sound level meters.
      b. S1.11 Specifications for Octave-Band and Fractional-Octave-Band analog and digital filters.

1.03 SUBMITTALS

A. Submit the following:
   1. Balancing Log – Existing Systems: Submit preliminary report indicating existing conditions prior to making any modifications to existing systems.
      a. Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes.
      b. Provide drawings identifying location of all outlets.
   2. Equipment Data Sheets – Existing Systems: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
   3. Balancing Log:
      a. Include all air and water outlets, actual field measured air and water volume, and percentage of design volumes.
      b. Provide drawings identifying location of all outlets.
   4. Equipment Data Sheets: Indicate actual equipment performance, model numbers, bearing and belt data, motor nameplate data, and final balanced motor data.
   5. Additional Data: Submit additional data as provided by Associated Air Balance Council (AABC) Standard forms.

6. Number of Copies: Submit six copies of the above completed information to the Engineer for review and insertion into the Operating and Maintenance Data.
7. Instrument Certification: When requested, submit certificate of calibration for equipment to be used.

B. Record data on NEBB forms or forms approved by the Architect.

1.04 PROJECT CONDITIONS

A. Where existing systems are to be adjusted, establish flow rates in all branches prior to making any modifications to system. Adjust central equipment as required and restore all unmodified branches and outlets to original condition. Obtain existing system drawings from Owner and become familiar with extent and nature of existing systems.

B. Do not perform final testing, adjusting, and balancing work until heating, ventilating, and air conditioning equipment has been completely installed and operating continuously as required.

C. Conduct air testing and balancing with clean filters in place. Clean strainers, etc., prior to performing hydronic testing and balancing.

1.05 WARRANTIES

A. In addition to the Requirements of the Contract, include an extended warranty of six months after completion of test and balance work during which time the Architect at his discretion may request a recheck or resetting of any equipment or device listed in the test reports.

PART 2 PRODUCTS – NOT APPLICABLE

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

A. Balance to maximum measured flow. Deviation from specified values of ±10 percent at terminal device and ±5 percent at equipment, or mean sound level deviation of 15 decibels. Advise Engineer if deficiencies are generally noted to enable proper corrective actions.

3.02 AIR SYSTEMS

A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
1. Identify and list size, type, and manufacture of all equipment to be tested including air outlets and inlets.
2. Use manufacturer’s ratings for equipment to make required calculations except where field test shows ratings to be impractical.

C. Central System:
1. Set speed to provide air volume at farthest run without excess static pressure. Provide additional sheaves and belts as required to accomplish speed adjustment.
2. Read and adjust air supply, return, and exhaust fan units to deliver design conditions at minimum OSA and at 100 percent OSA.
3. Adjust automatic dampers, outside air, return air, and exhaust dampers for design conditions.
4. Read static air pressure conditions on all air handling equipment including filter and coil pressure drops and total pressure across the fan. A Dwyer Series 400 air velocity meter only shall be used for final static pressures at equipment and where critical readings are required.
5. Measure temperature conditions across all outside air, return air, and exhaust dampers to check leakage.
6. Read and record motor data and amperage draw.

7. For variable volume systems, establish minimum static pressure required at sensing point to permit operation over entire VAV range. Adjust supply and return fan speed so that at maximum demand the associated VFD is controlling the motor of motor nameplate RPM to 100 percent. Adjust return fan speed so that return air volumes track with supply air volume minus exhaust air volume.
8. Assist controls contractor in establishing minimum outside air damper positions.

D. Distribution:
1. Evaluate all building and room pressure conditions to determine adequate supply and return air conditions. Balance the building to be slightly positive to outdoors.
2. Evaluate all building and room pressure conditions to determine adequate performance of the system to maintain temperatures without draft.
3. Perform multipoint pitot traverses to confirm instrumentation, shaft tightness, fan operation, etc. Pitot traverses shall be performed using a Dwyer Series 400 air velocity meter only with applicable duct probe.
4. Mark balancing dampers.

E. Fire Life Safety Systems:
1. Balance, adjust, and test the stair and elevator pressurization components in order to pass the city test as described in Section 23 09 00, Instrumentation and Controls for HVAC. The balancer shall rebalance the system as necessary until it passes the city tests.

3.03 HYDRONIC SYSTEMS

A. General: Make measurements in accord with Industrial Standards specified above. Record on appropriate forms.

B. Preliminary:
1. List complete data of tested equipment and verify against Contract Documents.
2. Open all line valves to full open position, close coil by-pass stop valves, and then set mixing control valve to full coil flow.
3. For each pump:
   a. Verify rotation.
   b. Test and record pump shut-off head.
   c. Test and record pump wide-open head.
4. Verify proper system pressures.
5. Verify air vents in high points of water are properly installed and operating freely.

C. Central Equipment:
1. Check all conditions at all coils for required performance at design conditions.
2. Check conditions at all primary source equipment for performance of design conditions.
3. Read and record pump heads, motor data, and amperage draw.

D. Distribution:
1. Read and adjust water flow for design conditions.
2. Set all memory stops and mark position of adjuster on balancing valves.

3.04 ELECTRIC HEATING EQUIPMENT

A. Test and record voltage and amperage readings at each electric heating device while fully energized and at part load conditions (each step) to verify proper operation.

B. Record data on appropriate forms.

3.05 AUTOMATIC CONTROL SYSTEM

A. In cooperation with control manufacturer's representative, set and adjust automatically operated devices to achieve required sequence of operations.

B. Testing organization shall verify all controls for proper calibration and list controls requiring adjustment by control system installer.

3.06 COORDINATION

A. Coordinate work with other trades to ensure rapid completion of the project.

B. Deficiencies noted during the course of air balancing in the mechanical installation shall be promptly reported to the Architect to allow corrective action to proceed.

C. Periodic review of progress shall be provided as requested.

END OF SECTION

SECTION 23 05 94

CLEANING OF HVAC EXISTING DUCTWORK

PART 1 GENERAL

1.01 SUMMARY

A. This section defines the minimum requirements necessary to render existing HVAC components clean and to verify the cleanliness through inspection and/or testing in accordance with items specified herein and applicable NADCA Standards. Removal of visible surface contaminants and deposits from within the HVAC system in strict accordance with these specifications.

B. Include interior surface of the facility's air distribution system for conditioned spaces and/or occupied zones. Includes entire heating, air-conditioning and ventilation system from the points where the air enters the system to the points where air is discharged from the system.

C. Return air grilles, return air ducts to the air handling unit (AHU), the interior surfaces of the AHU, mixing box, coil compartment, condensate drain pans, humidifiers and dehumidifiers, supply air ducts, fans, fan housing, fan blades, air wash systems, spray eliminators, turning vanes, filters, filter housings, reheat coils and supply diffusers are considered part of the HVAC system. HVAC system may also include other components such as dedicated exhaust, ventilation components, and make-up air systems.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

A. Membership: Certified member of the National Air Duct Cleaners Association (NADCA) or maintain membership in a nationally recognized non-profit industry organization dedicated to the cleaning of HVAC systems.

B. Certification: Minimum of one Air System Cleaning Specialist (ASCS) certified by NADCA on a full time basis or have staff members certified by a nationally recognized certification program and organization dedicated to the cleaning of HVAC systems.

C. Supervisor Qualification: Certified as an ACSC by NADCA or maintaining an equivalent certification by a nationally recognized program and organization responsible for the total work herein specified.

D. Experience:
1. Submit records of experience in the field of HVAC system cleaning as requested by the owner.
2. Bids considered from firms, which are regularly engaged in HVAC system maintenance with an emphasis on HVAC system cleaning and decontamination.

E. Equipment, Materials and Labor: Possess and furnish necessary equipment, materials, and labor to adequately perform the specified services.
1. Assure that its employees have received safety equipment training, medical surveillance programs, individual health protection measures, manufacturer's product, and material safety data sheets (MSDS) as required for the work by the U.S. Occupational Safety and Health Administration and as described by this specification. For work performed in countries outside of the USA, comply with applicable national safety codes and standards.
2. Maintain a copy of the current MSDS documentation and safety certifications and comply with other site documentation requirements of applicable OSHA programs and this specification.
3. Submit to Owner Material Safety Data Sheets (MSDS) for chemical products proposed to be used in the cleaning process.

F. Licensing:
1. Provide proof of maintaining the proper license(s).

2. Comply with Federal, state and local rules, regulations, and licensing requirements.

1.04 STANDARDS

A. NADCA Standards: Perform the services specified here in accordance with the current published standards of the National Air Duct Cleaners Association (NADCA).
   1. Terms in this specification have their meaning defined as stated in the NADCA Standards.
   2. NADCA Standards must be followed with no modification or deviations being allowed.

1.05 APPLICABLE STANDARDS AND PUBLICATIONS

A. The following current standards and publications of the issues currently in effect form a part of this specification to the extent indicated by the following references:
   1. National Air Duct Cleaners Association (NADCA): Assessment, Cleaning and Restoration of HVAC Systems
   2. National Air Duct Cleaners Association (NADCA): Understanding Microbial Contamination in HVAC Systems
   3. National Air Duct Cleaners Association (NADCA): Introduction to HVAC System Cleaning Services
   4. National Air Duct Cleaners Association (NADCA): Standard 05 Requirements for the Installation of Service Openings in HVAC Systems.
   5. Underwriters/ Laboratories (UL): UL Standard 181
   6. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62-89 Ventilation for Acceptable Indoor Air Quality
   7. American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE): Standard 62-89 Ventilation for Acceptable Indoor Air Quality
   8. Environmental Protection Agency (EPA): Building Air Quality
   9. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): HVAC Duct Construction Standards – Metal and Flexible
   10. North American Insulation Manufacturers Association (NAIMA): Cleaning Fibrous Glass Insulated Air Duct Systems

1.06 SUBMITTALS

A. Submit qualification of the HVAC System Cleaning Contractor

PART 2 PRODUCTS - NOT APPLICABLE

PART 3 EXECUTION

3.01 HVAC SYSTEM COMPONENT INSPECTIONS AND SITE PREPARATIONS

A. HVAC System Component Inspection:
   1. Prior to the commencement of cleaning work, perform a visual inspection of the HVAC system to determine appropriate methods, tools and equipment required to satisfactorily complete this project.
   2. Cleanliness inspection to include air handling units and representative areas of the HVAC system components and ductwork.
   3. HVAC systems including multiple air handling units should be inspected.

B. Conduct cleanliness without negatively impacting the indoor environment through excessive disruption of settled dust, microbial amplification or other debris. In cases where contamination is suspected and/or in sensitive environments where even small amounts of contaminant may be of concern, environment engineering control measures should be implemented.
   1. Document and bring to the attention of the Owner damaged system components found during the inspection.

C. Site evaluation and Preparation: Conduct a site evaluation and establish a specific, coordinated plan, which details how each area of the building will be protected during the various phases of the project.

D. Inspector Qualifications:
   1. Perform the HVAC cleanliness inspection to determine the need for cleaning.

2. At minimum, such personnel should have an understanding of HVAC system design and experience in utilizing accepted indoor environmental sampling practices, current industry HVAC cleaning procedures, and applicable industry standards.

3.02 GENERAL HVAC SYSTEM CLEANING REQUIREMENTS

A. Collect and take precautions for containment: debris removed during cleaning to ensure that debris is not otherwise dispersed outside the HVAC system during the cleaning process.

B. Particulate Collection:
1. Where equipment is exhausting inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron size (or greater) particles.
2. When exhausting outside the building:
   a. Mechanical cleaning operations are undertaken only with particulate collection equipment in place, including adequate filtration to contain debris removed from the HVAC system.
   b. Take precautions to locate the equipment down wind and away from air intakes and other points of entry into the building.

C. Controlling Odors: Take measures to control odors and/or mist vapors during the cleaning process.

D. Component Cleaning:
1. Visibly clean system components as defined in applicable NADCA Standards.
2. Upon completion, return components to settings recorded just prior to cleaning operations.

E. Air-Volume Control Devices:
1. Dampers and air-directional mechanical devices inside the HVAC system must have their position marked prior to cleaning.
2. Upon completion restore to their marked position.

F. Service Openings:
1. Utilize service openings, as required for proper cleaning, at various points of the HVAC system for physical and mechanical entry and inspection.
2. Utilize the existing service opening s already installed in the HVAC system where possible.
3. Create openings where needed and seal in accordance with industry codes and standards.
4. Closures must not significantly hinder, restrict, or alter the airflow within the system.
5. Closures must be properly insulated to prevent heat loss/gain or condensation on surfaces within the system.
6. Openings must not compromise the structural integrity of the system.
7. Construction techniques used in the creation of openings should conform to requirements of applicable building and fire codes, applicable NFPA, SMACNA, and NADCA Standards.
8. Cutting service openings into flexible duct not permitted. Disconnect flexible duct at ends as needed for proper cleaning and inspection.
9. Reseals rigid fiberglass duct systems in accordance with NAIMA recommended practices. Only closure techniques that comply with UL Standard 181 or UL Standard 181a are suitable for fiberglass duct system closures.
10. Reopen service openings for future inspection or remediation clearly marked and have their location reported to the owner in project report documents.

G. Ceiling Sections (Tile): Remove and reinstall ceiling sections to gain access to HVAC systems during the cleaning process.

H. Air Distribution Devices (Registers, Grilles and Diffusers): Clean air distribution devices.

I. Air Handling Units, Terminal Units (VAV, Dual Duct Boxes, etc.), Blowers and Exhaust Fans:
1. Ensure that supply, return and exhaust fans and blowers are thoroughly cleaned.
2. Areas to be cleaned include the following:
   a. Blowers

b. Fan Housings
c. Plenums, with the exception of ceiling supply and return plenums.
d. Scrolls
e. Blades or Vanes
f. Shafts
g. Baffles
h. Dampers
i. Drive Assemblies

3. Remove visible surface contamination deposits in accordance with NADCA Standards:
   a. Clean air handling units (AHU) internal surfaces, components and condensate collectors and drains.
   b. Ensure that a suitable operative drainage system is in place prior to beginning wash down procedures.
   c. Clean coils and related components, including evaporator fins.

J. Duct Systems:
1. Create service openings in the system as necessary in order to accommodate cleaning of otherwise inaccessible areas.
2. Mechanically clean duct systems to remove visible contaminants, such that the systems are capable of passing cleaning verification tests.

3.03 HEALTH AND SAFETY

A. Safety Standards:
1. Comply with applicable federal, state, and local requirements for protecting the safety of the contractor's employees, building occupants, and the environment.
2. Follow applicable standards of the Occupational Safety and Health Administration (OSHA) when working in accordance with this specification.

B. Occupant Safety: Do not employ processes or materials in such a manner that they will introduce additional hazards into occupied spaces.

C. Disposal of Debris: Remove debris from HVAC system disposed of in accordance with applicable federal, state, and local requirements.

3.04 MECHANICAL CLEANING METHODOLOGY

A. Source Removal Cleaning Methods:
1. Clean HVAC system using Source Removal mechanical cleaning methods designed to extract contaminants from within the HVAC system and safely remove contaminants from the facility.
2. Select Source Removal methods that will render the HVAC system visibly clean and capable of passing cleaning verification methods (see applicable NADCA Standards) and other specified test, in accordance with general requirements.
3. No cleaning method or combination of methods used which could potentially damage components of the HVAC system or negatively alter the integrity of the system.
   a. Methods used incorporate the use of vacuum collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of the section being cleaned through a predetermined opening. Use sufficient power to render areas cleaned under negative pressure.
   b. Equip vacuum devices exhausting air inside the building with HEPA filters (minimum efficiency) including hand-held vacuums and wet-vacuums.
   c. Equip vacuum devices exhausting air outside the facility with Particulate Collection including adequate filtration to contain Debris removed from the HVAC system. Exhaust in a manner that will not allow contaminants to re-enter the facility. Release of debris outdoors must not violate outdoor environment standards, codes, or regulations.

d. Methods require mechanical agitation devices to dislodge debris adhere to interior HVAC system surfaces, such that debris may be safely conveyed to vacuum collection devices. Acceptable methods will include those, which will not potentially damage the integrity of the ductwork, nor damage porous surface materials such as liners inside the ductwork or system components.

B. Methods of Cleaning Fibrous Glass Insulated Components:
1. Fibrous glass thermal or acoustical insulation elements present in equipment or ductwork thoroughly cleaned with HEPA vacuuming equipment, while the HVAC system is under constant negative pressure and not permitted to get wet in accordance with applicable NADCA and NAIMA standards and recommendations.
2. Cleaning methods used not to cause damage to fibrous glass components and will render the system capable of passing Cleaning Verification Tests.

C. Damage Fibrous Glass Material:
1. Evidence of damage: Identify for replacement evidence of damage, deterioration, delaminating, friable material, mold, or fungus growth, or moisture such that fibrous glass materials cannot be restored by cleaning or resurfacing with an acceptable insulation repair coating.
2. Replacement:
a. When requested or specified.
b. Capable of remediating exposed damaged insulation in air handlers and/or ductwork requiring replacement.
3. Replacement Material: In the event fiberglass materials must be replaced, and conform to applicable industry codes and standards, including those of UL and SMCNA.
4. Replacement of damaged insulation is not covered by this specification.

D. Cleaning of Coils:
1. Cleaning method may be used which will render the coil visibly clean and capable of passing coil cleaning verification.
2. Coil drain pans subject to nonporous surfaces cleaning verification. Keep drain for the condensate drain pan operational.
3. Cleaning methods not to cause appreciable damage to, displacement of, inhibit heat transfer or erosion of the coil surface or fin and conform to coil manufacturer recommendations when available.
4. Rinse coils completely with clean water to remove latent residues.

E. Antimicrobial Agents and Coatings:
1. Apply antimicrobial agents if active fungal growth is reasonably suspected or where unacceptable levels of fungal contamination have been verified through testing.
2. Perform application of antimicrobial agents used to control the growth of fungal or bacteriological contaminants after the removal of surface deposits and debris.
3. Apply antimicrobial treatments and coatings in strict accordance with the manufacturers' written recommendations and EPA registration listing.
4. Apply according to the manufacturer's written instructions. Spray coatings directly onto interior ductwork surfaces, rather than fogged downstream onto surfaces.

3.05 CLEANLINESS VERIFICATION

A. General: Verification of HVAC system cleanliness will be determined after mechanical cleaning and before the application of treatment or introduction of treatment related substance to the HVAC system, including biocidal agents and coatings.

B. Visual inspection: Visually inspect to ensure that no visible contaminants are present.
1. If no contaminants are evident through visual inspection, considered clean, however, the owner reserves the right further verify system cleanliness through Surface Comparison Testing or the NADCA vacuum test specified in the NADCA Standards.
2. If visible contaminants are evident through visual inspection, those portions of the system where contaminants are visible re-cleaned and subjected to re-inspection for cleanliness.

3. NADCA vacuum test analysis should be performed by a qualified third party experienced in testing of this nature.

C. Verification of Coil Cleaning:
1. Cleaning must restore the coil pressure drop to within 10 percent of the pressure drop measured when the coil was first installed.
2. If original pressure drop is not known, the coil will be considered clean only if the coil is free of foreign matter and chemical residue, based on a thorough visual inspection (see NADCA Standards).

3.06 PRE-EXISTING SYSTEM DAMAGE

A. Provide notice of pre-existing systems damage to owner prior to Work.

3.07 POST-PROJECT REPORT

A. At the conclusion of the project, provide a report to the owner indicating the following:
1. Success of the cleaning project, as verified through visual inspection and/or gravimetric analysis.
2. Areas of the system found to be damaged and/or in need of repair.

END OF SECTION

SECTION 23 07 00
INSULATION FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Pipe Insulation
2. Block Insulation
3. Ductwork Blanket Insulation
4. Ductwork Board Insulation
5. Duct Insulation, Internal
6. Duct, Pipe and Terminal Unit Acoustical Wrap
7. Duct Enclosure, Fire Rated
8. Accessories Piping
9. Accessories Ductwork

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 29, Hangers, Supports and Anchors for HVAC

D. Section 23 31 01, HVAC Ducts and Casing – Low Pressure

E. Section 23 31 02, HVAC Ducts and Casing – Medium Pressure

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
1. Prohibit insulating products from containing pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products within this specification contain these banned substances, provide complying products from approved manufacturers with equal performance characteristics.
2. Flame and Smoke Ratings: Installed composite flame spread not to exceed 25 and smoke developed not to exceed 50 as tested by UL 723 or ASTM E84.
3. Energy Codes: Local Building and Energy Codes govern where insulation performance requirements for thickness exceeds thickness specified.

B. Protection:
1. Protect against dirt, water, chemical, or mechanical damage before, during, and after installation.
2. Repair or replace damaged insulation at no additional cost.

C. Source Quality Control:
1. Service: Use insulation specifically manufactured for service specified.
2. Labeling: Insulation labeled or stamped with brand name and number.
3. Insulation and accessories not to provide nutritional or bodily use to fungi, bacteria, insects, rats, mice, or other vermin, not to react corrosively with equipment, piping, or ductwork, and asbestos free.

1.04 SUBMITTALS

A. Submit the following.
1. Product Data: For each type including density, conductivity, thickness, jacket, vapor barrier, and flame spread and smoke developed indices.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Pipe Insulation:
   1. Fiberglass:
      a. Johns Manville Microlok HP
   2. Calcium Silicate:
      a. Johns Manville Thermo-12 Gold
   3. Elastomeric:
      a. ArmacellAP Armaflex
      b. Rubatex
      c. K-Flex
   4. Cellular Glass:
      a. Pittsburgh Corning Foamglas
      b. Pittwrap SS Jacket

B. Block Insulation:
   1. Calcium Silicate:
      a. Manufacturer: Johns Manville Thermo-12 Gold
   2. Fiberglass:
      a. Johns Manville 1000 Series

C. Ductwork Blanket Insulation:
   1. Fiberglass:
      a. Johns Manville Microlite Type 100
   2. Semi-Rigid Fiberglass:
      a. Johns Manville Micro-Flex
   3. Elastomeric:
      a. Armacell Armafle

D. Ductwork Board Insulation:
   1. Semi-Rigid Fiberglass:
      a. Micro-Aire Duct Board Type LP
   2. Rigid Fiberglass:
      a. Johns Manville Diffuser Board

E. Duct Insulation, Internal:
   1. Round Ductwork:
      a. CertainTeed
      b. Johns Manville
   2. Rectangular Ductwork:
      a. CertainTeed
      b. Johns Manville
      c. Knauf
      d. Owens Corning

F. Duct, Pipe and Terminal Unit Acoustical Wrap:
   1. Kinetics Noise Control model KNM-100ALQ.

G. Duct Enclosure, Fire Rated:
   1. Johns Manville
   2. Firemaster
   3. Fyrewrap

2.02 PIPE INSULATION

A. Fiberglass: Split sectional or Snap-On type with 0.23 per-inch maximum thermal conductivity (K-factor) at 75 degrees F mean temperature, 850 degrees F maximum service rating and white, vapor barrier jacket with pressure sensitive closure system.

B. Calcium Silicate: Sectional with 14 pcf nominal density, 0.40 maximum K-factor at 300 degrees F mean temperature and 1200 degrees F maximum service rating.

C. Elastomeric:
   1. Expanded closed cell, 0.27 per-inch maximum K-factor at 75 degrees F mean temperature, 220 degrees F maximum service rating with fitting covers and paintable surface.
   2. Color:
      a. Concealed Locations: Black
      b. Exposed Locations: White.

D. Cellular Glass:
   1. Light weight rigid glass foam insulation, 0.34 per-inch maximum K factor at 75 degrees F mean temperature, 900 degree degrees F maximum service rating.
   2. Field applied jacketing, woven glass fabric, bituminous resin, poly-ethylene film.

E. Polyurethane Foam:
   1. Cellular rigid polyurethane foam insulation, minimum 90 percent closed cell, 2 pcf density, compressive strength of 30 psi at 75 degrees F, 0.16 per-inch maximum K-factor at 75 degrees F mean temperature, 230 degrees F maximum service rating.

F. High Temperature Polyurethane Foam:
   1. Cellular rigid polyurethane foam insulation, minimum 90 percent closed cell, 2 pcf density, compressive strength of 35 psi, 0.16 per-inch maximum K-factor at 75 degrees F mean temperature, 400 degrees F maximum service rating.
   2. Insulation capable of handling intermittent temperature spikes of 450 degrees F for one hour.

G. Mineral Wool: Sectional mineral wool, 8 psf density, 0.31 per-inch maximum K-factor at 75 degrees F temperature, 1200 degrees F maximum service rating.

2.03 BLOCK INSULATION

A. Calcium Silicate: 1-1/2-inch thick unless specified or shown otherwise with 14 pcf nominal density, 0.40 maximum K-factor at 300 degrees F mean temperature and 1200 degrees F maximum operating temperature limit.

B. Fiberglass: 1-1/2-inch thick unless specified or shown otherwise with 3 pcf nominal density, 0.23 per-inch maximum K-factor at 75 degrees F mean temperature and 450 degrees F maximum operating temperature limit.

2.04 DUCTWORK BLANKET INSULATION

A. Fiberglass: 1.0 pcf nominal density, 0.25 per-inch maximum K-factor at 75 degrees F mean temperature, 250 degrees F minimum operating temperature limit.
   1. Exposed: FSK facing (foil scrim Kraft) or vinyl - white appearance.
   2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
   3. Concealed without Vapor Barrier: Facing not required.

B. Semi-Rigid Fiberglass: 2.5 pcf nominal density, 0.24 per-inch maximum K-factor, at 75 degrees F mean temperature, 250 degrees F minimum operating temperature limit.
   1. Exposed: FSK facing (foil scrim Kraft) or vinyl-white appearance.
   2. Concealed with Vapor Barrier: FSK reinforced foil and paper.
   3. Concealed without Vapor Barrier: Facing not required.

C. Elastomeric: Expanded closed cell sheets, 0.27 per-inch maximum K-factor at 75 degrees F mean temperature and 220 degrees F minimum operating temperature limit.

2.05 DUCTWORK BOARD INSULATION

A. Semi-Rigid Fiberglass: 0.23 per-inch maximum K-factor at 75 degrees F mean temperature, 250 degrees F minimum operating temperature limit and all-purpose vapor barrier facing with white Kraft paper finish.

B. Rigid Fiberglass: Same as semi-rigid except with 4.0 pcf density and 0.23 per-inch maximum K-factor.

2.06 DUCT INSULATION, INTERNAL

A. Fiberglass Duct Liner.
   1. Thermal Conductance: k-0.23 in accordance with ASTM C518 and ASTM C177 at 75 degrees F mean temperature.
   2. Maximum Operating Temperature: 250 degrees F as determined by ASTM C 411.
   3. Maximum Air Velocity: 6,000 fpm as determined by ASTM C 1071.
   4. Fungi Resistance:
      a. Does not breed or promote as determined by ASTM C1338.
      b. No growth as determined by ASTM G21.
   5. Bacteria Resistance: No growth as determined by ASTM G22.
   6. Flame-spread index of 25 or less as determined by ASTM E 84 or UL 723.
   7. Smoke development index of 50 or less as determined by ASTM E 84 or UL 723.
   8. Acoustical Absorption Coefficients:
      a. NRC value as tested in accordance with ASTM C423, type A mounting:
         1) 1-inch thickness: Minimum NRC 0.70
         2) 2-inch thickness: Minimum NRC 0.90

2.07 DUCT, PIPE AND TERMINAL UNIT ACOUSTICAL WRAP

A. Barrier:
   1. Construct barrier of a 0.10-inch thick mass loaded, limp vinyl sheet bonded to a layer of reinforced aluminum foil on one side.
   2. Nominal density of 1 pound per square-foot and minimum STC rating of 28.
   3. Minimum thermal conductivity value of 0.29 and a rated service temperature range of -40 degrees F. to 220 degree F.
   4. Flame spread index of no more than 10 and a smoke development index of less than 40.

B. Decoulpling Layer:
   1. Combination of 1-inch fiberglass batting, non-woven porous scrim-coated glass cloth, quilted together in a matrix of 4-inch diamond stitch pattern, which encapsulates the glass fibers.

C. Composite Material: Fabricated to include a nominal 6-inch wide barrier overlap tab extending beyond the quilted fiber glass to facilitate a leak-tight seal around field joints.

2.08 DUCT ENCLOSURE, FIRE RATED

A. Johns Manville:
   1. 2-hour Rated: Johns Manville, Super Firetemp M, minimum 3-inch thickness, ASTME2336, 2-hour rated assembly.
   2. 1-hour Rated: Johns Manville, Super Firetemp L, minimum 2-1/4-inch thickness, ASTM E2336, 1-hour rated assembly.
   3. Joint: Johns Manville, Super Calstik adhesive, modified sodium silicate adhesive.

B. Firemaster: Thermal Ceramics Firemaster duct wrap ceramic fiber blanket, minimum 3-inch total thickness, ASTM E2336, 2-hour rated assembly.

C. Fyrewrap: Unifrax Firewrap duct wrap fiberglass blanket, 1-1/2-inch thickness for 1-hour rated assembly, 3-inch thickness for 2-hour rated assembly. ASTM E2336.

2.09 ACCESSORIES PIPING

A. Adhesives:
   1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
   2. Fiberglass: Integral closure system.
   3. Calcium Silicate: Benjamin Foster 30-36.
   4. Elastomeric: Armacell 520 BLV.

B. Cements:
   1. Insulating: Ryder.
   2. Heat Transfer: Chemax Tracit-300.

C. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

D. Pipe Fitting Covers: One piece PVC insulated pipe fitting covers. Zeston, Ceel-Co.

E. Grooved Coupling Insulation: One piece PVC insulated fitting cover. Zeston, Ceel-Co.

F. Metal Pipe Jacket: 0.016-inch thick aluminum jacket with formed fitting covers, aluminum snap straps and sealant.

G. Cloth Facing: Presized fiberglass cloth.

H. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F. Zeston Z-tape.

I. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

2.010 ACCESSORIES DUCTWORK

A. Adhesives:
   1. General: Maximum Flame Spread/Smoke Developed Rating of 25/50, SCAQMD Rule 1168 compliant.
   2. Fiberglass: Benjamin Foster 85-62, Design Polymerics 2501/2502
   3. Elastomeric: Armacell 520 BLV
   4. Duct Insulation, Internal: Foster 85-62, Design Polymerics 2501/2502

B. Weld Pins: Duro-Dyne with NC-1 nylon stop clips

C. Cements:
   1. Insulating: Ryder.
   2. Heat Transfer: Chemax Tracit-300

D. Wire Mesh: 1-inch mesh with 20 gauge annealed steel wire.

E. Mastic: Chicago Mastic:
   1. Vapor Barrier: 17-475
   2. Outdoor Mastic: 16-110 white

F. Cloth Facing: Presized fiberglass cloth

G. Tapes: Pressure sensitive, weather resistant, and for temperatures up to 150 degrees F. Zeston Z-tape.

H. Paint: Ultraviolet resistant latex paint with special adherence capabilities to the PVC fitting covers, elastomeric, aluminum facing, Kraft paper, tapes, and adhesives.

PART 3 EXECUTION

3.01 GENERAL

A. Workmanship:
   1. Installation: Insulation installed in first class, neat professional manner.
   2. Applicators: Employ by firm that specializes in insulation work.

B. Preparation: Surfaces of piping, ductwork, and equipment clean, free of oil or dirt, and dry before insulation is applied.

C. Stamps: ASME stamps, UL labels, and similar stamps and labels not covered.

3.02 HVAC PIPE AND EQUIPMENT INSULATION APPLIED LOCATIONS

A. Insulation Applied Locations – HVAC Piping:

System	Pipe Size	Insulation Type	Insulation Thickness	Notes
Heating Water (to 200 degrees F)	1-1/4-inch and smaller	Fiberglass	1-1/2-inch	Note 1
Heating Water (to 200 degrees F)	1-1/2-inch and above	Fiberglass	2-inch	Note 1
Heating Water (to 250 degrees F)	3-1/2-inch and smaller	Fiberglass	2-1/2-inch	Note 1
Heating Water (to 250 degrees F)	4-inch and above	Fiberglass	3-inch	Note 1
Secondary Water (to 40 degrees F minimum and 140 degrees F maximum)	1-1/4-inch and smaller	Fiberglass	1-inch	Note 1
Secondary Water (to 40 degrees F minimum and 140 degrees F maximum)	1-1/2-inch and above	Fiberglass	1-1/2-inch	Note 1
Pre-Insulated Heating Water (to 250 degrees F)	3-1/2-inch and smaller	Polyurethane foam	2-1/2-inch	Note 2
Pre-Insulated Heating Water (to 250 degrees F)	4-inch and above	Polyurethane foam	3-inch	Note 2
Refrigerant Suction Hot Gas	1-1/4-inch and smaller	Elastomeric	1-inch	Note 3
Refrigerant Suction Hot Gas	1-1/2-inch and above	Elastomeric	1-1/2-inch	Note 3
Air Separators and Storage Tanks	All	Fiberglass	3-1/2-inch	
Air Separators and Storage Tanks	All	Elastomeric	3-1/2-inch	Note 3
Note 1: Cover with metal pipe jacket where exposed to weather and over heat trace cable. Note 2: Refer to specification 23 20 14 for additional pre-insulated piping systems requirements. Note 3: Elastomeric insulation not allowed over heat trace cable. Note 4: Or per VRF manufacturer installation recommendations.				

B. The following piping is not insulated:
   1. Refrigerant relief valve discharge.
   2. Condenser water, inside building, except where used for water side economizer.
   3. Steam safety valve discharge higher than 8-feet above floor.
   4. Steam vents from condensate, higher than 8-feet above floor pumps, deaerators, etc.
   5. Steam traps.

C. Include fittings, unions, flanges, mechanical couplings, valve bodies, valve bonnets, piping through sleeves, except valve bonnets, unions and flanges need not be insulated on the following systems:
   1. Hot water heating, and heat recovery, inside building.

D. Piping insulation is not required between the control valve and coil on run-outs when the control valve is located within 4-feet of the coils and the pipe size is 1-inch or less.

E. Valves, humidifier bodies, and irregular fittings insulated with section of pipe insulation and insulating cement, securely fastened, and finished with 6 ounces canvas and Foster 30-36 lagging adhesive.

F. Option on flanges, valves, strainers, not requiring a vapor barrier to insulate with removable replaceable pads fabricated of 1-inch layer of Pittsburgh Corning Temp Mat sandwiched between inner and outer layer of 8 ounces glass cloth held together with stainless staples with sufficient stainless lacing hooks to hold pad firmly to flange or valve with minimum 3-inch overlap onto adjacent pipe insulation using 18 gauge SS lacing wire.

G. Expansion Joints and Flexible Connectors: Pipe insulation or block of same material and thickness as adjacent piping.

H. Gas Flues: 1-1/2-inch thick calcium silicate block.

I. PIPING INSTALLATION

J. General:
   1. Joints: Coat both sides of complete joining area with applicable adhesive.
      a. Longitudinal Joints: Make joints on top or back of pipe to minimize visibility. Except foam plastic, seal with closure system or 3-inch wide tape.
      b. Butt Joints: Butt lightly together and, except for foam plastic, seal with 3-inch wide tape or butt straps.
      c. Multiple Layered Insulation: Joints staggered.
   2. Access: Strainer and other items requiring service or maintenance with easily removable and replaceable section of insulation to provide access.
   3. Voids:
      a. Fill voids, chipped corners and other openings with insulating cement or material compatible with insulating material.
      b. In insulation with Heat Tracing: Where piping is shown or specified to be heat traced, bed heat tape into heat transfer cement with insulation over heat tape and cement.
   4. Seal joints, seams, and fittings of metal watertight jackets at exterior locations.

K. Fiberglass Insulation: Exterior insulation encased in metal jacket.

L. Calcium Silicate Insulation:
   1. Secure with 18-gauge wire embedded into insulation.
   2. On systems with vapor barrier, coat complete with vapor barrier mastic.
   3. Cover with cloth facing secured with applicable adhesive.
   4. Exterior insulation encased in metal jacket.

M. Cellular Glass Insulation (Pre-Insulated Piping):
   1. Install per manufacturer's instructions.
   2. Factory apply insulation and jacket to carrier piping and fittings.
   3. Apply bituminous wrap jacket.
   4. Installation to be liquid and vapor tight.

N. Elastomeric Insulation:
   1. Slit full length and snap around pipe.
   2. Make cuts perpendicular to insulating surface leaving no cut section exposed.
   3. Do not stretch insulation to cover joints or fittings.
   4. Seal joints in elastomeric insulation with adhesive.
   5. Exterior insulation painted with two coats of specified paint in accordance with the manufacturer's instructions and encase in metal jacket.
   6. Sealing joints with tape will not be allowed.

O. Polyurethane Foam Insulation (pre-insulated piping):
   1. Install per manufacturer's instructions.
   2. Factory apply insulation and jacket to carrier piping and fittings.
   3. Spray applied or injected with one shot into the annular space between carrier pipe and jacket

4. Liquid and vapor tight insulation.

P. Mineral Wool Insulation (pre-insulated piping):
1. Install per manufacturer's instructions.
2. Insulation and jacket factory applied to the carrier piping and fittings.
3. Band sectional insulation on pipe with stainless steel banding on 18 centers.
4. Liquid and vapor tight insulation.

Q. Fittings: Insulation specified with continuous vapor barrier, the vapor barrier must not be violated.
1. On Elastomeric Insulation: Fittings covered with covers made up of mitered sections of insulation or with formed pipe fitting covers.
2. In Other Insulation: Fittings covered with insulation to the same level of the adjoining insulation or fill with insulating cement. Finish with pipe fitting covers or cloth facing and tape.

R. Unions, Mechanical Joints, Valves, etc.:
1. General:
a. As specified for fittings.
b. Minimum thickness same as specified for piping.
2. Unions: Build up insulation at least 1/2-inch beyond adjoining insulation.
3. Flanges: With square corners. Where flanges are not insulated, terminate adjacent insulation so flange bolts can be removed.
4. Flanged Valves: Insulation with square corners.

S. Vapor Barrier Insulation:
1. Refer to Section 23 05 29 Hangers, Supports, and Anchors for HVAC, for support requirements.
2. Piping which requires vapor barrier protection has a continuous vapor barrier, which may not be pierced or broken. The following piping systems require vapor barrier protection:
a. Chilled water including radiant cooling water.
b. Brine water.
c. Refrigerant suction.
d. Other piping systems with a nominal operating temperature below 65 degrees F.
3. Vapor Barrier Insulation.
a. Insulation for pipe requiring vapor barrier protection 1-1/4-inch or smaller, insulation continuous through pipe hangers and rollers.
b. For pipe 1-1/2-inch and larger, 18-inch section of calcium silicate, same thickness as pipe insulation with continuous vapor barrier jacket at each hanger or roller. Provide pipe shield specified in Section 23 05 29, Hangers, Supports, and Anchors for HVAC.

T. Non-Vapor Barrier Insulation:
1. Refer to Section 23 05 29, Hangers, Supports, and Anchors for HVAC for support requirements.
2. Pipe 1-1/4-inch or Smaller: Isulation continuous through pipe hangers and rollers.
3. Pipe 1-1/2-inch and Larger:
a. 18-inch section of calcium silicate, same thickness as pipe insulation.
b. Provide pipe shield specified in Section 23 05 29, Hangers, Supports, and Anchors for HVAC.

3.03 EQUIPMENT INSTALLATION

A. General: Install true and smooth. Insulation over curved surfaces conform to curves of surface.
1. Access:
a. Insulated removable heads, water boxes, pump casings, access, etc., that require service, inspection or maintenance provided with covers or section that are easily removable and replaceable.
b. Reinforce openings in adjacent insulation with metal beading.

c. In vapor barriered insulation, coat joints with vapor barrier mastic.

2. Voids, Depressions and Cavities: Voids, chipped corners and other openings filled with insulating cement or material compatible with insulating material.
3. Vapor Barriered Insulation:
   a. Where insulation is specified to have a vapor barrier.
   b. No broken or pierced barrier.
      1) Coated with vapor barrier mastic and patched with insulation facing or tape.
      2) Staples brush coated with vapor barrier coating.
      3) Raw edges coated with vapor barrier mastic covered and cover sealed to equipment surface.
4. Non-Vapor Barriered Insulation:
   a. Patch with insulation facing or tape.
   b. Cover raw edges and neatly bevel to the equipment surface.
5. Multilayered Insulation: With staggered joints.

B. Calcium Silicate and Fiberglass Block:
1. Anchors: Lug nuts 10 gauge black annealed iron wire welded to metal surfaces.
2. Banding: Block secured to surface with 1/2-inch wide stainless steel bands maximum 18-inches on center and secured to anchors.
3. Insulating Cement: Block covered with insulating cement minimum thickness of 1/2-inch with smooth finish.
4. Vapor Barriered System: On vapor barriered system, apply continuous coat of vapor barrier mastic.
5. Finish: Finish with cloth facing secured with adhesive and lapped a minimum of 2-inches. Defects touched up with finishing cement.

C. Elastomeric Blanket:
1. Cut insulation to size, make corners with mitering cuts to preclude raw edges, continuously cement insulation to equipment with adhesive.
2. Cement both surfaces of joints and butt tightly together and cover raw edges with two coats of adhesive.

D. Expansion Joints:
1. Covered with larger size pipe insulation to allow full movement and be removable, ends turned back to pipe, coat with vapor barrier mastic on joints in vapor barriered system, and finished with cloth facing cemented to insulation with adhesive.

E. Boiler Breeching, Steel Stacks and Gas Flues:
1. As specified under calcium silicate block except air space 1-inch from metal with air space vented to room and atmosphere.

F. Heat Exchangers:
1. Insulation thickness and material as specified for piping and applicable service.

3.04 DUCT INSULATION APPLIED LOCATIONS

A. General:
1. External insulation with continuous vapor barriers unless specifically noted otherwise.
2. Internally lined completely to grille or diffuser or to indicated terminal points. Dimension shown are net inside of liner.
3. Internally lined ductwork need not be externally insulated.
4. In addition to locations described in specification, internally line medium, low, return and exhaust air ductwork where shown on drawings.

B. Insulation Applied Location – HVAC Ductwork:

System	Location	Duct Type	Insulation Type	Thickness	Notes
Medium Pressure Supply*	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	1-1/2-inch	
		Round/Oval	Internally Lined	1-1/2-inch	
	Concealed or in mechanical rooms	All	Fiberglass Blanket	1-1/2-inch	
	Exposed Outside Building Envelope	All	Internally Lined	3-inch	
	15-feet upstream and downstream of fans	All	Internally Lined	1-1/2-inch unless otherwise indicated	
Low Pressure Supply*	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	1-1/2-inch	
		Round	Internally Lined	1-1/2-inch	Note 3
	Concealed or in mechanical rooms	All	Fiberglass Blanket	1-1/2-inch	
	Exposed Outside Building Envelope	All	Internally Lined	3-inch	Note 3
	Under Slab Ductwork	All	Internally Lined	2-inch	
	Downstream of Air Terminal Units	All	Internally Lined	1-1/2-inch	Note 1 Note 3
	15-feet upstream and downstream of fans	All	Internally Lined	1-1/2-inch unless otherwise indicated	Note 3
Return Air* (not insulated except)	Concealed Outside Building Envelope	All	Externally insulated without vapor barrier	2-inch	
	Exposed Outside Building Envelope	All	Internally Lined	2-inch	Note 3
	Under Slab Ductwork	All	Internally Lined	2-inch	Note 3
	15-feet upstream and downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	Note 3
Exhaust Air* (not insulated except)	15-feet upstream and downstream of fans	All	Internally Lined	1-inch unless otherwise indicated	Note 3
	In Toilet Rooms, 10-feet downstream of exhaust grilles	All	Internally Lined	1-inch	Note 3

System	Location	Duct Type	Insulation Type	Thickness	Notes
Outside Air (untempered)	Exposed or Visible (Including above a cloud ceiling)	Rectangular	Internally Lined	2-inch	
		Round	Internally Lined	2-inch	Note 3
	Concealed or in mechanical rooms	All	Fiberglass Blanket	2-inch	
Supply and Return Plenums	All	All	Internally Lined	2-inch	Note 2
Grease Hood Exhaust	All	All	Duct Enclosure, Fire Rated	As Indicated	
Transfer Air	All	All	Internally Lined	1-inch	Note 3

* In addition to applied locations listed in this table, provide internally lined ductwork where indicated on drawings.
Note 1: Except ductwork downstream of terminal units serving patient care areas in hospitals
Note 2: Insulation not required on factory fabricated insulated housings and plenums (AHP).
Note 3: Where round or oval ductwork is indicated, provide double walled round/oval ductwork as specified in Section 23 31 02, HVAC Ducts and Casing-Medium Pressure, or provide internally lined rectangular ductwork with equivalent free area may be substituted.

3.05 DUCTWORK INSTALLATION

A. General:
   1. Install in accordance with manufacturer's instruction.
   2. Continuous vapor barrier. Coat with vapor barrier mastic and patch with facing or tape. Joints between insulation and access with vapor barrier mastic.
   3. Insulation at access panels to be removable or attached to panel with edges of panel and opening reinforced with metal beading.

B. External Blanket Insulation:
   1. Insulation secured to ductwork with 20-gauge snap wires 24-inches on center and at all joints.
   2. Joints and seams lapped a minimum of 3-inches and sealed with jacket tape.

C. Board Insulation:
   1. Rectangular ducts with weld pins spaced a maximum of 18-inches on center in both directions.
   2. Corners made with joints, bending insulation around corners not allowed.
   3. Joints and seams butted tight together.
   4. Butt joints with 3-inch wide tape.
   5. Corners finished with 3-inch wide tape.

D. Internal Duct Liner:
   1. Air stream coated surface.
   2. Weld pins spaced maximum of 15-inch on center in both directions and within 2-inches of corners and joints. Weld pins flush with liner surface.
   3. Complete duct surface coated with adhesive and insulation pressed tightly thereto.
   4. Provide edges at terminal points with metal beading and heavily coated with adhesive.
   5. Heavily coat joints and corners with adhesive.
   6. Damaged areas replaced or heavily coated with adhesive.

E. Duct Enclosure - Fire Rated:
   1. Installation: Per manufacturer's instructions.
   2. Joints:
      a. Cement attached boards to one another.
      b. Butter mating surfaces with a 1/8-inch layer adhesive.
      c. Secure fiberglass type material with stainless steel banding, Type 304.
   3. Support:
      a. Duct enclosure may be hung from a conventional trapeze arrangement.
      b. Provide adequate support at the bottom of vertical runs.
      c. Multi-Story Vertical Runs: Support Firetemp enclosure at each story penetration with an angle iron collar attached to the Firetemp.
   4. Expansion: Provide adequate clearance at the end of straight runs to allow for expansion of the metal duct inside the enclosure.

F. Plenums: Insulation on floors protected by wire mesh.

G. Blank-Off Panels: Insulation, enclosed with sheet metal on all sides. Joints with vapor barrier mastic and taped.

H. Volume Dampers: Where volume dampers do not allow for continuous insulation, terminate insulation clear of handle sweep, and finish edges to maintain vapor barrier and to prevent damage to the insulation.

3.06 DUCT, PIPE AND TERMINAL UNIT ACOUSTICAL WRAP

A. Installed in accordance with the manufacturer's instructions.

B. Applied locations for piping and duct systems:
   1. Variable and constant volume terminal units with maximum air volumes over 2000 cfm. Wrap installed such that control devices are easily accessible without circumventing the acoustical value.
   2. Where specified or indicated on drawings.

3.07 FIELD QUALITY CONTROL

A. Field Test: Test and approve systems prior to installation of insulation.

B. Existing Insulation:
   1. Repair existing insulation damaged during construction.
   2. Make neat connections where new and existing insulation meet.
   3. Where existing piping, ductwork or equipment is removed, cover existing surfaces neatly to match existing.
   4. Where existing insulation is damaged or missing, notify the architect prior to performing to work.

END OF SECTION

SECTION 23 08 00
COMMISSIONING

PART 1 GENERAL

1.01 SUMMARY

A. The commissioning process is described in Section 01 91 00 Commissioning.

B. Provide all labor and materials required to complete the commissioning of those Division 23, HVAC systems and equipment identified as Commissioned Systems and Equipment in Section 01 91 00 Commissioning.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 01 91 00 Commissioning.

1.03 SUBMITTALS

A. Refer to Section 01 91 00 Commissioning.

1.04 COMMISSIONING SCOPE OF WORK - COMMISSIONING AGENT

A. Refer to Section 01 91 00 Commissioning.

1.05 COMMISSIONING SCOPE OF WORK - CONTRACTOR

A. Refer to Section 01 91 00 Commissioning.

PART 2 PRODUCTS

2.01 TEST EQUIPMENT

A. Refer to Section 01 91 00 Commissioning.

PART 3 EXECUTION

3.01 MEETINGS

A. Refer to Section 01 91 00 Commissioning.

3.02 INSTALLATION, CHECK-OUT, START-UP AND PREFUNCTIONAL CHECKS

A. Refer to Section 01 91 00 Commissioning.

3.03 FUNCTIONAL TESTING

A. Refer to Section 01 91 00 Commissioning.

3.04 TRAINING OF FACILITY OPERATING STAFF AND BUILDING OCCUPANTS

A. Refer to Section 01 91 00 Commissioning.

END OF SECTION

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SECTION 23 09 00

INSTRUMENTATION AND CONTROLS FOR HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Materials and Equipment
2. Control Devices
3. DDC Field Panels
4. Connection to Existing Network
5. BACnet Compatibility
6. Operator Interface System
7. Application Programs
8. Input/Output Functions
9. Uninterruptable Power Supply
10. Energy Management System

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 22 05 93, Testing, Adjusting and Balancing for Plumbing

D. Section 23 05 93, Testing, Adjusting and Balancing

E. Section 23 08 00, Commissioning for HVAC

F. Section 23 09 93, Sequence of Operation for HVAC Controls

G. Section 23 21 13, Pipe and Pipe Fittings HVAC

1.03 QUALITY ASSURANCE

A. Provide control work by single company with specialists in the type of work required, so that only one control manufacturer is responsible for control and automation work for project.

B. Provide coordination with other contractors or subcontractors for work required by other trades for accomplishment of control work.

C. Prior to substantial completion, controls contractor must demonstrate to Owner that system is operating per the Specifications and final adjustments have been made as approved.

D. System, including components and appurtenances, configured and installed to yield a Mean Time Between Failure (MTBF) of at least 1,000 hours.

1.04 SUBMITTALS

A. System Drawings: Prepare on AutoCAD format and include the following:
1. Equipment installation, block diagrams, and wiring diagrams.
2. DDC panel physical layout and schematics.
3. Sensor and control wiring and installation drawings which identify each component and show interconnected or interlocked components.
4. Material and equipment descriptive material such as catalog cuts, diagrams, performance curves, and other data to demonstrate conformance with specifications.
5. Details of connections to power sources, including grounding.
6. Details of surge protection device installations.
7. Instrumentation and control diagrams.
8. Complete a written description of control sequences.
9. List of connected data points, including DDC panels to which they are connected, and input device (sensor, etc.).
10. Valve and damper schedules indicating flows, pressure drops, CVs, and actuator type.
11. Graphics: System graphics for review prior to implementation of programming.

B. Equipment Data: Submittals include complete data for materials, including field and system equipment.

C. Software Data:
   1. Submittals consist of complete descriptions of system, command, and applications software as specified.
   2. Include description of control sequences which are software based using detailed logic flow diagrams.
   3. Diagrams indicate logic used to achieve control sequence of calculation specified, and show relationship between control sequence and application software packages specified.

D. Testing Submittals:
   1. Provide test plan and test procedures for approval.
   2. Explain in detail, step-by-step actions and expected results to demonstrate compliance with the requirements of this specification and methods for simulating necessary conditions of operation to demonstrate performance of the system.
   3. Test plan and test procedures demonstrate capability of system to monitor and control equipment and to accomplish control and monitoring specified.

E. Operation and Maintenance Manuals:
   1. Provide three complete sets of manuals bound in loose-leaf binders within 30 days after completing acceptance tests.
   2. Identify each manuals contents on cover.
   3. Manuals include names, addresses, and telephone numbers of each subcontractor installing equipment and systems and of nearest service representatives for each item of equipment and each system.
   4. Place tab sheets at beginning of each chapter or section and at beginning of each appendix.
   5. Final copies delivered after completion of the acceptance tests include modifications made during installation, checkout, and acceptance.
   6. Operation and Maintenance Manuals to include hardware manual, software manual, operations manual, and maintenance manual.
   7. Hardware Manual: Furnish a hardware manual describing equipment provided, including:
      a. General description and specifications.
      b. Installation and checkout procedures.
      c. Equipment electrical schematics and layout drawings.
      d. System schematics and I-O wiring lists.
      e. Alignment and calibration procedures.
   8. Software Manual:
      a. Describe furnished software.
      b. Oriented to programmers and describe calling requirements, data exchange requirements, data file requirements and other information necessary to enable proper integration, loading, testing, and program execution.
      c. Provide one software manual per Operator’s Terminal.
   9. Operator’s Manual: Provide procedures and instructions for operation of the system, including:
      a. DDC Panels and Peripherals
      b. System start-up and shutdown procedures.
      c. Use of system, command, and applications software.
      d. Alarm Presentation
      e. Recovery and Restart Procedures
      f. Report Generation
      g. System Schematic Graphics
      h. Provide one Operator’s Manual per Operator’s Terminal

10. Maintenance Manual: Provide descriptions of maintenance for equipment including inspection, periodic preventive maintenance, fault diagnosis, and repair or replacement of defective components.
11. Acceptance Test Forms: Maintenance manual includes copies of signed-off acceptance test forms.

1.05 ACCEPTANCE TESTING AND TRAINING

A. Site Testing:
   1. General: Provide personnel, equipment, instrumentation, and supplies necessary to perform testing. Owner or Owner's representative will witness and sign off on acceptance testing.
   2. Acceptance Test: Demonstrate compliance of completed control system with contract documents. Using approved test plan, physical and functional requirements of project demonstrated.

B. Training:
   1. General:
      a. Conduct training courses for designated personnel in operation and maintenance of system.
      b. Oriented to specific system being installed under this contract.
      c. Provide trainee with two additional copies provided for archival at project site.
      d. Manuals include detailed description of the subject matter for each lesson.
      e. Provide copies of audiovisuals to Owner.
      f. Training day is defined as 8 hours of classroom instruction, including two, 15-minute breaks and excluding lunch time, Monday through Friday, during normal first shift in effect at training facility.
      g. Notification of any planned training given to the Owner's representative at least 15 days prior to the training.
   2. Operator's Training I:
      a. Teach first course at supplier's facility for period of two consecutive training days.
      b. Upon completion, each student, using appropriate documentation, perform elementary operations with guidance and describe general hardware architecture and functionality of system.
   3. Operator's Training II:
      a. Teach second course at project site for a period of one training day after completion of Contractor's field testing.
      b. Include instruction on specific hardware configuration of installed system and specific instructions for operating the installed system.
      c. Upon completion, each student able to start system, operate the system, recover the system after failure, and describe the specific hardware architecture and operation of system.
   4. Operator's Training III:
      a. Teach third course at project site for period of one training day no later than six months after completion of the acceptance test.
      b. Structure course to address specific topics that students need to discuss and to answer questions concerning operation of system.
      c. Upon completion, students fully proficient in system operation and have no unanswered questions regarding operation of installed system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Automated Logic by Climatech

B. Unless otherwise noted, installed by manufacturer.

C. SYSTEM DESCRIPTION

D. General:
   1. Provide a complete control system, consisting primarily of electronic direct digital control devices.
   2. System consists of modular and distributed microprocessor based control and monitoring units connected together by communications trunks. Capable of global data sharing and communication between controllers.
   3. System architecture distributed and not rely on central processing unit (CPU) for sharing point data between controllers, or for control functions requiring data from other controllers.
   4. Multipurpose controller(s) consisting of CPU, system program, memory, power supply, and input/output drivers which communicated with terminal equipment controllers through a communications network.
   5. Provide operator's interface.
   6. Provide equipment, installation, wiring, and accessories as required but not necessarily specified to accomplish operations as described.

E. Environmental Conditions:
   1. Rate DDC panels and other field equipment for continuous operation under ambient environmental conditions of 35 degrees F to 120 degrees F dry bulb and 10 percent to 95 percent relative humidity, noncondensing.
   2. Instrumentation and control elements rated for continuous operation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified or normally encountered for the installation.
   3. Install control devices in an enclosure suitable for the installed environment.

F. System Accuracy and Display:
   1. DDC system to control space temperature with a range of 50 degrees F to 85 degrees F ±1 degrees F for conditioned space (display to nearest 0.5 degrees F); 15 degrees F to 130 degrees F ±1 degrees F for unconditioned space (display to nearest 0.5 degrees F). Return air humidity controlled to 20 percent RH to 35 percent RH ±3 percent RH.
   2. DDC system to control duct temperature with a range of 40 degrees F to 140 degrees F ±1 degrees F (display to nearest 0.5 degrees F).
   3. Water temperature with a range of 30 degrees F to 100 degrees F ±1 degrees F (display to nearest 0.5 degrees F); the range of 100 degrees F to 300 degrees F ±2 degrees F (display to nearest 0.5 degrees F); and water temperatures for the purpose of performing BTU calculations using differential temperatures to ±0.5 degrees F using matched sensors (display to nearest 0.5 degrees F).
   4. Pressure with a range for the specific application ±5 percent of range.

2.02 MATERIALS AND EQUIPMENT

A. Controls and Power Wiring:
   1. General: Electric equipment and wiring in accordance with Division 26, Electrical. Manual or automatic control and protective or signal devices required for operation specified, and control wiring required for controls and devices.
   2. Wiring:
      a. Field and Subfield Panels:
         1) Voltage in panels not to exceed 120V. Where devices are wired to higher voltages, mount in suitable individual enclosures or group in separate control panel.
         2) Coordinate electrical power supply with Division 26.
      b. Motor Control Centers: Responsibility for correct voltage of holding coils and starter wiring in pre-wired motor control centers interfacing with automatic controls is included hereunder.
      c. Wiring for DDC systems communications buses two conductor minimum 18 gauge foil-shielded, stranded twisted pair cable rated at 300 VDC or more than 80 degrees C.

3. Communications Links Surge Protection: Protect communications equipment against surges induced on any communications link. Cables and conductors which serve as communications links have surge protection circuits installed that meet the requirements of REA PE-60d.
4. Communications Links Overvoltage Protection: Protect communications equipment against overvoltage on any communications link conductors. Cables and conductors which serve as communications links have overvoltage protection for voltages up to 480 VAC rms, 60 Hz installed. Instrument fuses or fusible resistors are acceptable for this application.
5. Power Line Surge Protection:
   a. Protect equipment connected to AC circuits from power line surges.
   b. Do not use fuses for surge protection.

B. Control Panels:
1. Provide wall-mounted control panels as required to contain relays, terminal strips, power supplies and other equipment in building control system.
2. UL listed, minimum NEMA 1, minimum 14 gauge steel with stiffeners, continuous hinge doors, locking handles, single point latch.
3. UL listed, minimum NEMA 4, minimum 14 gauge steel with stiffeners, continuous hinge doors, locking handles, single point latch for outdoor or high humidity environments. Locations to be approved by engineer prior to installation.
4. UL listed, minimum NEMA 4X, minimum 14 gauge steel with stiffeners, continuous hinge doors, locking handles, single point latch for outdoor or high humidity environments with corrosive conditions. Locations to be approved by engineer prior to installation.

2.03 CONTROL DEVICES

A. Temperature Instruments:
1. Room Temperature Sensors: Platinum RTD type with accuracy of ±0.4 degrees F at 70 degrees F; operating range 30 to120 degrees F; linear to DDC system; single point sensing element in wall-mounted ventilated enclosure with insulating back plate if mounted on exterior wall.
   a. Provide sensor with digital display.
   b. Sensor to have local user adjustment based on DDC programmed offset.
2. Duct Temperature Sensors: Platinum RTD element with accuracy of ±0.5 degrees F at 32 degrees F, averaging type consisting of array of single point sensing elements, securely mounted in duct or plenum; operating range 0 to 100 degrees F; linear signal; 20-foot element.
3. Outside Air Temperature Sensor: Platinum RTD element with accuracy of ±0.5 degrees F at 32 degrees F; Range -60 to 100 degrees F, single element, linear, with weather and sun shield for exterior mounting.
4. Low Temperature Limit Thermostat: Minimum 20-foot capillary sensing element, triggering on low temperature as sensed by any 6-inch segment; snap acting, normally open contacts, manual reset, line voltage.
5. Liquid Immersion Temperature Sensor: Platinum RTD element, with accuracy of ±0.5 degrees F at 32 degrees F, stainless steel well and assembly, range 40 to 240 degrees F.

B. Humidity Instruments:
1. Space Humidity Sensors: Operating range 10 to 95 percent relative humidity, accuracy ±5 percent, surface mounted ventilated enclosure for wall mounting.
   a. Provide sensor with digital display.
   b. Sensor not to have user adjustment based on DDC programmed offset.
2. Duct Humidity Transmitter: Capacitive type sensor and transmitter, linear output signal, automatic temperature compensating, air filter, ±2 percent RH accuracy from 0 to 100 percent RH, industrial quality.

C. Motorized Control Dampers:
   1. Multi-blade air foil type, except where either dimension is less than 10 inches a single blade may be used. Maximum blade length to be 48 inches. Provide parallel blades for positive or modulating mixing service and opposed blades for throttling service. Blades to be interlocking, minimum 16 gauge galvanized steel.
   2. Compression type edge seals and side seating stops. Damper blades reinforced, have continuous full-length axle shafts, axle to axle linkage, and/or operating jackshafts as required to provide coordinated tracking of blades. Dampers over 25 square feet in area to be in two or more sections, with interconnected blades. Maximum air leakage of 3 cfm per square foot at 1-inch w.g. pressure. Provide automatic dampers except those specified to be provided with units. Tested in accordance with AMCA Standard No. 500. Based on Ruskin CD-60.

D. Motorized Valves:
   1. Equip with equal percentage with tight shutoff.
   2. Two position valves line size (two position ball valves full port), modulating water valves sized at 5 psi drop or as shown on the Drawing.
   3. Screwed ends except 2-1/2-inch and larger valves with flanged ends.
   4. Select valves to modulate smoothly at system pressures and flows.
   5. Select valves with close-off ratings and spring ranges designed to operate at the maximum flows and maximum available pump heads scheduled without leakage.
   6. Bubble tight butterfly valves acceptable on 2-1/2-inch lines and above for two-position action only.
   7. Air handling unit heating and cooling coil valves sized for 5 psi drop, unless otherwise noted on drawings.

E. Valve and Damper Operators:
   1. Electronic modulating actuators with low voltage DC or current positioning signal.
   2. Each actuator have current limiting circuitry incorporated in its design to prevent damage to the actuator.
   3. Modulating actuators be provided and accept 0-10 VDC or 2-10 VDC or 4-20 mA input signal.
   4. Actuators provide the minimum torque required for proper close-off against the system pressure for the required application.
   5. The spring return feature permits normally open or normally closed positions of the valve or damper.
   6. Direct shaft mount rotational actuators have external adjustable stops to limit the travel in either direction.
   7. Power actuators by 24 VAC.
   8. The actuator provides a clamp position feedback signal of 2-10 VDC. The feedback signal independent of the input signal, and may be used to parallel other actuators and provide true position indication.

F. Flow Switches:
   1. Provide McDonnell Miller or approved equal.
   2. Install in piping to eliminate nuisance fluttering.
   3. Provide time delay relays where required to eliminate false alarms when equipment is started.
   4. Differential pressure type.
   5. Current switches set for pump or fan normal current ranges are acceptable.

G. Electric Solenoid Operated Pneumatic (EP) Valve:
   1. Three part operation
      a. Common
      b. Normally Open
      c. Normally Closed.

2. Rated for 25 psig when used in control system operation at 20 psig or less or rated at 150 psig when used in control system operation from 25 to 100 psig.

H. Electric to Pneumatic (EP) Transducers:
1. Match to the AO signals and have a linearly proportional pneumatic output compatible with the pneumatic control loop to be interfaced.
2. Pressure calibration adjustments and withstand pressures at least 150 percent of the maximum range.
3. Pneumatic output linearly proportional within 1 percent of the electric input.
4. Provide offset and span adjustment.

I. Differential Pressure Switch:
1. Required for proof of flow on fans and pumps.
2. Setpoint adjustable with operating range of 0.5 to 12-inches w.g. for fans, and 5-feet to 30-feet w.c. for pumps.
3. Close when set pressure differential is met or exceeded.

J. Differential Pressure Transducer:
1. Provides value of pressure drop across filter bank through DDC system.
2. Operating range 0 to 2 inches w.c., linear, accurate to ±2.5 percent of span.

K. Duct Static Pressure Transmitter:
1. Operating range 0 to 5-inches w.c. for duct mounted transmitter and 0 to 5-inches w.c. for fan high limit transmitters.
2. Sensors either diaphragm or rigid element bellows, electronic type.
3. Each transmitter be provided with stop cock and tubing for attacking portable pressure gauge.
4. Sensing tube securely mounted in duct with appropriate fitting.
5. Accuracy ±1 percent of span, maximum response time 1 second.

L. Current Transformer:
1. Current status switch, adjustable setpoint 1-135A, ±1 percent of range, capable of monitoring motor’s status and detection of belt breaking or slipping.
2. Manufacturer:
   a. Hawkeye 700
   b. Or equal.

M. Building Static Pressure Transmitter:
1. Operating range of -0.1 to 0.1 inches w.c., linear to DDC system.
2. Sensing tubes located inside and outside building use shielding and/or surge tanks to minimize effects of wind.
3. Accuracy ±1 percent of span.

N. Piping Pressure Transmitter:
1. Operating range 0 to 50 psig, linear to DDC.
2. Provide threadolet for mounting to pipe installed by others.
3. Accuracy ±1 percent of range.

O. Products of Combustion Detectors: Duct smoke detectors are provided under Division 28, Electronic Safety and Security, with single set of SPDT auxiliary contacts for control contractor connection.

P. Emergency Stop Switch: Red, mushroom type, pull out to operate.

Q. End Switches:
1. Turret head type SPDT
2. Manufacturer:
   a. Square D Class 9007, Type C54B2
   b. Or equal.

R. Carbon Dioxide Sensor: Infrared sensing, Carbon Dioxide gas monitor. Based on Airtest TR9290 series.
   1. Detection Range: 0-2000 ppm
   2. Accuracy: +/- 3 percent of measured value
   3. Response Time: 2 minutes
   4. Outputs: 0-10V, 4-20 mA
   5. Calibration: Self-calibrating, calibration not required
   6. Power Requirement: 24 VAC/VDC ±20 percent, 50-60Hz (half-wave rectified)
   7. Operating Temperature Range: 32 degrees F to 122 degrees F
   8. Operating Humidity Range: 0 percent - 95 percent RH, Non-Condensing
   9. Display: Provide sensor with digital display.

S. Carbon Monoxide Detector: Electrochemical sensing Carbon Monoxide gas monitor. Based on Vulcain 201T Series.
   1. Detection Range: 0-250 PPM
   2. Accuracy: +/- 3 percent
   3. Outputs: 4-20 mA, at contractors option a Network Converter may be used
   4. Relay Output Rating: 5A, 30 Vdc or 250 Vac (resistive load)
   5. Power Requirements: 17-27 Vac, 24-38 Vdc, 250mA
   6. Operating Temperature Range: -4 degrees F to 122 degrees F
   7. Operating Humidity Range: 10 percent -95 percent RH, Non-condensing
   8. Display: Provide sensor with digital display.

T. Natural Gas Sub-Meter
   1. Electromagnetic flow meter, insertion type.
      a. Accuracy: ±1 percent of reading from 500-7000 SFPM
      b. Output Signal: Analog 4-20 mA signal
      c. Display: Digital
      d. Based On: Onicon F-5100

U. Airflow Stations:
   1. Air Flow Station (Duct Mounted):
      a. Manufacturers:
         1) Ebtron
         2) Kurz
      b. General: Electronic air measuring system consisting of thermistor based sensor grid and microprocessor based electronics.
      c. Sensor Probes: Thermistors probes and linear ICs, aluminum casing, duct mounted, wiring Teflon or kynar coated and encased, 20 degrees F to 160 degrees F operating range, weather resistant finish, flanged welded aluminum frame.
      d. Microprocessor and Electronics: Solid state microprocessor, permanent non-volatile memory, regulated power supply, software based system, 0-5 vdc, 0-10 vdc, or 4-20 mA signals, linear flow and temperature outputs, line surge and transient protection.
      e. Performance: ±2 percent, +20 fpm across total calibrated range of 0 to 5000 fpm, for duct mounted, 0-10,000 fpm for fan inlet mounted, repeatability better than ±0.4 percent of reading. Pressure drop not to exceed 0.005 inch W.G. at 2000 fpm.
      f. Based On: Ebtron-Duct mounted XP000 series.
   2. Air Flow Station (Fan Inlet):
      a. Manufacturers:
         1) Ebtron
         2) Air Monitor
         3) Paragon
         4) Pace
         5) Or equal.

b. Fan inlet airflow traverse probe, multiple total and static pressure sensors place at concentric area centers along exterior surface of cylindrical probe, internally connected to averaging manifolds.
c. Dual end support swivel brackets suitable for mounting in fan inlet bell, aluminum construction, hard anodized finish.
d. Probes capable of producing steady, non-pulsating signals of standard total and static pressure, without need for flow corrections or factors with an accuracy of 3 percent of actual flow over a fan operating range of 6 to 1 capacity turndown.
e. Based On: Fan Inlet XF000 series.

V. Bay Door Switch, Option 1: Physical contact switch.
1. Manufacturers:
a. ABB, NEMA 4X, LS Series
b. Other Manufacturers: Submit substitution request
2. Switch provides input to Building Management System on status of door position (open/closed).
3. Switch to activate when door is in fully closed position.
4. Provide mating door bracket to engage switch when door is fully closed.

W. Bay Door Switch, Option 2: Magnetic contact switch.
1. Manufacturers:
a. GE Security, 2515A Series Industrial Extra Wide Gap Magnetic Door Switch
b. Other Manufacturers: Submit substitution request
2. Switch provides input to Building Management System on status of door position (open/closed).
3. Switch to activate when door is in fully closed position.

2.04 DDC FIELD PANELS

A. Multipurpose Controllers:
1. Stand-alone microprocessor based panels, enclosed in sturdy metal enclosure with two standard RS232 interface ports, network communications module, power supply, and battery back-up.
2. Panels will be used to connect field sensors and control devices. Fully supervise each panel to detect failures. Construct panel so functions are implemented on replaceable circuit boards to permit field maintenance. Completely field programmable through portable terminal. Minimum 8-hour battery backup system.
3. Each DDC panel linked with data trunk cable to other controllers and Operator's Terminals to distribute information. Field panels continuously exchange data through trunk cable without requiring output to input wiring between panels. The system arranged so that operations are maintained without the central computer being connected to the system.
4. Upon failure of the DDC field panel, including transmission failure, the panel automatically forces the controls to remain in the last command status.
5. Provide a real time clock with calendar maintaining seconds, minutes, hours, and days of the week, accurate to ±10 seconds per day.
6. Provide sufficient memory to perform specified and shown DDC field panel functions and operations, including spares. Each DDC panel to have 10 percent minimum spare memory board spacing.
7. Each DDC field panel contain hardware to support power fail automatic restart.
8. Provide locking type mounting cabinets with common keying.
9. DDC field panel have built-in diagnostics to display to operator interface terminal any sensor transmitting signal out of its design range.
10. Control logic done with software resident in each local DDC panel. Auxiliary relays may be used only when required for load contact rating.
11. Panels UL listed.

B. Terminal Equipment Controller:
   1. Terminal equipment controllers provided for each piece of equipment, as specified, and includes point inputs and outputs as necessary to perform specified control sequences.
   2. Each controller performing space temperature control provided with a matching room temperature sensor, which include terminal jack to monitor hardware and software associated with controller.
   3. Each room sensor includes setpoint adjustment dial, temperature indicator, and override switch. Override switch overrides night setback mode to normal (day) mode when activated by occupant. Adjustment dial and override switch may be locked out, overridden, or limited through software from central workstation or portable terminal.
   4. Each controller independent of other network communications. Controller receives real time data from central workstation or multipurpose controller.
   5. Controller utilizes proportional, integral, and derivative (PID) algorithms which is field adjustable.
   6. Database and sequence of operation programs stored in non-volatile EEPROM and EPROM.
   7. Controllers networked through communications link to the multipurpose controller.
   8. Controllers powered from 24 VAC source. Provide dedicated power source. Coordinate with Division 26.
   9. VAV box controllers include differential pressure transducer connected to manufacturer's standard velocity sensor, and includes provisions for both automatic and manual calibration of transducer to ensure against drift. Incorporate algorithm to allow for modulation of hot water heating valve, and supplementary hot water radiation valve. Fan-powered terminal units control series or parallel fan as appropriate. Provide fan status proof current switch.

2.05 CONNECTION TO EXISTING NETWORK

A. General: Communication between peer-to-peer DDC control panels via TCP/IP over the existing Ethernet system.

B. Provide software and system integration to seamlessly integrate to the existing server for common system graphics, alarming, paging out of alarms via existing paging system.

2.06 BACNET COMPATIBILITY

A. DDC System and components BACnet Data Communications Protocol compliant.

B. System fully integrated and installed as a complete package of BACnet compliant controls and instrumentation.

C. Capable of seamless BACnet integration with existing BACnet compliant devices as well as future BACnet compliant devices.

D. No portals or third party devices required for integration with existing or future equipment.

E. Devices utilized in the BACnet interface BACnet Testing Laboratories (BTL) listed and labeled.

2.07 OPERATOR INTERFACE SYSTEM

A. Web-Based Access:
   1. Control system to directly integrate into the database of the existing campus control system network.
   2. Provide a web-based controls interface with at least three user login accounts and password each with the capability of different access privileges that performs data access, operator's commands, alarm notification, requests for reports, file generation, diagnostics, and modifications.
   3. Controls accessible in mechanical room by direct connection from a laptop to a data port.
   4. Provide a temporary computer located on-site in the mechanical room until the commissioning, testing, and balancing has been completed.

5. Provide a temporary computer located on-site in the mechanical room, with software and capabilities necessary to support commissioning, testing, and balancing and other activities required for project completion.

B. Graphics: Provide a complete graphics package with the following features:
   1. Provide separate schematic diagram depicting each system. Diagrams to show major components such as fans, dampers, heating and cooling coils, humidifiers, pumps, heat exchangers, chillers, boilers, towers, ductwork, piping, etc., arranged to convey to viewer system configuration and flow of each system.
   2. Provide plot plan, riser plan, and selected floor plans of buildings with the location of each mechanical room and major equipment location indicated.
   3. Provide symbols superimposed on each schematic to indicate each control device including control valves, damper motors, temperature sensors, pressure sensors, etc. Provide real time dynamic displays of the temperature, humidity, pressure, flow rate, run status, alarm status, and etc., adjacent to each control symbol. Arrange CPU to update each displayed analog and digital value minimum of every 15 seconds.
   4. Provide indication of setpoints, with each setpoint value located adjacent to each sensed value.
   5. Provide means to allow the user to easily change or add graphics via computer assisted drawing function utilizing freehand mouse.
   6. Provide means to allow user to transfer repeated system schematics and symbols between graphics without redrawing them. Provide symbol library arranged to store commonly used symbols.
   7. Provide a “telescoping” or “zoom” program to allow use to move from plot plan to mechanical room plan to system graphic to control device display by simply clicking the mouse.
   8. Provide dual function windowing program to allow user to view a split screen and toggle between simultaneous operations.

C. Trend Data Collection and Historical Data:
   1. Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-intervals, time-synchronized intervals, change of value, or by event of which user-definable. Trend data collected and stored on hard disk for future diagnostics and reporting. Automatic trend collection may be scheduled of zones, events, and reports. Additionally, trend data may be archived to network drives or removable disk media for future retrieval.
   2. Provide trend data reports to allow the user to view trended point data. Display data in both tabular and graphical format. Reports may be customized to include individual points or predefined groups of selected points. Provide additional functionality to allow predefined groups of up to 250 trended points to be easily transferred online to Microsoft Excel.
   3. The following trend data provided for review by the commissioning agent:
      a. Adequate trending data maintained to evaluate system performance and diagnose system problems. Controls Contractor is responsible for trending points necessary to evaluate controlled equipment. Controls Contractor to coordinate with the Cx regarding trend intervals and specific points to be trended. The following systems trended and trend data provided for review by the engineer and commissioning agent at 15-minute intervals unless otherwise directed.
      b. Monitored temperatures including but not limited to space, supply, return, outside air, mixed air, chilled water, heating water, steam, pumped condensate, and etc.
      c. Occupancy modes as they apply to each piece of controlled equipment including but not limited to optimal start, occupied, unoccupied, temporarily occupied (override, etc.), night low limit, night high limit, night purge.
      d. Motor run commands and motor proofs for fans and pumps.
      e. VFD Speeds for controlled equipment.

f. Measured airflows for both air handlers and volume control units.
g. Damper positions for both air handlers and volume control units.
h. Heating and cooling valve positions.
i. Occupancy sensor indications used for HVAC control.
j. Heat recovery system operation.
k. Set points including but not limited to occupied and unoccupied space temperature, supply air temperature, hydronic supply temperature, radiant heating, and cooling temperature, pumping pressure, fan static pressure, etc.
l. Supporting information necessary to evaluate setpoint reset sequences.
m. Operating schedules for controlled equipment.
n. Loop tuning variables.

2.08 APPLICATION PROGRAMS

A. General: Provide user-programmable DDC system programs with library of base-level predefined functions with user specified parameters.

B. Time of Day Scheduling:
1. A minimum of six schedules provided for equipment operation.
2. Seven unique days per schedule provided.
3. Program individual time cycle capability for each piece of equipment.

C. Control Priorities:
1. Provide an effective order of control priorities such that each succeeding level of optimization does not interfere with a more critical function.
2. Allow features as alarm actions and manual commands from the operator to override lower level functions (such as duty cycling or scheduling).
3. Events, initiated outside the DDC system causing equipment shutdown automatically reset when events causing the shutdown is cleared, such as power failure or fire alarm. For alarms within the control system, mechanical equipment restart after the alarm condition is manually reset.

D. Alarms: System provides following alarm processing capabilities:
1. Connected status or analog point may be designated as alarm input point.
2. Start/stop points with status feedback as well as associated analog alarms have user-programmable inhibit time assigned to each point to prevent nuisance alarms from occurring during startup of HVAC equipment.
3. Each alarmable point have change-of-state priority assignment assignable at 3 levels. One each for its level of criticality: low for such things as maintenance alarms, high for critical HVAC equipment alarms, and emergency for life safety alarms.
4. User may designate which conditions of alarm causes alarms to be initiated for display. The user may also designate alarm message for alarm condition and for return to normal condition as desired. Each message may be up to 32 characters in length and up to 32 messages are available in each digital management system.
5. This feature provides for orderly display of alarms based on criticality; alarm with highest level of priority displayed first.
6. User may designate which conditions of alarm causes alarms to be initiated for display. User may also designate alarm message for alarm condition and for return to normal condition as desired. Each message may be up to 80 characters in length.
7. Provide automatic phone dialing feature with the capability to report a general alarm recorded message.

E. Security: System supports multi-level password access with the following minimum access levels:
1. Read-only level, without capability of changing any part of software.
2. Adjustment level, allowing operator to adjust setpoints and schedules, force outputs on/off, but not to modify programming.
3. Full programming access.
4. System supports additional levels of programming access.

F. Power Failure:
   1. In the event of the loss of normal power, there is an orderly shutdown of controllers to prevent the loss of database or operating system software.
   2. Non-volatile memory incorporated for critical controller configuration data, and battery backup provided to support the real-time clock and volatile memory for a minimum of 72 hours.
      a. During a loss of normal power, the control sequences go to normal system shutdown conditions.
      b. Upon restoration of normal power and after a minimum off-time delay, the controller automatically resumes full operation without manual intervention through a normal soft-start sequence.
      c. Should a controller memory be lost for any reason, the operator workstation automatically reloads the program without any intervention by the system operators.

G. INPUT/OUTPUT (I/O) FUNCTIONS

H. Analog Inputs (AI):
   1. AI function monitors each analog input, perform A-to-D conversion, and hold the digital value in a buffer for interrogation.
   2. Provide signal conditioning for each analog input.
   3. Individually calibrate analog inputs for zero and span, in hardware or in software.
   4. Minimum 12 bit A to D resolution.

I. Analog Outputs (AO):
   1. The AO function accepts digital data, perform D-to-A conversion, and output a signal compatible with the operator.
   2. Individually calibrate analog outputs for zero and span.
   3. Provide short circuit protection.
   4. Minimum 8 bit D to A resolution.

J. Digital Inputs (DI):
   1. DI function accepts ON/OFF, OPEN/CLOSE or other change of state (two-state data) indications.
   2. Provide isolation and protection against input voltage up to 180 Vac peak.

K. Digital Outputs (DO):
   1. DO function provides contact closures for momentary and maintained operation of output devices.
   2. Closures have a minimum duration of 0.1 second.

2.09 UNINTERRUPTABLE POWER SUPPLY (UPS)

A. General:
   1. Provide an uninterruptable power supply (UPS) for each DDC field panel.
   2. Fed by 120V AC emergency power circuits.
   3. Floor or wall mountable.

B. UPS:
   1. Provide MGE Pulsar UPS or pre-bid approved equal.
   2. Products carry UL 1778 listing.
   3. Base sizing on peak current requirements of connected load plus 15 percent factor of safety.
   4. Provide manufacturer’s standard three-year comprehensive warranty, including batteries.

PART 3 EXECUTION

3.01 INSTALLATION

A. Operator Workstation: Locate as shown or submit proposed location where not shown.

B. Mounting Panels: Locate panels where shown on Drawings or near item of equipment to be controlled, but not on equipment itself.

C. DDC Field Panels: Provide number of panels required to accommodate DI, DO, AI, and AO points and hardware and software to accomplish specified control sequenced. Locate panels in mechanical or electrical rooms. Submit proposed locations for approval prior to preparing control drawings.

D. Pneumatic Signals: The use of pneumatic signals to start and stop motors is not allowed.

E. Electrical:
   1. Provide control wiring for control devices and control panels.
   2. Run control wiring in conduit
   3. Provide power wiring for control devices and control panels. Utilize designated circuits in electrical power panels. Refer to Electrical Drawings. If no circuits are designated for DDC Controls, submit detailed request for use of spare circuits at no additional cost.
   4. Install power wiring in conduit.
   5. Grounding: Instrumentation and communication grounding installed as necessary to preclude ground loops, noise, and surges from adversely affecting system operation.
   6. Control voltage limited to maximum of 120V.
   7. Where relay coil is connected to load side of motor starter to energize with motor operation, external control circuit properly fused with fuse block located in respective starter enclosure.
   8. Where relays are used to control single-phase motors directly, provide contacts rated for not less than horsepower rating of largest motor switched by relay.

F. Identification: Provide engraved nameplates identifying switches, lights and starters, and each control device where control function is not readily apparent.

G. Room Thermostats and Room Sensors:
   1. Wall Thermostats and Room Sensors with User Adjustment: Mount at height of 48-inches above finished floor.
   2. Wall Thermostats and Room Sensors without User Adjustment: Mount at height of 60 inches above finished floor.
   3. Provide insulating back on thermostats mounted on exterior walls.
   4. Provide one thermostat for each zone of temperature control.
   5. Submit proposed locations for approval prior to preparing control drawings, where not shown or alternate location is proposed.

H. Carbon Dioxide Sensor:
   1. Mount sensor at 5 feet above finished floor or as indicated on the plans.
   2. Provide sensor quantity as indicated on plans or as required by sensor coverage rating (maximum 20-foot radius).
   3. Alarm above 850 ppm.
   4. Refer to sequence of operations for more information on sensor use.

I. Carbon Monoxide Detector:
   1. Mount sensors at 5 feet above finished floor as indicated on the plans.
   2. Provide sensor quantity as indicated on plans or as required by sensor coverage rating (maximum 50-foot radius).
   3. Operate system to maintain less than 25 ppm. Alarm if levels exceed 200 ppm for longer than 15 minutes.
   4. Refer to sequence of operations for more information on sensor use.

J. Airflow Station (Duct-Mounted):
   1. Install grid array in ductwork according to manufacturer’s recommendations.
   2. Provide gasket between frame and duct.

K. Airflow Station (Fan Inlet): Install in fan inlet bell in accordance with the manufacturer’s instructions.

L. Bay Door Switch:
   1. Installation of door switches in accordance with door manufacturer’s requirements and not to void door warranty.

2. Provide necessary components for a complete installation.
3. Coordinate with door manufacturer for factory or field installation of components.
4. Coordinate installation with Architect and other trades.

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SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

A. This Section includes control sequences for HVAC systems, subsystems, and equipment.

1.02 RELATED WORK

A. This Section shall be used in conjunction with the following other specifications and related Contract Documents to establish the total requirements for the system.
   1. Section 23 05 00 Common Work Results for HVAC.
   2. Section 23 05 14 Variable Frequency Drives for HVAC Equipment.
   3. Section 23 05 19 Meters and Gauges for HVAC Piping.
   4. Section 23 05 93 Testing, Adjusting & Balancing.
   5. Section 23 09 00 Instrumentation and Controls for HVAC.
   6. Section 23 33 00 Air Duct Accessories.
   7. Section 23 34 00 HVAC Fans.
   8. Section 23 36 00 Air Terminal Units.
   9. Section 23 55 23 Gas Radiant Heating System.
   10. Section 23 63 13 Air Cooled Refrigerant Condensers.
   11. Section 23 70 00 Central HVAC Equipment.
   12. Section 23 72 00 Air to Air Energy Recovery Units.
   13. Section 23 81 00 Decentralized Unitary HVAC Equipment.
   14. Section 23 82 00 Convection Heating and Cooling Units.
   15. Section 23 84 10 Electric Heating Equipment.
   16. Section 23 08 00 Commissioning for HVAC.

1.03 SUBMITTALS

A. Reference Section 23 09 00, Instrumentation and Controls for HVAC, for required submittals.

1.04 SERIAL COMMUNICATION WITH EQUIPMENT OF OTHER SECTIONS

A. The DDC controller shall accomplish communication with the following equipment via network interface. Refer to other sections of this Specification for detailed information regarding the network interface.
   1. Section 23 81 00 Decentralized Unitary HVAC Equipment.
   2. Section 23 05 15 Variable Frequency Drives for HVAC Equipment.
   3. Section 23 81 23 Computer Room Air Conditioners.
   4. Section 28 30 00 Fire Detection and Alarm.
   5. Section 28 30 01 Fire Detection and Communication.

1.05 GENERAL REQUIREMENTS

A. General
   1. Sequences of Operation for all equipment are described in PART 2 – SEQUENCES OF OPERATION below.
   2. All system functions and operations shall be accomplished by the DDC controller, except where explicitly defined as hard-wired, stand-alone, or factory-installed equipment controls.
   3. Where factory-installed equipment controls are furnished as specified under other Sections, install and wire all switches, sensors, accessories and other control devices and wiring required for a complete operational system. Set up and adjust all controls to perform the sequences described below.
   4. Refer to Section 230900 Instrumentation and Controls for HVAC, Table 2.1 Valve Table for information on valves, including type, configuration and de-energized position.
   5. Refer to Section 230900 Instrumentation and Controls for HVAC, Table 2.2 Damper Table for information on dampers, including type, configuration and de-energized position.

6. Provide all devices, materials, equipment, software, wiring, labor and engineering necessary to achieve the Sequences of Operation described in Part 2 below.

PART 2 SEQUENCES OF OPERATION

2.01 HEATING WATER SYSTEM – EXISTING HEATING WATER SYSTEM, SERVES RADIANT CEILING PANELS

A. System Level Sequence
   1. System Equipment
      a. Existing Heating Water System
      b. Radiant Ceiling Panel (RCP-101, RCP-102, RCP-103, RCP-104)

2.02 VARIABLE AIR VOLUME DEDICATED OUTSIDE AIR SYSTEM (DOAS)

A. System Level Sequence
   1. System Equipment
      a. Heat Recovery Unit (HRU-301, HRU-302)

2.03 GAS RADIANT HEATERS (RH-101-112, RH-120-122)

2.04 EXHAUST FANS (EF-201, 202, EF-301-305)

2.05 SPLIT SYSTEM UNITS (ALL SPLIT SYSTEMS)

A. Normal Operation
   1. Unit Enable/Disable:
      a. Unit shall operate based on manufacture provided thermostatic controls.
   2. Unit/Space Status Monitoring:
      a. Monitor space room temperature.

B. Alarms and Safeties
   1. Unit Failure Alarm: Generate an alarm if the space temperature exceeds the high limit space temperature set point (Initial setting: 80 degrees-F) or when the space temperature falls below the low limit space temperature set point (Initial setting: 55 degrees-F).

2.06 VARIABLE AIR VOLUME ROOF TOP AIR HANDLING UNIT (RTU-301)

2.07 TERMINAL UNIT WITH ELECTRIC REHEAT (TU-201, TU-202)

END OF SECTION

SECTION 23 21 13
PIPE AND PIPE FITTINGS HVAC

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Black Steel Pipe Schedule 40
   2. Black Steel Pipe Schedule 80
   3. Copper Pipe
   4. PVC Pipe
   5. Press Fit Pipe and Fittings
   6. Flanged Joints
   7. Unions
   8. Mechanical Pipe Couplings and Fittings
   9. Soldering and Brazing
   10. Utility Markers
   11. Pipe Wrapping
   12. Radiant Floor Heating

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 25 00, HVAC Water Treatment

1.03 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Piping material and installation to meet requirements of the local building codes and serving utility requirements.

B. Grooved joint couplings and fittings products of a single manufacturer. Grooving tools by the same manufacturer as the grooved components.
   1. Castings used for coupling housings, fittings, valve bodies, etc., date stamped for quality assurance and traceability.

C. Pipe Cleaning: Should any pipe be plugged or should foaming of water systems occur, disconnect piping, re-clean, and reconnect without additional expense to the Owner.

D. Correct damage to the building or systems resulting from failure to properly clean the system without additional expense to the Owner.

1.04 SUBMITTALS

A. Submit the Following:
   1. List of piping materials indicating the service it is being used for. Do not submit piping product data.
   2. Product data on mechanical couplings and related components, double wall fuel oil pipe and fittings, and polypropylene waste and vent pipe.
   3. Certificate of completion
   4. Treatment Reports
   5. Radiant Floor Heating and Cooling Piping layout shop drawings.
   6. Radiant Floor Heating and Cooling Piping installation digital photographs.

B. Test Reports and Certificates: Submit certificates of inspections and pipe tests to Owner.

C. Other: Make certified welders' certificates available.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. As indicated.

2.02 BLACK STEEL PIPE, SCHEDULE 40 AND STANDARD

A. Pipe:
1. Schedule 40 conforming to ASTM A 135 or A 53.
2. Schedule 40 up to 10-inch diameter.
3. Standard weight for 12-inch diameter and above.

B. Fittings:
1. 150 pound screwed malleable iron on 2 inches and below, Schedule 40 welding fittings conforming to ASTM A 234 for 2-1/2 inches and above or mechanical couplings on select piping as herein specified.
2. Fittings Below Grade: Welding fittings.
3. Long Radius Elbows: Pumped systems.
4. Short Radius Elbows: Not acceptable for use except as approved on a case by case basis.

C. Service:
1. Chilled and Heating Water Piping (up to and including 6-inches)
2. Condenser Water Piping Above Ground
3. Heat Recovery Piping
4. Medium Temperature Heating Water Piping (greater than 230 degrees F)
5. Refrigerant Relief Vent
6. Emergency Generator Exhaust
7. High Pressure Steam
8. Medium Pressure Steam
9. Low Pressure Steam
10. Safety and Relief Valve Discharge
11. Chemical Treatment
12. Boiler Water Sampling
13. Steam Vent

2.03 BLACK STEEL PIPE, SCHEDULE 80

A. Pipe: Schedule 80 conforming to ASTM A135 or A53.

B. Fittings: Extra heavy Class 300 screwed cast iron on 2-inch and below, extra strong welding fittings conforming to ASTM A234 for 2-1/2-inch and above.

C. Service:
1. Boiler feed water.
2. Boiler blow down.
3. Pumped and gravity steam condensate return.

2.04 COPPER PIPE

A. Pipe: Hard drawn copper tubing, Class L, ASTM B 88.

B. Fittings:
1. Wrought copper, 150 psi; ANSI B16.22 for soldered joints, ANSI B16.50 for brazed joints; Chase, Revere, Mueller or approved equal.
2. Service:
3. Refrigerant piping (Type L, hard drawn, ACR cleaned).
4. Chilled and heating water piping (Type L, hard drawn) up to and including 4-inches.
5. Condenser water piping above ground (Type L, hard drawn) up to and including 4-inches.
6. Heat recovery piping (Type L, hard drawn) up to and including 4-inches.
7. Coil condensate drains and traps, cooling tower drains, and other miscellaneous drains.

2.05 FLANGED JOINTS

A. Flanged Joints:
   1. Flanges:
      a. Cast iron or steel for screwed piping and forged steel welding neck for welded line sizes.
      b. In accordance with ANSI B16.1; 150 lb. for system pressures to 150 psig; 300 pounds for system pressures 150 psig to 400 psig.
   2. Pressure Rating and Drilling: Match apparatus, valve, or fitting to which they are attached.
   3. Gaskets:
      a. Flanged Services: With the exception of steam and pumped condensate, Garlock 3700 or equal, 1/8-inch thick, non-metallic type.
      b. Steam and Pumped Condensate: Flexitaulic Style CG or equal, 1/8-inch thick, semi-metallic type.
   4. Make joint using American Standard hexagon head bolts, lock washers, and nuts (per ASTM A307 GR.B) for service pressures to 150 psig; alloy steel stud bolts, lock washer, and American Standard hexagon head nuts (per ASTM A307 GR.B) for service pressures 150 psig to 400 psig.
   5. Use length of bolt required for full nut engagement.
   6. Provide electro-cad plated bolts and nuts on cold and chilled water lines.

2.06 UNIONS

A. 150 psi malleable iron, brass to iron seat, ground joint, black or galvanized to match pipe. 200 psi WOG bronze, ground joint, solder type for copper tubing.

B. Dielectric Fittings:
   1. Nationally listed, have a dielectric thermoplastic interior lining, and meet requirements of ASTM F1545.
   2. Suitable for the pressure and temperature to be encountered.

2.07 MECHANICAL PIPE COUPLINGS AND FITTINGS

A. Acceptable Manufacturers:
   1. Victaulic
   2. Anvil Gruvlok 7401, 7001
   3. Other Manufacturers: Submit substitution request.

B. Couplings: Ductile iron conforming to ASTM A 536, Grade 65-45-12, rust inhibiting paint.

C. Fittings:
   1. Ductile iron conforming to ASTM A 536, Grade 65-45-12.
   2. Long radius elbows.

D. Bolts and Nuts: Zinc electroplated track head bolts conforming to ASTM A 183.

E. Gasket: Grade E EPDM:
   1. Temperature Range: -30 degrees F to 230 degrees F.
   2. Heating water below 230 degrees F.

2.08 SOLDERING AND BRAZING

A. Brazed Joints:
   1. Westinghouse Phos-Copper or Dyna-Flow by J.W. Harris Co., Inc.
   2. Applied locations:
      a. Below grade piping.
      b. Above grade piping larger than 2-inches for the following services: heating water, chilled water, condenser water, heat recover water.
      c. Refrigerant piping. Braze in accordance with Copper Development Association Copper Tube Handbook using BCUP series filler material.

B. Soldered Joints:
   1. Wrought Copper Pipe Fittings: All-State 430 with Duzall Flux, Engelhard Silvabrite with Engelhard General Purpose Flux or J.W. Harris Co.
   2. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.
   3. Applied locations: Above grade piping 2-inch and smaller for the following services: Heating water, chilled water, condenser water, heat recovery water, industrial cold water, trap priming lines.

C. Valves, Cast Fittings or Bronze Fittings: Harris Stay-Silv-15 or Handy & Harmon Sil-Fos.

2.09 UTILITY MARKERS

A. Provide plastic tape utility markers over buried piping. Provide identification on tape.

B. Material to be Brady Identoline plastic tape, 6-inch, Seton, or as approved.

2.010 PIPE WRAPPING

A. Below ground steel piping and fittings, provide complete covering of Scotchrap 51, 20 mil thickness, protective tape applied over Scotchrap pipe primer applied at 1 gal/800 SF of pipe surface.

B. Pipe may be furnished with factory applied jacket of X-tru-coat with Scotchrap as previously specified for field joints.

2.011 RADIANT FLOOR HEATING AND COOLING

A. Piping:
   1. Manufacturer:
      a. Uponor
      b. Rehau
      c. Heat Link
   2. Description:
      a. Tubing cross-linked polyethylene oxygen diffusion barrier tubing rated at 180 degrees F maximum working temperature and 100 psi working pressure in accordance with ASTM F877.
      b. Oxygen barrier conforms to DIN 4726.
      c. Tubing manufactured in accordance with ASTM F876 using the Engel method (PEX-A).
   3. Service: Radiant Floor Heating and Cooling.

B. Fittings:
   1. Manufacturer:
      a. Uponor
      b. Rehau
      c. Heat Link
   2. Description:
      a. Manufactured of dezincification resistant brass with barbed insert, compression ring, and compression nut rated at 180 degrees F maximum working temperature and 100 psi working pressure in accordance with ASTM F877.
      b. Service: Radiant Floor Heating and Cooling.

C. Manifold:
   1. Manufacturer:
      a. Uponor
      b. Rehau
      c. Heat Link
   2. Description:
      a. Manifold manufactured of copper or stainless steel rated at 180 degrees F maximum working temperature and 100 psi working pressure in accordance with ASTM F877.
      b. Supply Manifold: Integral 3/4 inch branches with isolation valve on each branch.

c. Return Manifold: Integral 3/4 inch branches with isolation valve and balance valve on each branch.

3. Size:
   a. 1-inch diameter: 0 to 6.5 GPM.
   b. 2-inch diameter: 6.5 to 40 GPM.
4. Service: Radiant Floor Heating and Cooling.

PART 3 EXECUTION

3.01 PREPARATION

A. Measurements, Lines and Levels:
   1. Check dimension at the building site and establish lines and levels for work specified in this Section.
   2. Establish inverts, slopes, and manhole elevations by instrument, working from an established datum point. Provide elevation markers for use in determining slopes and elevations in accordance with Drawings and Specifications.
   3. Use established grid and area lines for locating trenches in relation to building and boundaries.

3.02 EXCAVATION AND BACKFILL

A. General:
   1. Perform necessary excavation and backfill required for the installation of mechanical work in accord with Division 02, Existing Conditions.
   2. Repair pipelines or other work damaged during excavation and backfilling.

B. Excavation:
   1. Excavate trenches to the necessary depth and width, removing rocks, roots, and stumps.
   2. Include additional excavation to facilitate utility crossovers, additional offsets, etc.
   3. Excavation material is unclassified. Width of trench adequate for proper installation of piping.
   4. Widen trench if not wide enough for a proper installation.

C. Bedding:
   1. Cast iron, steel, and copper piping full bedded on sand.
   2. Place a minimum 4-inch deep layer on the leveled trench bottom for this purpose.
   3. Remove the sand to the necessary depth for piping bells and couplings to maintain contact of the pipe on the sand for its entire length.
   4. Lay other piping on a smooth level trench bottom so that contact is made for its entire length.

D. Backfill:
   1. Place in layers not exceeding 8 inches deep, and compact to 95 percent of standard proctor maximum density at optimum moisture content.
   2. Earth backfill free of rocks over 2 inches in diameter and foreign matter.
   3. Disposal of excess material as directed.
   4. Interior: Backfill under interior slabs bank sand or pea gravel.
   5. Exterior:
      a. Excavated material may be used outside of buildings.
      b. First 4 inches sand and final 12-inch layer course soil in any event.

3.03 PIPING INSTALLATION

A. Install unions in non-flanged piping connections to apparatus and adjacent to screwed control valves, traps, and appurtenances requiring removal for servicing so located that piping may be disconnected without disturbing the general system.

B. Mechanical Pipe Couplings and Fittings:
   1. Grooved joint couplings, fittings, valves, and specialties products of a single manufacturer. Grooving tools of the same manufacturer as the grooved components.

2. Flexible couplings to be used only when expansion, contraction, deflection or noise and vibration is to be dampened, as detailed or specified.
3. On systems using galvanized pipe and fittings, fittings galvanized at factory.
4. Before assembly of couplings, lightly coat pipe ends and outside of gaskets with approved lubricant.
5. Pipe grooving in accordance with manufacturer's specifications contained in latest published literature.
6. Mold and produce gaskets by coupling manufacturer, and suitable for the intended service.
7. Coupling manufacturer's factory trained representative to provide on-site training for the contractor's field personnel in the use of grooving tools and installation of grooved joint products. Periodically visit the project site to ensure best practices in grooved installation are being followed (a distributor's representative is not considered qualified to conduct the training or field visits).

C. PIPING JOINTS

D. Pipe and Fittings:
1. Join using methods and materials recommended by manufacturer in conformance with standard practice and applicable codes.
2. Cleaning, cutting, reaming, grooving, etc. done with proper tools and equipment.
3. Hacksaw pipe cutting prohibited.
4. Peening of welds to stop leaks not permitted.

E. Purge refrigerant piping with nitrogen continuously during the piping installation, and seal each branch outlet with Visqueen and tape or similar method to assure continued cleanliness of interior of piping until system is completed.

F. Copper Piping:
1. Pipe cut evenly with cutter, ream to full inside diameter; end of pipe and inside of fitting thoroughly cleaned and polished.
2. Joints uniformly heated, and capillary space completely filled with solder or braze material, leaving full bead around entire circumference.

G. No couplings installed in floor or wall sleeves.

H. Steel Piping:
1. Screwed Joints:
   a. Pipes cut evenly with pipe cutter reamed to full inside diameter with burrs and cuttings removed.
   b. Joints made up with suitable lubricant or Teflon tape applied to male threads only, leaving two threads bare.
   c. Tightened so that not more than two threads are left showing.
   d. Junctions between galvanized steel waste pipe and bell of cast iron pipe made with tapped spigot or half coupling on steel pipe to form spigot end and caulked.
2. Flanged Joints:
   a. Pressure rating of flanges to match valve or fitting joined.
   b. Coat joint gaskets with graphite and oil.

I. Welded Joints:
1. Preparation for Welding: Bevel piping on both ends before welding:
   a. Use following weld spacing on buttwelds:

Nominal Pipe Wall Thickness	Spacing	Bevel
1/4-inch or less	1/8-inch	37-1/2
Over 1/4-inch, less than 3/4-inch	3/16-inch	27-1/2

   b. Before welding, remove corrosion products and foreign material from surfaces.
2. Welded Joints:
   a. Arc weld joints using certified welders.

b. Port openings of fittings must match the inside diameter of the pipe to which they are welded.
c. Use full radius welding elbows for turns, use welding tees for tees.
d. Reducing fittings must be used for size reduction.
e. Weldolets may be used for branches up through one-half the pipe size of the main to which they are attached.
f. Nipples are not allowed.

3. Welding Operation:
a. After deposition, clean each layer of weld metal to remove slag and scale by wire brushing or grinding. Chip where necessary to prepare for proper deposition of next layer.
b. Weld reinforcement no less than 1/16-inch not more than 1/8-inch above normal surface of jointed sections. Reinforcement crowned at center and taper on each side to surfaces being joined. Exposed surface of weld present professional appearance and be free of depressions below surface of jointed members.
c. Do not weld when temperature of base metal is lower than 0 degrees F. Material to be welded during freezing temperatures made warm and dry before welding is started. Metal warm to the hand or approximately 60 degrees F.

J. Screwed Joints: Use Teflon tape or Teflon liquid dope applied to male threads only.

K. Flexible Couplings: Provide where indicated on the Drawings.

L. PVC Piping:
1. Socket weld joints with solvent cement and application method recommended by manufacturer.
2. Use power saw and miter box to cut PVC pipe, except DI piping must be cut with a wheel cutter specifically made for plastics.
3. Allow proper curing time based on temperature range during cure period before pressure testing.

3.04 PIPE WRAP

A. Apply per manufacturer's written instructions.

B. Apply wrapping to fittings in field after installation.

3.05 ADJUSTING AND CLEANING

A. General:
1. Clean interior of piping before installation.
2. Flush sediment out of piping systems after installation before connecting mechanical equipment to the piping.
3. When placing the water systems in service during construction, each system cleaned by circulating a solution with 1000 ppm of trisodium phosphate for 24 hours, then drained, flushed and placed in service.
4. Clean strainers prior to placing in service.

END OF SECTION

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SECTION 23 25 00
HVAC WATER TREATMENT

PART 1 GENERAL

1.01 SUMMARY

A. Closed Loop Systems

1.02 RELATED SECTIONS

A. Division 01, General Requirements

1.03 SUBMITTALS

A. Submit the following:
   1. Shop drawings.
   2. Product data.
   3. Operating and maintenance data.
   4. Certificate of completion.
   5. Treatment reports.

PART 2 PRODUCTS

2.01 MANUFACTURER

A. US Water Services

B. Nalco

C. Mogul

D. Chemax

E. Chemcoa

F. DuBois Chemicals

G. Industrial Treatment of Water

H. Other Manufacturer/Suppliers: Submit substitution request.

2.02 CLOSED LOOP SYSTEMS

A. Chemicals:
   1. 75 ounces of Nalco 39 per 100 gallons of water, or Mogul 7174 borate nitrite of required dosage. Filling may be through bypass shot feeder across pump.
   2. Final system treatment achieves 800-1200ppm Sodium Nitrite in the system water. Apply tolyltriazole levels of minimum 3ppm in closed loop water.

B. One Shot Feeder:
   1. Description: Furnished and install one-shot chemical bypass feeders on each closed loop system where water treatment is specified.
   2. Construction:
      a. 2 quart, 4 quart, 10 quart, or maximum of 5 gallon volume as required to initially treat the system served in two shots.
      b. Pressure Rating: 150 psig or 300 psig to match other valve and pressure vessel ratings.
      c. Provide fill funnel and valve, air vent cock and drain valve and plug.

PART 3 EXECUTION

3.01 INSTALLATION

A. HVAC Closed Loop Systems:
   1. Install shot feeders across pump or appropriate restricting valve with adequate mounting to prevent piping damage and preclude transmitting vibration to structure.
   2. Filling may be through bypass shot feeder across pump.
   3. Final system treatment achieves 800-1200ppm Sodium Nitrite in the system water. Apply tolyltriazole levels of minimum 3ppm in closed loop water.

4. Test to confirm proper inhibitor levels.
5. Install glycol mixing tank according to manufacturer's recommendations to provide scheduled concentration of glycol.
6. Install corrosion coupon rack per manufacturer's recommendations around the supply and return side of circulating pump. Install isolation valves at each side of rack within easy reach of operator.

3.02 FINAL ADJUSTMENT

A. When the systems are accepted by the Owner the chemical treatment supplier to make final adjustments in the required concentrations.

B. Submit report of indicating initials and final concentrations and system chemistry.

C. Furnish sufficient chemicals to constitute one years supply for systems.

END OF SECTION

SECTION 23 31 01

HVAC DUCTS AND CASING-LOW PRESSURE

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Supports, Anchorage And Restraints
   2. Sheet Metal Ductwork
   3. Single Wall Housing Plenums
   4. Flexible Ducts
   5. Exposed or Visible Ductwork In Finished Spaces

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 22 30 00, Plumbing Equipment

D. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping Equipment

E. Section 23 07 00, Insulation for HVAC

F. Section 23 33 00, Air Duct Accessories

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Work performed by qualified, experienced mechanics, in accordance with the manual of Duct and Sheet Metal Construction of the Sheet Metal and Air Conditioning Contractors National Association and these Specifications.

B. Regulatory Requirements:
   1. Entire ductwork system, including materials and installation, installed in accordance with NFPA 90A.
   2. Ductwork and components UL 181 listed, Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.04 SUBMITTALS

A. Submit the following:
   1. Provide catalog data on each product specified hereunder.
   2. Schedule of duct construction standards.
   3. Provide shop drawings showing materials and construction details for single wall housing plenum.
   4. Provide shop drawings showing construction details, support, and seismic restraint of ductwork distribution systems.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Supports, Anchorage And Restraints:
   1. [_____]

B. Sheet Metal Ductwork:
   1. [_____]

C. Single Wall Housing Plenums:
   1. [_____]

D. Flexible Ducts:
   1. Thermaflex M-KE
   2. Gen Flex IMP-25S
   3. Other Manufacturers: Submit substitution request.

E. Exposed or Visible Ductwork in Finished Spaces:
   1. [_____]

2.02 SUPPORTS, ANCHORAGE AND RESTRAINTS

A. General:
   1. Provide design for supports, anchorages, and seismic restraints for equipment when not shown on the Drawings.
   2. Supports, anchorage and restraints provided are required to resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
   3. Follow provisions in Section 23 05 48, Vibration and Seismic Control for HVAC Piping and Equipment for seismic restraints.
   4. Seismic restraints are not to introduce stresses in the ductwork caused by thermal expansion or contraction.
   5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Suspended Ductwork: Provide seismic restraints in accordance with the latest edition of the SMACNA, Seismic Restraint Manual - Guidelines for Mechanical Systems for the seismic hazard level corresponding to the seismic zone in which the project is constructed.

C. Engineered Support Systems: Provide designs and details for the following support systems with the seal of a professional engineer registered in the State having jurisdiction:
   1. Supports and seismic restraints for suspended ductwork and equipment.
   2. Support frames for ductwork and equipment which provide support from below.
   3. Equipment and ductwork support frame anchorage to supporting slab or structure.

2.03 SHEETMETAL DUCTWORK

A. Fabricate from galvanized steel, unless noted otherwise.

B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers, and supports in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, Latest Edition.

C. Duct Classification: Ducts considered low pressure when design velocities are 2000 fpm or less and maximum static pressure is 2-inches wg positive or negative.
   1. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1/2-inch wg positive or negative.
      a. Supply ductwork downstream from terminal units.
      b. Supply, return or exhaust ductwork serving fans scheduled to operate at less than 1/2-inch wg
      c. Supply, return, or exhaust branch ductwork which serves one or two inlets/outlets.
   2. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 1-inch wg positive or negative.
      a. Supply, return, or exhaust ductwork serving fans scheduled to operate at less than 1-inch wg On supply fans pressure drops for louvers, coils, clean filters, and sound traps may be deleted from scheduled fan static.
      b. Supply, return, or exhaust ductwork serving multiple duct branches where contractor can demonstrate that pressures will not exceed 1-inch wg positive or negative.
      c. Boiler direct vent combustion air intake ductwork.
      d. Water heater direct vent combustion air intake ductwork.
   3. The following ductwork constructed in accordance with minimum reinforcement requirements for static pressure class of 2-inches wg, positive or negative.
      a. Supply, return, or exhaust ductwork serving fans scheduled to operate at pressures greater than 1-inch wg positive or negative.

D. Longitudinal seams on rectangular duct, Pittsburgh or Button punch snap lock. Snap lock seams for round duct may be used only on ducts classified for 1/2-inch wg. Longitudinal seams for round ducts using lap and rivet, spot weld, or fillet weld may be used only on ducts classified for statics 1-inch wg or less.

E. Joining and reinforcing systems manufactured by Ductmate, Roloc, or TDC are acceptable. Ductmate 35 is equivalent to SMACNA J, and Ductmate 25 is equivalent to SMACNA F.

F. Use of adjustable round elbows not permitted.

2.04 SINGLE WALL HOUSING PLENUMS

A. Fabricate from galvanized steel, unless otherwise noted.

B. Minimum gauge not less than 18 gauge except panels 10-feet-1-inch or longer 16 gauge.

C. Housing panels constructed in accordance with the latest edition of SMACNA HVAC Duct Construction Standards – Metal and Flexible.

D. Minimum pressure classification for single wall housing panels is 2-inches wg positive or negative.

E. Maximum allowable panel width 24-inches with standing interlocking seams.

F. Openings in panels for air inlets/outlets, or access doors reinforced per SMACNA standards.

G. Provide intermediate reinforcing and/or bracing when spans are 8-feet or longer.

H. Line interior surfaces of single wall plenums with minimum of 2-inch thick acoustical lining.

I. Access Doors:
   1. Construct of 20-gauge galvanized steel, double wall construction.
   2. Install in opening in plenum panel reinforced with 10-gauge channel.
   3. Doors mounted on three hinges and seat against neoprene gaskets.
   4. Doors in plenums at humidifiers have 12-inch by 12-inch double glass inserts from observation.
   5. Doors 24-inch by 60-inch height unless otherwise indicated.

2.05 FLEXIBLE DUCTS

A. Flexible air duct with CPE or metal film liner permanently bonded to coated spring steel wire helix with 1-inch thick fiberglass insulation blanket covered with fiberglass reinforced metal film vapor barrier jacket.

B. Duct rated for 6-inch wg positive and 1-inch wg negative.

2.06 EXPOSED OR VISIBLE DUCTWORK IN FINISHED SPACES

A. Round:
   1. Material:
      a. Round or flat oval, machine formed, spiral lock-seam galvanized sheet metal ductwork of thicknesses as listed for sheet metal duct.
      b. Paintable surface.
   2. Fittings: Machine formed, shop fabricated, with welded seams, designed for easiest air flow, similar to United Sheet Metal numbers listed.
      a. Mitered Elbow with Turning Vanes: Type EV-90-2.
      b. Radius Elbows: Type E090-5. Similar for less than 90 degree elbows.
      c. Tees: Type Con-T-1.
      d. Reducing Fittings: May be used unless noted otherwise.

B. Rectangular:
   1. Same as for sheet metal ductwork but paintable surface.
   2. Inside reinforcing.
   3. Use special care to prevent imperfections in the metal surface.

2.07 STAINLESS STEEL DUCTWORK

A. Ductwork listed below and ductwork indicated on drawings constructed of 18 gauge minimum stainless steel with 2D finish concealed and No. 4 finish exposed. Type 304 or 316 as indicated.

B. Seams: Welded and liquid tight.

C. Accessories:
   1. Stainless steel including dampers
   2. Damper Hardware
   3. Turning Vanes

2.08 ALUMINUM DUCTWORK

A. Ductwork listed below and ductwork indicated on drawings constructed of 3003-H-14 alloy aluminum. Gauge of metal and construction details to be determined by using minimum equivalent thickness and reinforcing for galvanized steel tables in SMACNA.

B. Longitudinal seams, Pittsburgh type.

C. Button punch snap lock seams not allowed.

PART 3 EXECUTION

3.01 APPLIED LOCATIONS

A. Supply ductwork on downstream side of terminal box. Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.

B. Supply Ductwork from Spin-In Fittings to Supply Outlet Collar Connection: Flexible duct, maximum 4-foot length.

C. Return Air Trunk Ductwork from End Run to Unit Connection: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.

D. Exhaust Ductwork: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.

E. Ductwork between Transfer Grilles: Galvanized sheet metal ductwork, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.

F. Exposed or Visible Ductwork in Finished Spaces: Sheet metal as specified for application, lined where indicated on the Drawings or as specified in Section 23 07 00, Insulation for HVAC.

3.02 INSTALLATION

A. Ductwork:
   1. Seal traverse joints with an approved mastic during joining procedure or tape after joining to provide airtight duct system.
   2. Low pressure ductwork hanger and support systems in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible. Wire supports are not allowed.
   3. Provide supplementary steel for support of ductwork in shafts and between building structural members.
   4. Fabricate changes in direction to permit easy air flow, using full 1.5D radius bends or fixed turning vanes in square elbows. Radius elbows less than 1.5D radius, splitter vanes.
   5. Change in duct size or shape necessitated by interference made using rectangular equivalents of equal velocity.
   6. Where pipe, structural member, or other obstruction passes through a duct, provide streamlined sheet metal collar around member and increase duct size to maintain net free area. Fit collar and caulk to make air tight.

B. Dampers: Install where shown and where necessary to complete final balancing of system. Install regulators as specified in Section 23 33 00, Air Duct Accessories for each specific project condition. Leave dampers locked wide open in preparation for balancing.

C. Extractors: Install behind supply grilles and registers where shown.

D. Flexible Connectors: Make connections to fans and other rotating equipment with flexible connectors with 2-inch minimum clearance between casing and ductwork. Not required on internally spring isolated units.

E. Spin-in Fittings:
   1. Install at branch takeoffs to outlets using round or flex duct.
   2. Connect to flexible duct with draw band strap and minimum of two wraps of duct tape.
   3. Leave dampers locked wide open.

F. Flexible Ducts:
   1. Make connections at ends using draw band strap and a minimum of 2 wraps of duct tape.
   2. Suspend center spans from structure above using wire as required by code. Connect to manufacturer's eyelet on jacket or use 1-inch wide galvanized steel strap with single loop at top and smooth edges.
   3. Suspending duct by laying it on the ceiling is prohibited.
   4. Avoid crimping flex duct. Changes in direction made using 2D radius. Duct connections to grilles, registers, and diffusers using less than 2D radius bends are not acceptable. Where space is constricted, use sheet metal elbows or Thermaflex Flex Boots (or equal).

G. Ductwork, Exposed or Visible in Finished Areas:
   1. Use extreme care in handling and installing.
   2. Replace dented or damaged sections.
   3. Install ductwork straight and true, parallel to building lines.
   4. Make connections with pop rivets using couplings where applicable. Grind raw edges smooth and apply paintable sealant to cover imperfections.
   5. Remove excess sealant to provide a finished joint.
   6. Provide floor, wall, and ceiling plates as specified in Section 23 05 00, Common Work Results for HVAC.
   7. Finish, clean and prime ductwork, and hangers for painting.

H. Single Wall Housing Plenums:
   1. Install housing plenums in accordance with SMACNA HVAC Duct Construction Standards – Metal and Flexible, latest edition.
   2. Joints and seams sealed with high pressure duct sealer or gaskets and fastened with bolts, screws, or pop rivets.
   3. Pipe, duct, conduit, and control penetrations sealed to prevent air leakage using close off sheets and strips.
   4. Securely anchor housing panels to floor or roof curbs.
   5. Block outside air or return air dampers open to prevent damage during construction until automatic control system is operational and adjusted.
   6. Provide access doors where indicated on drawings and where required to provide access for cleaning and maintenance. Access doors installed to open against air pressure.
   7. Slope plenum and connected ductwork to drain towards the exterior louver or building exterior opening.
   8. For single wall plenums installed behind exterior louvers or wall openings, slope plenum floor and connected ductwork at 1/4-inch/foot to drain towards the exterior louver or opening.
   9. For single wall plenums installed below roof ventilators or roof openings, slope floor of plenum at 1/4-inch/foot to drain connection. Pipe drain connection to floor drain.

3.03 FIELD QUALITY CONTROL

A. Coordination with Balance Agency:
   1. Provide services of a sheet metal person familiar with the system ductwork to provide assistance to the balancing agency during the initial phases of air balancing in locating sheet metal dampers.
   2. Install missing dampers required to complete final balancing.

END OF SECTION

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SECTION 23 31 02

HVAC DUCTS AND CASING-MEDIUM PRESSURE

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Supports, Anchorage, and Restraints
   2. Single Wall Round Duct and Fittings
   3. Single Wall Oval Duct and Fittings
   4. Double Wall Round and Flat Oval Ductwork
   5. Rectangular Steel Ductwork

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment

D. Section 23 05 90, Pressure Testing for HVAC Systems

E. Section 23 07 00, Insulation for HVAC

F. Section 23 33 00, Air Duct Accessories

1.03 QUALITY ASSURANCE

A. Installer Qualifications: Work performed by qualified, experienced mechanics, in accordance with the manual of Duct and Sheet Metal Construction of the Sheet Metal and Air Conditioning Contractors National Association and these Specifications.

B. Regulatory Requirements:
   1. Entire ductwork system including materials and installation, installed in accordance with NFPA 90A.
   2. Ductwork and components UL 181 listed Class I air duct, flame rating not to exceed 25 and smoke rating not to exceed 50.

1.04 SUBMITTALS

A. Submit the following:
   1. Shop Drawings of ductwork specified hereunder. Include details of supports and seismic restraint of ductwork distribution systems.
   2. Product data on medium pressure round and flat oval ductwork and fittings.
   3. Schedule of rectangular duct construction standards.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Supports, Anchorage, and Restraints:
   1. [ ]

B. Single Wall Round Duct and Fittings:
   1. [ ]

C. Single Wall Oval Duct and Fittings:
   1. [ ]

D. Double Wall Round and Flat Oval Ductwork:
   1. [ ]

E. Rectangular Steel Ductwork:
   1. [ ]

2.02 GENERAL

A. Fabricate from galvanized steel unless otherwise noted.

B. Minimum gauge, duct construction, joint reinforcing, fittings, hangers, and supports in accordance with the latest edition of SMACNA HVAC Duct Construction Standards, Third Edition, 2005.

C. Duct Classification:
   1. Medium pressure when design velocities exceed 2000 fpm or static pressure is 2.0-inches wg or greater positive.
   2. Ducts constructed in accordance with minimum reinforcement requirements for static pressure class of 4-inches positive.

2.03 SUPPORTS, ANCHORAGE AND RESTRAINTS

A. General:
   1. Provide design for supports, anchorages, and seismic restraints for equipment when not shown on the Drawings.
   2. Supports, anchorage and restraints provided are required to resist seismic forces as specified in the latest edition of the International Building Code for the seismic zone in which the project is constructed.
   3. Follow provisions in Section 23 05 48, Vibration and Seismic Control for HVAC Piping and Equipment for seismic restraints.
   4. Seismic restraints are not to introduce stresses in the ductwork caused by thermal expansion or contraction.
   5. Connections to structural framing are not to introduce twisting, torsion, or lateral bending in the framing members. Provide supplementary steel as required.

B. Suspended Ductwork: Provide seismic restraints in accordance with the latest edition of the SMACNA, Seismic Restraint Manual - Guidelines for Mechanical Systems for the seismic hazard level corresponding to the seismic zone in which the project is constructed.

C. Engineered Support Systems: Provide designs and details for the following support systems with the seal of a professional engineer registered in the State having jurisdiction:
   1. Supports and seismic restraints for suspended ductwork and equipment.
   2. Support frames for ductwork and equipment which provide support from below.
   3. Equipment and ductwork support frame anchorage to supporting slab or structure.

2.04 SINGLE WALL ROUND DUCT AND FITTINGS

A. Materials:
   1. Medium pressure round ductwork up to 36-inch diameter spiral lock seam. Round ducts over 36-inches in diameter either spiral lock seam or shop fabricated with longitudinal seams.
   2. Takeoffs:
      a. Main and branch takeoffs similar to United Spiral Uniform Duct fittings type SRHTC, SRHTL, or SRHL, typically.
      b. No saddle fittings allowed.
      c. Welded fittings.
      d. Saddle fittings with pop rivet fasteners and sealed with high pressure duct sealer may be used only when adding takeoff fittings to existing duct.
   3. Transitions, Elbows:
      a. Transitions of concentric type or eccentric type to maintain elevations detailed, with not more than 15 degree angle variation on sloped portion.
      b. 90 degree elbows of 5 piece design with centerline radius equal to 1-1/2 of duct diameter minimum. Mitered elbows not allowed.
      c. 60 degree and 45 degree elbows of 3 piece design with long radius.
      d. Y-Branch fittings similar to United Uniseal SRHY or SRHYR. Bull head tees not allowed.

2.05 SINGLE WALL OVAL DUCT AND FITTINGS

A. Materials:
   1. Medium pressure oval ductwork through 24-inches minor axis (duct height) fabricated from spiral lock seam.
   2. Ducts with minor axis above 24-inches fabricated from longitudinal seam ducts.
   3. Takeoffs:
      a. Main and branch takeoffs similar to United Uniseal fittings type SOSTC, SOSTL, or SOSL, typically.
      b. No saddle fittings allowed except saddle fittings may be used with pop rivet fasteners and sealed with high pressure duct sealer when adding fittings to existing duct.
      c. Provide standing seam joints sealed with high pressure duct sealer, or provide welded joints, or provide spot welded joints sealed with high pressure duct sealer.
   4. Transitions and Elbows:
      a. Transitions of concentric type or eccentric type to maintain elevations detailed, with not more than 15 degree angle variation on sloped portion.
      b. 90 degree elbows of pie stamped or 5 piece design with centerline radius equal to 1-1/2 of duct diameter minimum. Mitered elbows not allowed.
      c. 60 degree and 45 degree elbows of 3 piece design with long radius.
      d. Y-Branch fittings similar to United Uniseal SOSYH or SOSYE. Bull head tees not allowed.

2.06 DOUBLE WALL ROUND AND FLAT OVAL DUCTWORK

A. Materials:
   1. Medium pressure double wall round and oval ductwork have outer pressure sheet from spiral lock seam up to 36-inch diameter round and 22-inch minor axis oval. Round ducts over 36-inch diameter round and 22-inch minor axis oval.
   2. Round ducts over 36-inch diameter and oval ducts over 22-inch minor axis have spiral lock seam or longitudinal welded seams. Provide 1-inch thick layer of fiberglass insulation having a k-factor of not less than 0.27 BTU/HR/SF °F at 75 degrees F ambient, based on Johns Manville SG Series Spinglas. Inner liner perforated with not less than 23 percent free area.
   3. Double wall fittings similar to single wall fittings and conform to double wall construction as specified above.

2.07 RECTANGULAR STEEL DUCTWORK

A. Fabricate from galvanized steel unless noted otherwise.

B. Longitudinal seams, Pittsburg type. Button punch snap lock may be used only if sheet metal screws are added on 24-inch centers.

C. Joining and reinforcement systems as manufactured by Ductmate, Roloc, or TDC are acceptable. Ductmate 35 is equivalent to SMACNA J reinforcement and Ductwork 25 is equivalent of SMACNA F. Fasten Ductmate to duct with sheet metal screws minimum of 6-inch on center.

D. Fittings:
   1. Fabricate fittings for easiest airflow using radius elbows with center-line radius elbows equal to 1-1/2 times the duct dimension in the plane of the turn.
   2. Transitions: Concentric or eccentric type to maintain elevations with not more than 15 degree angle variation on sloped portion.
   3. Conical Taps: For branch take-off to terminal unit, construct with inlet 4-inches wider than outlet and no raw edges inside.

E. Use of mitered elbows with turning vanes is not acceptable except where indicated on drawings. Radius elbows with centerline radius less than 1.5D radius vaned type and may be used only with approval of engineer.

2.08 ACCESS DOORS:

1. Construct of 20-gauge galvanized steel double wall construction, 24-inches wide by 60-inches high unless otherwise indicated.
2. Panel opening for door reinforced with 10-gauge channel.
3. Doors mounted on three ball bearing hinges and secured with two latches which can be open from either side.
4. Doors seat against neoprene gaskets for air tight seal.
5. Doors in plenums at humidifiers 12-inch by 12-inch double glass inserts for observation without opening doors.

PART 3 EXECUTION

3.01 APPLIED LOCATIONS

A. Supply ductwork on upstream side of air terminal unit.

B. Supply ductwork serving fans scheduled to operate at pressures greater than 2-inches wg positive.

C. Supply ductwork 20-feet downstream of air handling equipment and the first 6-feet of duct mains connect to the vertical ducts at each floor with round or oval double walled ductwork.

D. Acoustical line plenums on discharge of rooftop units. Plenum size sufficient for supply duct connections as shown on plans, minimum plenum size the same as unit opening.

3.02 MEDIUM PRESSURE ROUND AND OVAL DUCTWORK INSTALLATION

A. Install in accordance with manufacturer's instructions and with the latest edition of SMACNA HVAC Duct Construction Standards.

B. Seal traverse and longitudinal joints with high pressure duct sealer and wrap with duct sealer tape or hard cast with minimum 2-inch overlap.

C. Field connections for ducts 36-inch diameter and less for round duct and 42-inches major axis and less for oval ducts not requiring additional reinforcing, use slip on connections. For other ducts use flanged joint connections, fabricated and sealed per manufacturer's instructions.

D. Oval duct uses reinforced per SMACNA standards.

E. Branch takeoffs rigidly connected to terminal unit without flex duct.

3.03 MEDIUM PRESSURE ROUND AND OVAL DOUBLE WALL DUCT INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Seal traverse and longitudinal joints with high pressure duct sealer and wrap with duct sealer tape or hardcast with minimum 2-inch overlap. Treat welded seams with protective paint inside and outside.

C. Use slip on connections for double wall round duct 34-inches diameter and below or 40-inch major axis on oval duct and below. Use flange connections on other sizes.

3.04 MEDIUM PRESSURE RECTANGULAR DUCT INSTALLATION

A. Install duct, fittings, supports, and hangers in accordance with the latest edition of SMACNA HVAC Duct Construction Standards.

B. Seal traverse and longitudinal joints with high pressure duct sealer and wrap with duct sealer tape or hard cast with minimum 2-inch overlap.

C. Provide supplementary steel for support of ductwork in shafts and between building structural members.

D. Change in duct size or shape necessitated by interference made using rectangular equivalents of equal velocity.

3.05 FIELD QUALITY CONTROL

A. Field Tests: Perform leakage tests in accord with Section 23 05 90, Pressure Testing for HVAC Systems.

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Medium Pressure Duct Accessories
   2. Low Pressure Duct Accessories
   3. Fire and Smoke Dampers

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 31 01, HVAC Ducts and Casing-Low Pressure

D. Section 23 31 02, HVAC Ducts and Casing-Medium Pressure

E. Section 23 09 00, Instrumentation and Controls for HVAC

1.03 QUALITY ASSURANCE

A. Work performed by qualified, experienced mechanics in accordance with the manual of Duct and Sheet Metal Construction of the National Association of Sheet Metal and Air Conditioning Contractors and these Specifications.

B. Install entire ductwork system, including materials and installation, in accordance with NFPA 90A.

C. Flexible connectors, flexible equipment connections, tapes, and sealants listed as UL 181, Class I air duct. Flame spread rating not to exceed 25 and smoke developed rating not to exceed 50.

1.04 SUBMITTALS

A. Submit the following: Product data for Duct Accessories.
   1. Medium Pressure Duct Accessories:
      a. Acoustical Turning Vanes
      b. Access Doors
      c. Bell Mouth Fittings
   2. Low Pressure Duct Accessories:
      a. Constant Airflow Regulators
      b. Access Doors
      c. Backdraft Dampers
      d. Water Eliminators
      e. Security Grates
      f. Dryer Vent
      g. Roof Jack
      h. Automatic Dampers
   3. Fire and Smoke Dampers:
      a. Fire Dampers
      b. Smoke Damper
      c. Combination Smoke and Fire Dampers
   4. Air Flow Station:
      a. Air Flow Station

B. Operation and Maintenance Data: Automatic dampers, fire dampers, smoke dampers. Combination smoke and fire dampers, air flow station.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Medium Pressure Duct Accessories:
   1. Duct Sealer:
      a. McGill Airseal Zero
      b. Design Polymerics DP 1090.
      c. Other Manufacturers: Submit substitution request.
   2. Flexible Equipment Connector:
      a. Duro Dyne Corporation
      b. Ventfabrics
   3. Acoustical Turning Vanes:
      a. AirSan Acoustiturn
      b. Or approved equal.
   4. Access Doors:
      a. United Sheetmetal APR or ASR
      b. Metco
      c. Semco
      d. Cesco
      e. Ruskin
      f. Nailor-Hart
      g. Or approved equal.

B. Low Pressure Duct Accessories:
   1. Flexible Equipment Connector:
      a. Duro Dyne Corporation
      b. Ventfabrics
   2. Extrators:
      a. Carnes
      b. Anemostat
      c. Barber-Coleman
      d. Nailor-Hart
      e. Or approved equal.
   3. Access Doors:
      a. Air Balance
      b. Ruskin
      c. Metco
      d. Duro Dyne Corporation
      e. Cesco
      f. Nailor-Hart
      g. Or approved equal.
   4. Backdraft Dampers:
      a. Air Balance
      b. Ruskin
      c. Cesco
      d. Advanced Air
      e. Nailor-Hart
      f. Or approved equal.
   5. Security Grates:
      a. Kees
      b. Or approved equal.

C. Fire and Smoke Dampers:
   1. Where Ruskin is the only manufacturer indicated, equivalent products may be furnished.

2.02 MEDIUM PRESSURE DUCT ACCESSORIES

A. Duct Sealer:
   1. Description:
      a. Suitable for indoor/outdoor use, including application in moist conditions, rated to 10-inch wg.
      b. Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 420 g/L less water.
      c. SCAQMD Rule 1168 compliant.

B. Flexible Equipment Connector:
   1. Description: Woven fiberglass fabric with neoprene coating, air-tight, water-tight, fire retardant.
   2. Minimum Density: 30 oz. per sq. yd.
   3. Temperature Range: -20 degrees F to 200 degrees F
   4. Pressure Range: -10-inch wg to +10-inch wg

C. Turning Vane Assemblies:
   1. Sheet Metal Vanes: Multiple radius hollow vane air foil type with 4-1/2-inch inside radius, galvanized steel construction.
   2. Runners: Embossed type.

D. Acoustical Turning Vanes: Multiple radius air foil type, perforated steel construction with fiberglass fill.

E. Access Doors:
   1. Round, oval or rectangular to match duct, single wall to open against positive duct pressure, fastened with spring clips, pressure seal gasket, fastened with chain. Double wall access doors similar except provide insulated frame and insulated door.

F. Bell Mouth Fittings: Round or flat oval, radius of 0.20 D minimum.

2.03 LOW PRESSURE DUCT ACCESSORIES

A. Damper Regulators:
   1. Acceptable Manufacturers:
      a. Ventlok
      b. Young
      c. Duro Dyne Corporation
      d. Approved equal
   2. Dial Regulator – Concealed or exposed duct in unfinished spaces:
      a. Blade lengths 18-inch and less: 3/8-inch shaft
      b. Blade lengths 19-inches and above: 1/2-inch shafts
      c. Ventlok 635, or 638 for insulated duct.
   3. Dial Regulator – Exposed duct in finished space:
      a. 3/8-inch shaft
      b. Ventlok 640
   4. Dial Regulator – Concealed or non-accessible duct:
      a. Blade lengths 18-inch and less: 3/8-inch shaft
      b. Blade lengths 19-inches and above: 1/2-inch shafts
      c. Ventlok 666 regulator with 680 mitered gear assembly where right angled turn is necessary.
   5. End Bearings:
      a. Ducts rated to 1-inch WG, open end, Ventlok 607.
      b. Ducts rated above 1-inch WG, closed end, Ventlok 609.
      c. Exposed ductwork, finished spaces, Ventlock 609.
      d. Spring end bearings not allowed.

B. Constant Airflow Regulator:
   1. Constant volume pressure regulator, round or rectangular, as conditions dictate, UL listed for flame and smoke generation.
   2. Factory assembled and calibrated assembly, no field adjustment necessary.
   3. Regulators maintain constant airflow +/- 10 percent of scheduled airflow rates within operating the pressure range of the system.
   4. Units to have flange connection.
   5. Provide 5-year warranty.
   6. Based on: CAR by American Aldes or approved equal.

C. Volume Damper Fabrication:
   1. Single blade dampers reinforced or crimped for rigidity, with pivot rod extending through duct. Dampers over 12-inches high use multiple opposed blade damper. Single blade damper no larger than 12-inches by 48-inches. Multiple blade damper factory fabricated, Ruskin MD-35 or equal.
   2. Minimum gauge and duct construction in accordance with SMACNA, HVAC Duct Construction Standards, latest edition.
   3. Splitter and butterfly dampers fabricated of 18 gauge galvanized steel.
   4. Dampers of length suitable to close branch ducts without damper flutter.
   5. Damper blade must be aligned with handle and index pointer.

D. Flexible Equipment Connector:
   1. Description: Woven fiberglass fabric with neoprene coating, air-tight, water-tight, fire retardant.
   2. Minimum Density: 30 oz. per sq. yd.
   3. Temperature Range: -20 degrees F to 200 degrees F
   4. Pressure Range: -10-inch wg to +10-inch wg

E. Extractors (EX): Gang operated blades, steel construction, blades at 1-inch centers, slide operator set 15 degrees into main trunk duct, Titus AG-45 with No. 1 operator.

F. Spin-in Fittings:
   1. Sheet Metal Duct:
      a. Straight pattern sheet metal spin-in fitting with scoops designed for connection to sheet metal ductwork, volume damper, and locking quadrant.
      b. Construction with spot welds or rivets.
      c. Button-punch fabrication prohibited.
   2. Fiberglass Duct:
      a. Straight pattern sheet metal spin-in fitting with scoops designed for connection to fiberglass ductwork volume damper, and locking quadrant.
      b. Spot weld or rivet construction.
      c. Button-punch fabrication prohibited.

G. Duct Sealer:
   1. Based On:
      a. McGill Airseal Zero
      b. Design Polymerics DP 1090
   2. Description:
      a. Suitable for indoor/outdoor use, including application in moist conditions, rated to 10-inch wg.
      b. Maximum Flame Spread/Smoke Developed Rating of 25/50, maximum VOC of 420 g/L less water.
      c. SCAQMD Rule 1168 compliant.

H. Duct Tape for Sheet Metal:
   1. ARNO C520 duct tape similar United
   2. Duro Dyne Corporation
   3. Nashua

I. Tape and Adhesive/Activator System for Sheet Metal: Hardcast, Polymer Adhesives.

J. Turning Vane Assemblies:
   1. Sheet Metal Vanes: Multiple radius hollow vane air foil type 2-inch (small vane) or 4-1/2-inch (large vane) inside radius, galvanized steel construction.
   2. Runners: Push-on type.
   3. Acoustical Vanes: Multiple radius air foil type, perforated steel construction with fiberglass fill. AirSan Acoustiturn or as approved.

K. Access Doors:
   1. Doors complete with steel frame, steel door with backing plate, cam latches (two on units 14-inch by 14-inch and larger), hinge, and gasketing. Insulate doors on insulated or lined ducts.
   2. Grease Duct Access Door: Construct of metal thickness equal to metal duct, doors air, and grease tight with hinge and hand operable latches. Ductmate.
   3. Size:

Duct Width or Duct Diameter	Net Access Door Opening
Up to 8-inch	6-inch by 6-inch
9-inch to 12-inch	8-inch by 8-inch
13-inch to 20-inch	12-inch by 12-inch
21-inch to 30-inch	16-inch by 14-inch
31-inch to 42-inch	18-inch by 14-inch
Over 42-inch	Two 16-inch by 14-inch

L. Backdraft Dampers:
   1. Description: Gravity operated, vinyl edged, metal bladed backdraft dampers.

M. Drip Pans: Provide Type 304 stainless steel drip pans for cooling coils and exhaust heat recovery coils on built-up units as indicated.

N. Louver Blank-off Panels:
   1. At air intake or exhaust louvers which are only partially active area, blank off inactive area with sheet metal closure panels caulked airtight secured to louver frame and insulated with 2-inch rigid fiberglass insulation per Section 23 07 00, Insulation for HVAC.

O. Security Grates:
   1. Constructed from welded 1/4-inch steel plates with 1/4-inch by 3-inch wide mounting flange welded to sides with 5/16-inch diameter mounting holes at 8-inch centers. Frame O.D. to equal duct size.
   2. 1/2-inch diameter steel security bars spaced vertically at minimum of 3-inch and maximum of 6-inch centers welded around at top bottom. Horizontal cross bars welded to vertical bars at maximum of 1-inch centers on ducts over 12-inch deep.

P. Roof Jack: Enamel finish steel with back draft damper and bird screen. Broan 636, or equal.

Q. Automatic Dampers:
   1. Description:
      a. Multi-blade air foil type, except where either dimension is less than 10-inches a single blade may be used. Maximum blade length to be 48-inches.
      b. Provide parallel blades for positive or modulating mixing service and opposed blades for throttling service.
      c. Blades to be interlocking, minimum 16 gauge galvanized steel.
   2. Compression type edge seals and side seating stops.
   3. Reinforced blades, have continuous full length axle shafts, axle to axle linkage, and/or operating jackshafts to provide coordinated tracking of blades.
   4. Dampers over 25 square-feet in area to be in two or more sections, with interconnected blades. Maximum air leakage of 3 cfm per square foot at 1-inch wg pressure.
   5. Provide automatic dampers except those specified to be provided with units. Tested in accordance with AMCA Standard 500. Based on Ruskin CD-60.
   6. Damper Operators: Refer to Section 23 09 00, Instrumentation and Controls for HVAC.

7. Manufacturers:
   a. Ruskin
   b. Greenheck
   c. Air Balance
   d. Cesco
   e. Or equal.

2.04 FIRE AND SMOKE DAMPERS

A. Static Fire Dampers:
   1. Code Compliance: Provide static fire dampers with a UL 555 label for fire rating indicated and in conformance with NFPA 90A.
   2. Integrally hinged, folding blade curtain type, for installation in ductwork complete with 160 degrees F fire link and retainer.
   3. Suitable for horizontal or vertical installation as required. Furnish stainless steel closure springs and cam lock for complete damper closure on dampers to be installed in vertical air flow positions.
   4. Medium pressure, 1-1/2-hour: Use in partitions up to 2-hour rating with damper out of air stream. Ruskin Model IBD2, Style C for rectangular, Style CR for round, style CO for oval.
   5. Medium pressure, 3-hour: for use in partitions over 2-hour rating with damper out of air stream. Ruskin Model IBD23, Style C for rectangular, Style CR for round, Style CO for oval.
   6. Low pressure, 1-1/2-hour: For use in partitions up to 2-hour rating with damper out of air stream for supply.
      a. Ruskin Model IBD2 Style B for supply.
      b. Ruskin Model IBD2 Style A for return or exhaust.
   7. Low pressure, 3-hour: for use in partitions over 2-hour rating with damper out of air stream for supply.
      a. Ruskin Model IBD23 Style B for supply.
      b. Ruskin Model IBD23 Style A for return or exhaust.
   8. Transfer grilles, 1-1/2-hour: 7/8-inch deep for use in partitions up to 2-hour rating. Ruskin Model IBDT Thinline.
   9. Ceiling fire dampers with 20 gauge galvanized steel blades, 212 degrees F fusible link, UL listed, Ruskin CFD (R) 2 or CFD (2) 3. Provide thermal blanket.

B. Smoke Damper:
   1. Fabricate from 16 gauge channel and blades, UL555S leakage Class II, conforms to NFPA 90A smoke damper requirements, internal 120V electric operator, maximum blade length 36-inches by 6-inches.
   2. Ruskin SD36.

C. Combination Fire and Smoke Dampers:
   1. Multiblade damper with linkage, extended control rod, and damper operator with UL Fire Damper Label. Provide round or oval duct connections where required. Operator to be factory-installed, electric type, 120V with spring return to closed position. Stall type motors are not acceptable.
   2. Medium pressure, 1-1/2 hour: for use in partitions up to 2-hour rating. Airfoil shape blades, Ruskin Models FSD60 or FSDR25.
   3. Medium pressure, 3 hour: for use in partitions over 2-hour rating. Airfoil shape blades, Ruskin Model FSD60-3
   4. Low pressure, 1-1/2 hour: for use in partitions up to 2-hour rating. Ruskin Model FSD36.
   5. Low pressure, 3-hour: for use in partitions over 2-hour rating. Ruskin Model FSD60-3.
   6. Provide factory installed and wired UL listed duct smoke detector for 0-3000 fpm flow, Ruskin Model DSDN as part of assembly. Provide contactor from smoke detector to fire alarm system.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install devices as shown on the Contract Drawings and per manufacturer's recommendations.

B. Medium Pressure Duct Accessory installation specified under Section 23 31 02, HVAC Ducts and Casing-Medium Pressure.

C. Low Pressure Duct Accessory installation specified under Section 23 31 01, HVAC Ducts and Casing-Low Pressure.

D. Fire Dampers:
   1. Install dampers in accordance with NFPA 90A and manufacturer's written recommendations.
   2. Size and locate dampers as shown on Drawings.
   3. Install dynamic fire dampers in correct position with regards to direction of air.
   4. Where dampers are not accessible for servicing by removing an outlet, provide access doors for servicing. Doors compatible with the duct in which they are installed.

E. Smoke Dampers and Combination Fire and Smoke Dampers:
   1. Install dampers in accordance with NFPA 90A and manufacturer's written recommendations.
   2. Size and locate dampers as shown on Drawings.
   3. Where dampers are not accessible for servicing by removing an outlet, provide access doors for servicing. Doors compatible with the duct in which they are installed.

F. Access Doors: Install where indicated and at duct mounted coils, humidifiers, automatic control dampers, smoke dampers, fire dampers, air flow stations, to provide access for cleaning and maintenance.

G. Back Draft Dampers: Install where indicated and at the discharge (or inlet) of exhaust fans where automatic dampers are not indicated.

H. Automatic Dampers:
   1. Install where indicated and are not specified with equipment or in Section 23 09 00, Instrumentation and Controls for HVAC.
   2. Coordinate damper operators with Section 23 09 00, Instrumentation and Controls for HVAC.

I. Drip Pans:
   1. Install under each cooling coil and exhaust heat recovery coil as indicated.
   2. Provide drain connection from each drip pan and pipe to nearest floor drain through trap.
   3. Drip pans over 6-feet in length require drain connections from both ends.
   4. Pitch drip pans in direction of air flow and to drain.

J. Louver Blank-off Panels: Install blank-off panels on unused portions of louvers.

END OF SECTION

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SECTION 23 33 19
DUCT SILENCERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Duct Silencers

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 31 01, HVAC Ducts and Casing-Low Pressure

D. Section 233102, HVAC Ducts and Casing-Medium Pressure

E. Section 233300, Air Duct Accessories

1.03 QUALITY ASSURANCE

A. Silencer performance characteristics, including insertion loss, pressure drop, and generated noise, attained through testing in accordance with the latest ASTM E477 test standard for acoustical duct silencers.

B. Performance Data:
   1. Obtain from the manufacturer's NVLAP accredited laboratory.
   2. Laboratory performance verification in the manufacturer's test facility may be requested, in which case a comparative test report made available to the engineer.

C. Combustion ratings for acoustic media equal to or less than the combustion ratings noted below when tested in accordance with ASTM E84 or UL723:
   1. Flame Spread Classification: < 25
   2. Smoke Development Rating: < 50

D. Silencers factory fabricated and supplied by the same manufacturer.

E. Construct silencers in accordance with ASHRAE and SMACNA standards for the pressure and velocity classification specified for the air distribution system in which it is installed.

1.04 SUBMITTALS

A. Submit the following:
   1. Manufacturer's performance data for dynamic insertion loss, generated noise, and pressure drop provided and obtained in accordance with ASTM E477.
   2. Schedule of data for each silencer with the size, configuration, airflow rate, and airflow direction.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Duct Silencers
   1. Price
   2. Vibro-Acoustics
   3. Ruskin
   4. Dynasonics
   5. Commercial Acoustics
   6. Semco
   7. Other Manufacturers: Submit substitution request.

2.02 DUCT SILENCERS

A. Pressure rated airtight at 6-inch wg differential between inside and outside of silencer.

B. Acoustical Fill Material:
   1. Inorganic Glass Fiber:
      a. Not less than 4 pcf density.
      b. Not less than 10 percent compression.
      c. Inert, vermin resistant, and moisture resistant.
      d. Silencers with Internal Velocities that exceed 4000 fpm: Add fiberglass cloth to the silencer between the internal perforated liner and the acoustic media to protect the media from erosion.
   2. Packless (No-Media) Silencers: No absorptive media.
   3. Fiber Free Open Cell Foam:
      a. Fiber free, open cell melamine-based foam not to cause or accelerate corrosion of aluminum or steel.
      b. CFC/HCFC free, halogen-free, non-porous, and resistant to mold growth.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in ducts per manufacturer's recommendations.

B. Seal space between each module with nosing strips and duct sealer to prevent air from passing between modules.

C. Where attenuators are installed directly on concrete, provide 30 roofing felt or 1-inch roofing insulation under attenuators. Not required when attenuators do not come in contact with concrete.

END OF SECTION

SECTION 23 34 00

HVAC FANS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Centrifugal Fans
   2. Vane Axial Fans
   3. Mixed Flow Fans
   4. Roof Exhaust Fans
   5. Propeller Fans
   6. Plug Fans
   7. Roof Vents
   8. Ceiling Exhaust Fans
   9. Small Cabinet Fans
   10. Inline Centrifugal Fans

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

A. Submit the following:
   1. Shop Drawings: Showing dimensions, details of construction.
   2. Product Data: Showing performance of fans.
   3. Operation and Maintenance Data
   4. Submit certified sound power ratings for each fan.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Centrifugal Fans:
   1. Pace
   2. Trane
   3. Barry
   4. Twin City
   5. Peerless
   6. Aerovent
   7. Acme
   8. Greenheck
   9. Cook
   10. Other Manufacturers: Submit substitution request.

B. Vane Axial Fans:
   1. Greenheck
   2. Cook
   3. Twin City
   4. Joy
   5. Strobic Air
   6. Trane
   7. Woods
   8. Other Manufacturers: Submit substitution request.

C. Mixed Flow Fans:
   1. Greenheck
   2. Cook

3. Twin City
4. Other Manufacturers: Submit substitution request.

D. Roof Exhaust Fans:
1. Carnes
2. Penn
3. Greenheck
4. Cook
5. Acme
6. Twin City
7. Other Manufacturers: Submit substitution request.

E. Propeller Fans:
1. Carnes
2. Greenheck
3. Penn
4. Cook
5. Acme
6. American Coolair
7. Aerovent
8. Twin City
9. Other Manufacturers: Submit substitution request.

F. Plug Fans:
1. Tempmaster
2. Twin City Blower
3. Barry
4. Cook
5. Acme
6. Other Manufacturers: Submit substitution request.

G. Roof Vent:
1. Carnes
2. Penn
3. Greenheck
4. Acme
5. Cook
6. Twin City
7. Other Manufacturers: Submit substitution request.

H. Ceiling Exhaust Fans:
1. Penn
2. Greenheck
3. Carnes
4. Cook
5. Acme
6. Twin City
7. Other Manufacturers: Submit substitution request.

I. Small Cabinet Fans:
1. Pace
2. Acme
3. Greenheck
4. Penn
5. Cook
6. Twin City
7. Other Manufacturers: Submit substitution request.

J. Inline Centrifugal Fans:
   1. Greenheck
   2. Penn
   3. Cook
   4. Acme
   5. Carnes
   6. Twin City
   7. Other Manufacturers: Submit substitution request.

2.02 CENTRIFUGAL FANS

A. Description: Centrifugal or utility type centrifugal fans as indicated, standard factory finish, AMCA rated.

B. Fans:
   1. Single width, single inlet, double width, double inlet, forward curved, backward inclined, or air foil blades as scheduled.
   2. Welded steel housing with sloped cut-off plates, spun steel, or die formed inlet cone, welded steel supports.
   3. Statically and dynamically balanced in the factory as an assembly within its own bearings with a maximum full amplitude shaft deflection at bearings not to exceed 0.001-inch at 1200 RPM to meet ANSI S 2.19 G2.5 balance quality grade.
   4. Grease packed pillow block sealed bearings with not less than two pillow blocks per fan assembly. L-10 bearing life of 80,000 hours minimum per AFBMA Standards.

C. Motor:
   1. Integrally mounted, 1800 rpm maximum, with pre-lubricated sealed ball bearings.
   2. Refer to Section 23 05 00 for energy efficient motor requirements.

D. Drive:
   1. Sized for 150 percent of motor horsepower, cast iron adjustable sheaves, V-belt type, sheaves statically and dynamically balanced, multiple belt drives on units over 2 HP.
   2. Metal guard over drive, OSHA approved.
   3. Provide fixed sheaves units over 5 HP.
   4. Replace fan sheaves as necessary to obtain desired results.
   5. Include allowance for one sheave change for fans with fixed sheaves.
   6. For fans used as part of a life safety system, provide 1-1/2 times the number of belts required, with a minimum of 2.

E. Provide vibration isolation as indicated on drawings and in accordance with Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

F. Fans exposed to weather have heavy gauge protective covers over bearings and shaft assembly.

G. Fan outlets with removable angles and bolts for attaching flexible connections or discharge dampers.

H. Scroll on fans used for kitchen grease exhaust, dishwasher exhaust, and cart wash exhaust, which are subject to moist air streams fully welded and have scroll drains.

I. Provide automatic motor operated discharge dampers where indicated. Damper as specified in Section 23 09 00, Instrumentation and Controls for HVAC.

J. Provide fans as indicated with AMCA Type B spark resistant construction.

K. Provide fans as indicated with protective coating on fan wheel and interior of fan housing. Apply coating before balancing fans and repair breaks in coating which occur during balancing. Coating one 6 mil coat of white plasite 7122 and one 6 mil coat of black plasite 7122.

L. Sound power level (10W-12W) at fan inlet and discharge when producing CFM at static pressure not to exceed following in octave band:

FAN				Octave Band Center Frequency (HZ)				
ID	63	125	250	500	1000	2000	4000	8000

2.03 VANE AXIAL FANS

A. General Description: Axial flow fans as indicated, AMCA rated, standard factory finish.

B. Fans:
1. Fan Blades: air foil design.
2. Minimum 14 gauge welded steel housing, welded steel straightening vanes, companion flanges on both ends.
3. Statically and dynamically balanced in the factory as an assembly within its own bearings with a maximum full amplitude shaft deflection at bearings not to exceed 0.001-inch at 1200 RPM to meet ANSI S 2.19 G2.5 balance quality grade.
4. Bearings grease lubricated with grease lines extended to exterior of fan housing. Bearings have minimum L-10 life of 80,000 hours per AFBMA Standards.
5. Provide automatic controllable blade pitch assembly complete with industrial type pneumatic operator with pilot positioner.

C. Smoke Control Fans: Provide UL listing as Power Ventilators for Smoke Control Systems where used as a smoke control fan.

D. Motor: Integrally mounted, 1800 RPM maximum, with pre-lubricated sealed ball bearings. Suitable for across-the-line starter. Refer to Section 23 05 00, Common Work Results for HVAC for energy efficient motor requirements.

E. Vibration Isolation: Refer to Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment.

F. Drives: Fans direct drive with motor in line with airflow and accessible through fan.

G. Drives:
1. Belt drive sized for 150 percent of motor horsepower, cast iron adjustable sheaves, V-belt type, statically and dynamically balanced, multiple belt drives on units over 2 HP.
2. Metal guard over drive, OSHA approved.
3. Fans used as part of a life safety system, provide 1.5 times the number of belts required, with a minimum of 2.

H. Provide fixed sheaves on units over 5 HP. Replace fan sheaves as necessary to obtain desired results. Include allowance for one sheave change for fans with fixed sheaves.

I. Accessories:
1. Where indicated provide automatic motorized inlet dampers, inlet bell with screen, outlet cone, and supports.
2. Outlet cone acoustical type, sized to match fan outlet, IAC D-Duct or approved equal.

2.04 MIXED FLOW FANS

A. General Description: Mixed flow fans as indicated, AMCA rated, standard factory finish.

B. Fans:
1. Fan impeller mixed flow design.
2. Minimum 14 gauge welded steel housing, welded steel straightening vanes, companion flanges on both ends.
3. Statically and dynamically balanced in the factory as an assembly within its own bearings with a maximum full amplitude shaft deflection at bearings not to exceed 0.003-inch at 1200 RPM to meet ANSI S 2.19 G6.3 balance quality grade.
4. Bearings grease lubricated with grease lines extended to exterior of fan housing. Bearings have a minimum L-10 life of 80,000 hours per ABMA Standards.

C. Smoke Control Fans: Provide UL listing as “Power Ventilators for Smoke Control Systems” where used as a smoke control fan.

D. Motor:
   1. Integrally mounted, 1800 rpm maximum, pre-lubricated, sealed ball bearings. Suitable for across-the-line started.
   2. Refer to Section 23 05 00, Common Work Results for HVAC for energy efficient motor requirements.

E. Vibration Isolation: Refer to Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

F. Direct Drive: Fan with motor in line with air flow and accessible through fan.

G. Belt Drive:
   1. Belt drive sized for 150 percent of motor horsepower, v-belt type, statically and dynamically balanced. Metal guard over drive, OSHA approved.
   2. Provide cast iron adjustable sheaves on units up to 5 HP.
   3. Provide fixed sheaves on units over 5 HP. Replace fan sheaves as necessary to obtain desired results. Include allowance for one sheave change for fans with fixed sheaves.
   4. For fans used as part of a life safety system, provide 1.5 times the number of belts required, with a minimum of 2.

H. Accessories: Where indicated provide automatic motorized inlet dampers, belt tunnel, thrust restraints, outlet cone, and supports.

2.05 ROOF EXHAUST FANS

A. General Description: Provide curb mounted centrifugal roof exhauster.

B. Fans:
   1. Single width, single inlet, airfoil blades as indicated.
   2. One piece heavy gauge spun aluminum construction , steel inlet bell, arranged for curb mounting.
   3. Kitchen grease exhaust fans up blast vertical discharge type, with NFPA restaurant installation curb. Units designed for use in kitchen hood applications with motor located outside the air stream. Provide non-sparking wheel assembly and scroll drain.
   4. Statically and dynamically balanced in the factory as an assembly within its own bearings with a maximum full amplitude shaft deflection at bearings not to exceed 0.003-inch at 1200 RPM to meet ANSI S 2.19 G6.3 balance quality grade.
   5. Grease packed pillow block sealed bearings with not less than two pillow blocks per fan assembly.

C. Motor:
   1. Integrally mounted, 1800 rpm maximum, with pre-lubricated sealed ball bearings.
   2. Provide two speed motors where indicated.
   3. Refer to Section 23 05 00, Common Work Results for HVAC for energy efficient motor requirements.

D. Drive:
   1. Sized for 150 percent of motor horsepower, cast iron adjustable sheaves, V-belt type, sheaves statically and dynamically balanced, multiple belt drive on units over 2 HP.
   2. For fans used as part of a life safety system, provide 1.5 times the number of belts required, with a minimum of 2.

E. Drive: Direct drive matched to fan loads.

F. Fan wheel and motor mounted on integral double deflection neoprene isolators.

G. Accessories:
   1. Bird screen
   2. Integral Motor Starter
   3. Disconnect Switch under Enclosure
   4. Acoustical Curb with Removable Baffles for Access To Dampers, Greenheck ATS or Equal
   5. Roof Curb

H. Account for roof slope to provide level mounting service for equipment.

I. Curb height accounts for roof insulation depth and flashing requirements.

J. Provide automatic motorized control damper, aluminum blades with felt edges.

2.06 PROPELLER FANS

A. Description: Axial flow panel mounted sidewall propeller fan, belt drive, belt guard, OSHA approved screens, and automatic motor operated control damper, supply or exhaust as indicated, weatherhood with bird screen where indicated.

B. Smoke Control Fans: Provide UL listing as Power Ventilators for Smoke Control Systems where used as a smoke control fan.

C. Motor: 1800 rpm maximum, prelubricated, sealed ball bearings. Refer to Section 23 05 00 for energy efficient motor requirements.

D. Drive: Sized for 150 percent motor horsepower, adjustable sheaves, v-belt drive. For fans used as part of a life safety system, provide 1-1/2 times the number of belts required, with a minimum of 2.

2.07 PLUG FAN

A. Description:
   1. Centrifugal plug fan, horizontal or vertical arrangement as indicated, with motor, drive, mounted on a common welded steel base.
   2. AMCA rated.

B. Fan:
   1. SWSI, Arrangement 1, airfoil blade wheel with inlet cone.
   2. Statically and dynamically balanced as an assembly within its own bearings with a maximum full amplitude shaft deflection at bearings not to exceed 0.001-inch at 1200 rpm to meet ANSI S 2.19 G2.5 balance quality grade.
   3. Bearings: Spherical roller bearings, 80,000 hour L-10 (AFBMA Standards) life, factory lubricated with easily accessible grease fittings.

C. Motor:
   1. 1800 rpm, with pre-lubricated sealed ball bearings, mounted on an adjustable steel base.
   2. Refer to Section 23 05 00, Common Work Results for HVAC for energy efficient motor requirements.

D. Drive:
   1. Multiple belt with fixed sheave and OSHA approved metal guard.
   2. Size drive for 150 percent of motor horsepower.
   3. Fans used as part of a life safety system, provide 1-1/2 times the number of belts required, with a minimum of 2.

E. Vibration Isolation: Provide vibration isolation as indicated on drawings and in accordance with Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

F. Cabinet: Cabinet enclosure 16 gauge galvanized steel, adjustable reinforced, 2-inch thick 1-1/2 pound density fiberglass internal lining, access door, flexible connections from fan to cabinet.

2.08 ROOF VENT

A. General Description:
   1. Heavy gauge galvanized steel, low silhouette, roll formed rib sections, exterior baked enamel finish with interior grey prime coat, suitable for curb mounting, with bird screen and automatic motorized control damper.
   2. Account for roof slope to provide level mounting service for equipment.

2.09 CEILING EXHAUST FANS

A. General Description: Centrifugal direct drive cabinet fan, AMCA rated.

B. Fan:
   1. Double width, double inlet forward curved aluminum blade wheel, integral backdraft damper.
   2. Provide duct mounted automatic motorized damper where indicated or required by code.

C. Casing: Fabricated acoustically insulated steel casing, steel scroll with inlet cone and steel base, factory standard finish.

D. Motor:
   1. Integrally mounted, 1050 RPM nominal, lubricated sleeve bearing, internal disconnect plug.
   2. Refer to Section 23 05 00, Common Work Results for HVAC for energy efficient motor requirements.

E. Vibration Isolation: Factory mount motor on double deflection neoprene mounts.

F. Inlet and Outlet: Provide egg crate inlet grille. Provide discharge with backdraft damper. Arrange for access to fan and motor through grille.

G. Accessories: Provide flat roof cap sized to match fan discharge, built in bird screen and damper, aluminum construction.

2.010 SMALL CABINET FANS

A. General Description: Centrifugal direct drive cabinet fan, AMCA rated.

B. Fan: Double width, double inlet forward curved stamped aluminum, spun inlet cones, integral backdraft damper.

C. Casing:
   1. Fabricated acoustically insulated steel casing, steel scroll, and base, factory standard finish.
   2. Provide bottom or side access as required.

D. Motor:
   1. Integrally mounted, 1050 rpm nominal, lubricated sleeve bearing.
   2. Refer to Section 23 05 00, Common Work Results for HVAC for energy efficient motor requirements.

E. Vibration Isolation: Factory mount motor and fan scroll on double deflection neoprene mounts.

F. Inlet and Outlet: Provide ducted inlet and outlet.

2.011 INLINE CENTRIFUGAL FANS

1. General Description: Inline centrifugal, belt driven, cabinet fan, AMCA rated, backward inclined wheel, heavy gauge steel housing adequately braced with edges sealed, externally mounted 1800 rpm motor, hinged access doors.
2. Refer to Section 23 05 00, Common Work Results for HVAC for energy efficient motor requirements.

B. Smoke Control Fans: Provide UL listing as “Power Ventilators for Smoke Control Systems” where used as a smoke control fan.

C. Drive:
   1. Multiple belt with fixed sheave and OSHA approved metal guard.
   2. Size drive for 150 percent of motor horsepower.
   3. Fans used as part of a life safety system, provide 1-1/2- times the number of belts required, with a minimum of 2.

D. Vibration Isolation: Provide vibration isolation as indicated on drawings and in accordance with Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

PART 3 EXECUTION

3.01 INSTALLATION, GENERAL

A. Provide flexible connections on inlet and discharge duct connection. Flexible connection for vane axial fans to be barium loaded vinyl.

3.02 CENTRIFUGAL FANS

A. Suspend from structure with isolating hanger rods or mount on isolator base.

B. Extend scroll drain to over floor drain with pipe size the same as outlet size.

C. Lubricate bearings as recommended by the bearing manufacturer.

D. Startup: After installation and before starting:
   1. Check fan isolation for freedom of motion.
   2. Perform pre-startup tasks as recommended by the manufacturer.
   3. Perform a field vibration test to statically and dynamically balance the fan as an assembly with maximum vibration velocity measured at the fan bearings of 0.15 in/sec over the full range of operational speeds (filter-out reading). Submit vibration test results.

3.03 VANE AXIAL FANS

A. Mount on structural steel supports angle iron with springs, restraints, snubbers, and structural steel base.

B. Anchor springs, restraints and snubbers to supports and base. Anchor supports to structure.

C. Provide access door of adequate size at fan outlet for removal of fan motor.

3.04 MIXED FLOW FANS

A. Mount on structural steel supports angle iron with springs, restraints, snubbers, and structural steel base.

B. Anchor springs, restraints and snubbers to supports and base.

C. Anchor supports to structure.

D. Provide access door of adequate size at fan outlet for removal of fan motor.

3.05 ROOF EXHAUST FANS

A. Mount fan on roof curb in accordance with the manufacturer's recommendations. Anchor fan to curb and curb to roof. Coordinate roof opening size and curb location.

B. Connect ductwork.

3.06 PROPELLER FANS

A. Mount fan where indicated.

B. Provide access door on both the motor and discharge side, of adequate size for service and repair.

3.07 PLUG FAN

A. Install per manufacturer's written installation instructions.

B. Mount on isolators as specified in Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.

C. Make duct connections using flexible connections as specified in Section 23 33 00, Air Duct Accessories.

D. Lubricate bearings as recommended by the bearing manufacturer.

E. Startup: After installation and before starting:
   1. Check fan isolation for freedom of motion.
   2. Perform pre-startup tasks as recommended by the manufacturer.
   3. Perform a field vibration test to statically and dynamically balance the fan as an assembly with maximum vibration velocity measured at the fan bearings of 0.15 in/sec over the full range of operational speeds (filter-out reading). Submit vibration test results.

3.08 ROOF VENT

A. Mount roof vent on roof curb in accordance with the manufacturer's recommendations. Anchor roof vent to curb and curb to roof. Coordinate roof opening size and curb location.

B. Make ductwork connections.

3.09 CEILING EXHAUST FANS

A. Install fan in ceiling with inlet grille tight to surface.

B. Make connection from fan outlet to ductwork.

3.010 SMALL CABINET FANS

A. Mount in ductwork suspended from structure with threaded rod.

B. Arrange for unobstructed access to components.

3.011 INLINE CENTRIFUGAL FAN

A. Mount in ductwork using Vibration Isolation as specified in Section 23 05 48 Vibration and Seismic Controls for HVAC Piping and Equipment, and as indicated on drawings.

B. Connect ductwork using flexible connections.

C. Arrange for unobstructed access to access door.

END OF SECTION

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SECTION 23 37 00
AIR OUTLETS AND INLETS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Diffusers and Grilles

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 33 00, Duct Accessories

1.03 SUBMITTALS

A. Submit the following:
   1. Shop Drawings: Showing dimensions and details of construction.
   2. Product Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Where only Titus figure numbers are listed, equivalent products by the following manufacturers by using only one:
   1. Carnes
   2. Price
   3. Krueger
   4. Tuttle & Bailey
   5. Anemostat
   6. Nailor
   7. Other Manufacturers: Submit substitution request.

2.02 DIFFUSERS AND GRILLES

A. Ceiling Supply Diffuser (C-1):
   1. Perforated face modular diffuser with adjustable modular core, steel panel, square or rectangular neck size as indicated, discharge pattern as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan).
   2. White baked enamel finish, Titus PMC.

B. Ceiling Supply Diffuser (C-1):
   1. Steel ceiling diffuser for lay in or surfaced mounted as required (coordinate with architectural reflected ceiling plans).
   2. Steel face panel that captures a secondary formed panel
   3. White baked acrylic finish, Titus OMNI.

C. Ceiling Return/Exhaust Grille (C-2): Perforated face modular ceiling grille, steel panel, with duct adapters for round or rectangular as indicated, lay-in tee bar ceiling, or surface mounted as required (coordinate with architectural reflected ceiling plan), white baked enamel finish, Titus PAR.

D. Ceiling Filter Return Grille (C-3): Same as C-2 with 1-inch filter frame and hinged face, Titus 8RF.

E. Ceiling Return/Exhaust Grille (C-4): Same as C-2 except 3/8-inch drop face, Titus PDR, Border Type 3.

F. Ceiling Return/Exhaust Grille (C-5): Same as [C-3] [C-4] except 12-inch by 24-inch face, Titus [PAR] [PDR], Border type 3.

G. Ceiling Supply Diffuser (C-6):
   1. Louver face square or rectangular ceiling diffuser, removable core, neck size and discharge pattern as indicated, steel construction, baked white enamel finish, [surface mounted] [24x24 tee bar module] [beveled drop face].
   2. Titus TDC, Border type [1] [3] [6].

H. Ceiling Supply Diffuser (C-7):
   1. Curved vane square or rectangular ceiling diffuser, individually adjustable blades, neck size and discharge pattern as indicated, steel construction, baked white enamel finish, [surface mounted] [24-inch by 24-inch tee bar module]
   2. Titus Model 250, Border type [1] [3].

I. Ceiling Supply Diffuser (C-8):
   1. Round ceiling diffuser, two horizontal discharge patterns, round neck size as indicated, steel construction, baked white enamel finish.
   2. Titus TMR.

J. Ceiling Supply Diffuser (C-9):
   1. Round ceiling diffuser, adjustable horizontal and vertical discharge pattern, round neck size as indicated, steel construction, baked white enamel finish.
   2. Titus TMRA.

K. Ceiling Return/Exhaust Grille (C-10):
   1. 1/2-inch by 1/2-inch by 1/2-inch egg crate grille, neck size as indicated, aluminum construction, baked white enamel finish [surface mounted] [24x24 tee bar module].
   2. Titus Model 50F, Border type [1] [3].

L. Ceiling Supply Diffuser (C-11):
   1. Perforated steel face radial diffuser with 3/16-inch diameter holes on 1/4-inch staggered centers, steel backplate, one piece face, lower air chamber, directional blades, and pressure induction plate, square or rectangular neck size as indicated, discharge pattern as indicated, lay-in tee bar ceiling, white baked enamel finish.
   2. Titus Tri Tec.

M. Ceiling Supply Diffuser (C-12):
   1. Thermally powered variable air volume module.
   2. Complete VAV terminal and thermostat self-contained in a nominal 2-foot by 2-foot diffuser.
   3. Module varies supply air volume to provide both VAV heating and VAV cooling, Acutherm Therma-Fuser TF-HC.

N. Titus TBDI-30.

O. Titus Model 3F manufacturer.

P. Drum Louver (H-10):
   1. Drum louver with 1-1/4-inch steel borders, (opposed blade dampers), counter sunk screw holes, extruded aluminum drum, rotatable 25 degrees up/down form centerline, individually adjustable blades, white baked enamel finish.
   2. Titus model DL.

Q. Filter Return Grille (H-11):
   1. Aluminum 45 degree fixed single deflection, horizontal blades, 3/4-inch spacing, 1-1/4-inch border, gasketed around face flange, hinged with frame for 1-inch filter, [surface] [lay-in tee bar] mounted, baked white enamel finish.
   2. Titus 3FF.

R. Door Transfer Grille (T-1):
   1. Steel door transfer grille, inverted V-site proof, [channel] [flanged with auxiliary] border, white baked enamel finish.
   2. Titus Model T-700.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install diffusers tight to their respective mounting surfaces.

B. Installed plumb and true with room dimensions and accurately centered on projections as shown on the Architectural reflected ceiling plans.

C. Install extractors behind duct mounted sidewall supply grilles, and where shown. Turning vanes allowable if condition is the last outlet on a branch.

D. Set pattern control for directions of throw as shown on Drawings prior to air balancer arriving on Project.

E. Paint ductwork behind outlets flat black.

3.02 PERFORMANCE

A. Unit sizing is based on air being introduced at 20 degrees F temperature differential and being diffused at the 5-foot level to a velocity not greater than 50 FPM and a temperature differential not greater than 1.5 degrees F. Units are also selected so as not to exceed the NC-30 curve.

END OF SECTION

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SECTION 23 40 00

HVAC AIR CLEANING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Bag Filters, Non-Supported Type
2. Bag Filters, Supported Type
3. Medium Efficiency Pleated Filters
4. High Efficiency Pleated Filters
5. High Efficiency Pleated Filters (High Capacity)
6. Filter Gauge
7. Extruded Aluminum Filter Framing Module
8. Side Access Filter Housing

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

A. Submit the following:
1. Shop Drawings: Details of construction and dimensional data.
2. Product Data: Air filters, gauges, including performance data.
3. Operation and maintenance data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Bag Filters, Non-Supported Type:
1. Cambridge
2. Camfil-Farr
3. American Air Filter
4. Eco-Air Products
5. Flanders Precisionaire
6. Other Manufacturers: Submit Substitution Request.

B. Bag Filters, Supported Type:
1. Camfil-Farr
2. American Air Filter
3. Cambridge
4. Eco-Air Products
5. Flanders Precisionaire
6. Other Manufacturers: Submit substitution request.

C. Medium Efficiency Pleated Filters:
1. Camfil-Farr 30-30, Cambridge, American Air Filter, Eco-Air Products, Flanders Precisionaire.
2. Other Manufacturers: Submit Substitution Request.

D. High Efficiency Pleated Filters:
1. Camfil-Farr
2. Cambridge
3. American Air Filter
4. Eco-Air Products
5. Flanders Precisionaire

E. High Efficiency Pleated Filters (High Capacity) :
1. Camfil-Farr

2. Cambridge
3. American Air Filter
4. Eco-Air Products
5. Flanders Precisionaire
6. Other Manufacturers: Submit substitution request.

F. Filter Gauge:
1. Dwyer No. 2002-ASF
2. Other Manufacturers: Submit substitution request.

G. Extruded Aluminum Filter Framing Module:
1. Eco-Air K-Trac, Camfil-Farr, Cambridge.
2. Other Manufacturers: Submit Substitution Request.

H. Side Access Filter Housing:
1. Eco-Air Surepleat
2. Camfil-Farr
3. Cambridge
4. American Air Filter
5. Other Manufacturers: Submit substitution request.

2.02 BAG FILTERS, NON-SUPPORTED TYPE

A. Description:
1. Multiple pocket type replaceable element with glass media, UL Class II, with galvanized steel enclosing frame.
2. Size of filter bank as indicated on drawings.
3. Provide polyfoam gaskets on vertical sides of header frame to prevent leakage.

B. Rating: Unit efficiency of 80 percent, MERV 13 minimum rated on ASHRAE Standard 52.1-1992 and 52.2-1999 respectively.

C. Performance: Filters capable of maintaining rated efficiency at 500 fpm face velocity with initial pressure drop not to exceed 0.30 wg and final pressure drop of 1-inch wg.

D. Frame:
1. Provide complete factory assembled galvanized steel frame assembly suitable for filters, including necessary hardware for supporting and holding filters in place with an airtight seal around frame.
2. Upstream load on built-up systems, side access on air handling units.

E. Prefilters:
1. Replaceable type, 2-inch thick, glass fiber, installed in frame in front of medium efficiency filters.
2. Prefilters capable of performance at 500 FPM.

2.03 BAG FILTERS, SUPPORTED TYPE

A. Description:
1. Deep pleated replaceable element with synthetic fiber or glass fiber media, UL Class II, with galvanized steel enclosing frame, and media retainer holding frame.
2. Size of filter bank as indicated on drawings.
3. Provide polyfoam gaskets on vertical sides of header frame to prevent leakage.

B. Rating: Unit efficiency of 80 percent, MERV 13 minimum rated on ASHRAE Standard 52.1-1992 and 52.2-1999 respectively.

C. Performance: Filters capable of maintaining rated efficiency at 500 fpm face velocity with initial pressure drop not to exceed 0.32-inches wg and final pressure drop at 1.0-inches wg.

D. Frame: Provide complete factory assembled, galvanized steel frame assembly suitable for installation where shown, including necessary hardware for supporting and holding filters in place with an airtight seal around frame upstream load on built-up systems, side access on air handling units.

E. Prefilters:
1. Replaceable type, 2-inch thick, glass fiber, installed in frame in front of medium efficiency filters.
2. Capable of performance at 500 FPM.

2.04 MEDIUM EFFICIENCY PLEATED FILTERS

A. Description:
1. 2-inch thick medium efficiency, pleated fabric media disposable type filter with support grid and enclosing frame.
2. UL Class 2.
3. Size as indicated on drawings.

B. Rating: 25-30 percent MERV 7 efficiency rated on ASHRAE Standard 52.1-1992 and 52.2-1999 respectively.

C. Performance: Filters capable of maintaining rated efficiency at 500 fpm face velocity with initial pressure drop not to exceed 0.30-inch wg and final pressure drop at 0.90-inch wg.

D. Frame: Provide complete factory assembled galvanized steel frame assembly suitable for filters, including necessary hardware for supporting and holding filters in place with an air tight seal around frame, upstream load on built-up systems, side access on air handling units.

2.05 HIGH EFFICIENCY PLEATED FILTERS

A. Description:
1. 4-inch, pleated, rigid, replaceable, with glass media, media support grid, contour stabilizers, and galvanized steel enclosing frame.
2. Size of filter bank as indicated on drawings.

B. Rating: Unit efficiency of 80 percent, MERV 13 minimum rated based on ASHRAE Standard 52.1-1992 and 52.2-1999 respectively.

C. Performance: Filters capable of maintaining rated efficiency at 500 fpm face velocity with initial pressure drop not to exceed 0.60-inches wg and final pressure drop at 1-1/2-inches.

D. Frame: Provide complete factory assembled galvanized steel frame assembly suitable for filters, including necessary hardware for supporting and holding filters in place with an air tight seal around frame, upstream load on built-up systems, side access on air handling units.

E. Prefilters:
1. Replaceable type, 2-inch thick, glass fiber, installed in frame in front of high efficiency filters.
2. Prefilters capable of performance at 500 FPM.

2.06 HIGH EFFICIENCY PLEATED FILTERS (HIGH CAPACITY)

A. Description:
1. 12-inch deep, V-bank, pleated, rigid, replaceable, with glass media, media support grid, contour stabilizers, and galvanized steel enclosing frame.
2. Size of filter bank as indicated on drawings.

B. Rating: Unit efficiency of 80 percent, MERV 13 minimum rated based on ASHRAE Standard 52.1-1992 and 52.2-1999 respectively.

C. Performance: Filters capable of maintaining rated efficiency at 500 fpm face velocity with initial pressure drop not to exceed 0.30-inches wg and final pressure drop at 2.0 inches.

D. Frame: Provide complete factory assembled galvanized steel frame assembly suitable for filters, including necessary hardware for supporting and holding filters in place with an air tight seal around frame, upstream load on built-up systems, side access on air handling units.

E. Prefilters:
1. Replaceable type, 2-inch thick, glass fiber, installed in frame in front of high efficiency filters.
2. Capable of performance at 500 FPM.

2.07 FILTER GAUGE

A. Description:
1. Magnehelic Gauge with Plastic Vent Valves
2. Adjustable Signal Flag
3. External Front Screw for Zero Adjustment

B. Accessories:
1. Pressure Tap Plugs
2. Static Pressure Tips
3. Tubing
4. Mounting Adapters with Screws

C. Range: 0 to 2 inches wg, with 0.05-inch divisions.

2.08 EXTRUDED ALUMINUM FILTER FRAMING MODULE

A. Description:
1. Factory design Type 6063-T6 mill finish extruded aluminum modules.
2. Factory cut to length, pre-drilled and gasketed for quick field assembly.
3. No clips or filter fasteners required.

B. Filter Track:
1. 2-inch wide pre-filter track with 1-1/4-inch wide final filter track in one extrusion.
2. Permanently gasketed to eliminate air bypass.
3. Spring loaded sealing lever actuates a pressure bar to positively seal final filter header in track.

C. Performance: Capacities as shown on drawings.

2.09 SIDE ACCESS FILTER HOUSING

A. Description:
1. Factory assembled, 16 gauge galvanized steel construction.
2. Z channel vertical support members on all four corners.
3. Upstream and downstream outwardly turned flanges for connection to ductwork or air handling unit (weatherproof for outdoor installation).

B. Filter Track:
1. Extruded aluminum with a replaceable poly-pro gasket to insure sealing of filters to track.
2. Filter track 2-inches wide.

C. Access Doors:
1. Provide on both sides of housing with continuous neoprene gasketing.
2. Equip with positive-pressure adjustable latches and easy grip knobs.

D. Performance: Capacities as shown on drawings.

PART 3 EXECUTION

3.01 INSTALLATION, BAG FILTERS

A. Arrange for access and removal of filter elements.

B. Provide suitable guides and latch operated access doors for filter removal.

C. Air handling units or fans may not be operated without specified filters properly installed.

3.02 INSTALLATION, PLEATED FILTERS

A. Arrange for access and removal of filter elements.

B. Install filters in air handling unit filter racks, filter grilles and other locations shown on the plans.

C. Air handling unit or fans not operated without specified filters properly installed.

3.03 INSTALLATION, FILTER GAUGE

A. Install filter gauge around each filter assembly with static pressure taps for entering and leaving side of filter.

B. Fasten tubing with metal fasteners.

3.04 PROTECTION

A. Equipment Operation During Construction:
   1. Bag Filters:
      a. Provide a treated 2-inch media construction filter in front of prefilters during construction. Replace periodically during construction as required to prevent dirt carryover.
      b. Remove construction filter and replace prefilter prior to air balancing.
   2. Pleated Filters:
      a. If air handlers are operated during construction, replace filters periodically as required to prevent dirt carryover.
      b. Install clean filters prior to air balancing.

END OF SECTION

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SECTION 23 55 23

GAS RADIANT HEATING SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Radiant Heating System

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 SUBMITTALS

A. Submit the following:
   1. Shop Drawings:
      a. Submit dimensioned drawings showing location of burners, reflectors, pipe inverts, height of pipe above floor, pumps, control panels, thermostats, hanger locations, wiring diagram.
      b. Hanger locations be approved by the Architect prior to fabrication.
      c. Drawings approved by manufacturer of system.
      d. Show clearances to combustible material.
   2. Product Data: Showing performance of equipment.

B. Operating and maintenance data in accordance with Division 01, General Requirements.

C. Certification that system is complete, adjusted, and operating satisfactorily as specified in this Section.

PART 2 PRODUCTS

2.01 MANUFACTURERS

1. Radiant Heating System:
   a. Ultra Schwank by Schwank
   b. Other Manufacturers: Submit substitution request.

2.02 RADIANT HEATING SYSTEM

A. General:
   1. Furnish and install gas-fired, vented, infrared, radiant heaters, AGA certified and FM approved.
   2. Equip heaters with direct sense silicon-carbide hot surface ignition control system with 100 percent shut-off ignition device.
   3. Equip burner with totally enclosed motor with thermal overload protection, balance air rotor, combustion air proving safety switch, nickel plated burner cup, combustion chamber with sight glass for visual inspection of igniter element and burner flame.
   4. Radiant Tube: 16-gauge hot rolled steel, 4-inch diameter, aluminized steel for first 10 feet after burner.
   5. Reflector:
      a. Aluminum, designed to reflect radiant output below horizontal centerline of tube.
      b. Nickel plated hangers, chrome plated hardware.
   6. Controls include 3-try ignition module, door interlock safety switch, 24V control transformer, fan relay, factory pre-wired. Provide 24V thermostat and spring-wound two hour timer switch and a other control components and wiring required for a complete system.
   7. Provide stainless steel flexgas line and high pressure gas cock, mounting hardware.

PART 3 EXECUTION

3.01 INSTALLATION FOR RADIANT HEATING SYSTEMS

A. Installation of equipment and material conforms to the practices of good workmanship, in accordance with applicable codes and regulations and the manufacturer's written installation instructions, diagrams and prints. Attach or suspend the combustion chambers, pipe work, gas lines and electrical conduit from the building structure in a suitable manner as shown.

B. Clearances to combustible materials not to exceed those as specified by manufacturer.

C. Locate equipment where shown on Drawings. Prior to installation, verify equipment locations and mounting height with other shop equipment.

3.02 FIELD QUALITY CONTROL

A. Installation under supervision of local representative's agent, and certify when complete that system is adjusted and operating satisfactorily.

END OF SECTION

SECTION 23 63 13
AIR COOLED REFRIGERANT CONDENSERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Air Cooled Condensing Unit
   2. Refrigeration Accessories

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

1.03 QUALITY ASSURANCE

A. Contractor Qualifications: Minimum of 5 years of continuous experience in the installation and maintenance of refrigeration systems of similar or greater size.

1.04 SUBMITTALS

A. Submit the following:
   1. Shop drawings showing actual installed conditions and capacities.
   2. Product data on devices specified herein.

B. Operation and maintenance data and parts lists.

1.05 WARRANTY

A. In addition to the contract conditions provide an extended 4 year compressor warranty for parts and labor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Air Cooled Condensing Unit:
   1. LG
   2. Mistubishi
   3. Other Manufacturers: Submit substitution request.

B. Refrigeration Accessories:
   1. LG
   2. Mitsubishi

2.02 AIR COOLED CONDENSING UNIT

A. General:
   1. Provide air cooled condensing units, designed for outdoor installation.
   2. Properly assembled and tested at the factory.
   3. completely weatherproofed and include compressor, condenser coils, condensing fans, motors, refrigerant reservoir, charging valve, controls, and a holding charge of R22.
   4. Provide guards on condenser fans and coil guard.

B. Compressors:
   1. Furnish hermetically sealed type with isolation and sound muffling.
   2. overload and inherent winding thermostat protection to prevent burn out.
   3. Provide crankcase heater.
   4. Manifold multiple compressor for single joint connection on liquid and suction lines.

C. Refrigeration Circuits:
   1. Include back seating service valve and gauge ports in liquid and suction lines.
   2. Provide refrigerant filter-dryer.

D. Condenser coil: Non-ferrous construction consisting of aluminum plate fins mechanically bonded to seamless copper tubes and circuited for sub-cooling.

E. Condenser Fans and Motors: Direct driven propeller type fans with permanently lubricated motors.

F. Sizing: Select units for actual refrigerating capacities at coil including line losses.

G. Controls:
   1. Provide high and low pressure cutouts, contractors and internal overload protection on motors.
   2. Provide low ambient operation to 50 degrees F outside to maintain condensing temperature on part load operation.
   3. Provide short cycle timer.

2.03 REFRIGERATION ACCESSORIES

A. Expansion Valves: Sized for capacity required with remote suction bulb and external equalizer.

B. Sight Glass: Combination sight glass and moisture indicator.

PART 3 EXECUTION

3.01 INSTALLATION AIR COOLED CONDENSING UNIT

A. Install units per manufacturer's installation instructions.

B. Mount condensing unit on concrete pad when shown on Drawings.

C. Install expansion valve for each coil and sight glass for each system in accordance with recommended industry practices. Provide gauge tap on suction line at each coil connection.

D. Make refrigerant piping connection, install refrigeration accessories, and charge system. Provide additional refrigerant as required for proper operation at design capacities.

3.02 END OF SECTION

SECTION 23 72 00

AIR TO AIR ENERGY RECOVERY UNITS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Heat Recovery Units

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 14, Variable Frequency Drives for HVAC Equipment

D. Section 23 05 29, Hangers, Supports, and Anchors for HVAC

E. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment

F. Section 23 09 00, Instrumentation and Controls for HVAC

G. Section 23 40 00, HVAC Air Cleaning Devices

1.03 SUBMITTALS

A. Submit the following:
   1. Shop drawings showing details of construction, dimensions, arrangement of components, isolation, filters, etc.
   2. Product data showing performance data, standard items and accessories, operating weight.
   3. Operating and Maintenance Data
   4. Coordination letter from controls vendor indicating control points have been coordinated between equipment supplier and controls vendor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

1. Heat Recovery Units:
   a. Plate Type:
      1) Aaon
   b. Other Manufacturers: Submit substitution Request.

2.02 HEAT RECOVERY UNITS

A. Description:
   1. Furnish complete packaged unit including cabinet, fans and motor assemblies, flat plate heat exchanger, hot water heating coils, and filters. Suitable for rooftop installation.
   2. Mount assemblies on a structural steel base.
   3. UL approved for application and wired per NEC.

B. Cabinet:
   1. 18 gauge (minimum) steel, hinged and latched panels for access to components.
   2. Exterior finished with baked enamel, or powder coated paint finish, color – factory finish color as selected by Architect
   3. Casing internally insulated to a depth of 1-inch, enclosed to form double wall construction.

C. Configuration: Horizontal unit, ducted inlet, and outlet connection, with flex connection.

D. Sound Requirements:
   1. Furnish sound power levels at the supply air connection, return air connection, outside air opening, relief air openings and casing radiation for each air handling unit.

2. Sound power level 10W-12W when producing scheduled airflow (cfm) at static pressure not to exceed following in octave band:

Octave Band Center Frequency (HZ)								
	63	125	250	500	1000	2000	4000	8000
Supply Air								
Outside Air								
Return Air								
Relief Air								
Casing Radiated								

E. Filters:
1. Provide filters in the supply and exhaust steams upstream of the heat exchanger.
2. Provide medium efficiency and high efficiency pleated filters (as scheduled).
3. Refer to Section 23 40 00, HVAC Air Cleaning Devices.
4. Provide one extra set of each type of filters for each unit.

F. Variable Frequency Drives:
1. Mount in external weatherproof NEMA rated VFD enclosure.
2. Refer to Section 23 05 14, Variable Frequency Drives for HVAC Equipment for additional requirements.

G. Plate Heat Exchanger Section:
1. Flat plate air-to-air type with no moving parts or secondary heat transfer surfaces.
2. Heat exchanger to withstand differential pressures to 10-inches wc and operate at temperatures at 220 degrees F.
3. Seal corners with silicone and plate edges both mechanically and with sealant to prevent cross contamination.
4. Constructed of 0.008-inch thick 99.5 percent pure aluminum.
5. House in an aluminum tube frame.
6. Entire transfer surface visible for inspection and cleaning without removing the exchanger.
7. Face/Bypass Dampers and Motorized Control Dampers:
   a. Dampers opposed blade type.
   b. Multi-blade type, except where either dimension is less than 10-inches a single blade may be used.
   c. Maximum blade length to be 48-inches.
   d. Provide parallel blades for positive or modulating
   e. Blades to be interlocking, minimum 16 gauge galvanized steel.
      1) Dampers have compression type edge seals and side seating stops.
      2) Reinforce damper blades, have continuous full length axle shafts, axle to axle linkage, and/or operating jackshafts as required to provide coordinated tracking of blades.
      3) Maximum air leakage of 3 cfm per square foot at 4-inches wg pressure. Tested in accordance with AMCA Standard 500.
      4) Actuator provided by Division 23 09 00, Instrumentation and Controls for HVAC. Extended shaft for connection to actuator.

H. Service Outlet:
1. Provide 115 VAC circuit with ground fault interrupter electrical outlet mounted in the unit controls cabinet.
2. Rate outlet circuit at 15A and factory wired to a step down transformer, fuse block, and 115V disconnect.
3. Wire circuit to line side of power block or power switch permitting use of the outlet while power to the unit is shut off.

I. Controls: Provide terminal strip connections for DDC controls. unit controls. Reference Section 23 09 00, Instrumentation and Controls for HVAC.
1. DDC Control connections:
   a. Fan command, On/Off

b. Fan Speed
c. Outside Air, Supply Air, Exhaust Air and Bypass Damper Command Position.

J. Isolation Dampers:
1. Provide isolation dampers on the outside air intake and exhaust air discharge of the unit.
2. Automatic, motorized control dampers to provide shut off function when the unit is not in operation.

K. Weather Hoods: Provide intake and exhaust with weather hoods to prevent water intrusion (tested in accordance with AMAC Standard 500-L).

L. Vibration Isolators:
1. Provide as an integral part of each unit as indicated. Refer to Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment.
2. Coordinated weights and location of support points with the vibration isolation equipment supplier.
3. Provide vibration isolator restraints.

M. Flexible Connections:
1. Constructed in accordance with UL 181, Class 1 airduct with flanged connections.
2. Flexible, neoprene-coated glass fabric not lighter than 30 oz/sq. yd.
3. Ventglas by Vent-Fabrics, Inc.

N. Warranty: One-year on parts.

PART 3 EXECUTION

3.01 HEAT RECOVERY UNIT

A. Installation:
1. Coordinate roof penetration with others.
2. Provide roof curb per Section 23 05 29.
3. Install unit where shown, with air filters in place before operating unit. Comply with manufacturer's recommendation.
4. Provide minimum of 3-inch trap seal on condensate drain connections.
5. Keep access door to roof mounted equipment closed to prevent wind and weather damage.

B. Flexible Connections:
1. Provide flexible connections between fans and the connected ducts or plenums.
2. Install with 1-inch space between the fan and connecting duct with fabric snug but not stretched tightly.
3. Provide accurate alignment between fan and duct.
4. Secure in place with flanged connections. Do not crimp into the duct construction. Ends of the screws not to project into the duct more than 1/8 inch.

C. Start-Up:
1. General: Comply with manufacturer's instructions.
2. Start-up of units provided under the direct supervision of the manufacturer's representative with factory trained personnel.

D. Testing and Adjusting/Performance Test: Except where initial unit operation clearly shows the performance meets or exceeds the requirements, test to show compliance. Tests performed by the manufacturer's representative in the presence of the Engineer.

END OF SECTION

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SECTION 23 81 00

DECENTRALIZED UNITARY HVAC EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Rooftop Mounted Packaged HVAC Unit
   2. Split System Air Conditioning Unit

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 23, Heating, Ventilating, and Air Conditioning (HVAC)

C. Section 23 05 14, Variable Frequency Drives for HVAC Equipment

D. Section 23 05 48, Vibration and Seismic Controls for HVAC Piping and Equipment

E. Section 23 09 00, Instrumentation and Controls for HVAC

F. Section 23 09 93, Sequence of Operations for HVAC Controls

1.03 SUBMITTALS

A. Submit the following:
   1. Shop drawings showing details of construction, dimensions, arrangement of components, isolation, filters, etc.
   2. Product data showing performance data, standard items, and accessories, operating weight.
   3. Flow diagrams and pipe sizing for refrigerant systems.
   4. Operating and maintenance data.
   5. Testing Submittals:
      a. Provide test plan and test procedures for approval.
      b. Explain in detail, step-by-step, actions and expected results to demonstrate compliance with the requirements of this specification and methods for simulating necessary conditions of operation to demonstrate performance of the system.
      c. Test plan and test procedures demonstrate capability of system to monitor and control equipment and to accomplish control and monitoring specified.

1.04 ACCEPTANCE TESTING AND TRAINING

A. Site Testing:
   1. General:
      a. Provide personnel, equipment, instrumentation, and supplies necessary to perform testing by a representative authorized by the manufacturer.
      b. Owner or Owner's representative will witness and sign off on acceptance testing.
   2. Acceptance Test:
      a. Demonstrate compliance of completed control system with contract documents.
      b. Use approved test plan, physical and functional requirements of project

B. Training:
   1. General:
      a. A representative authorized by the manufacturer conduct training courses for designated personnel in operation and maintenance of system.
      b. Orient training to specific system being installed under this contract.
      c. Provide training manuals for each trainee, with two additional copies provided for archival at project site.
      d. Manuals include detailed description of the subject matter for each lesson.
      e. Copies of audiovisuals delivered to Owner.

f. Training day is defined as 8 hours of classroom instruction, including two 15-minute breaks and excluding lunchtime, Monday through Friday, during normal first shift in effect at training facility.
g. Notification of planned training given to the Owner's representative at least 15 days prior to the training.

2. Operator's Training I:
   a. Teach at a convenient location for a period of one training day.
   b. Upon completion, each student, using appropriate documentation, should be able to perform elementary operations with guidance and describe general hardware architecture and functionality of system.
3. Operator's Training II:
   a. Teach at project site for a period of one training day after completion of field-testing.
   b. Course includes instruction on specific hardware configuration of installed system and specific instructions for operating the installed system.
   c. Upon completion, each student should be able to start system, operate the system, recover the system after failure, and describe the specific hardware architecture and operation of system.
4. Operator's Training III:
   a. Teach at project site for period of one training day no later than six months after completion of the acceptance test.
   b. Course will be structured to address specific topics that students need to discuss and to answer questions concerning operation of system.
   c. Upon completion, students should be fully proficient in system operation and have no unanswered questions regarding operation of installed system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Rooftop Mounted Packaged HVAC Unit:
   1. AAON
   2. Other Manufacturers: Submit substitution request.

B. Split System Air Conditioning Unit:
   1. Mitsubishi
   2. LG
   3. Other Manufacturers: Submit substitution request.

2.02 ROOFTOP MOUNTED PACKAGED HVAC UNIT

A. Description: Roof-mounted variable volume packaged heat pump designed for full curb mounting, natural gas heat, variable frequency drives, capacities as indicated, factory assembled, wired, piped, tested and shipped in one piece with UL listing.

B. Unit Casing:
   1. Heavy gauge galvanized steel, phosphatized and coated with baked enamel finish, gasketed and insulated with 1-inch 1 pound density glass fiber insulation.
   2. Gas-fired heat exchanger section insulation: Foil faced

C. Heat Pump Refrigeration:
   1. Air-cooled with heating and cooling refrigerant line filter driers, dual thermostatic expansion valves, factory refrigerant charge, high and low pressure cutouts, loss of charge protection.
   2. Suction line accumulator, refrigerant check valves, heavy duty, high capacity, four-way reversing valve.
   3. Provide two refrigerant and control circuits.
   4. Low ambient operation to 0 degrees F.
   5. Activate defrost cycle upon demand only.

D. Compressors:
   1. Hermetic type compressor with positive constant pressure lubrication, current and thermal overloads, crankcase heater, time delay, and anti-recycle relays.
   2. Each unit contains a minimum of 2 compressors.
   3. Provide compressor isolation valves.

E. Heating/Cooling Coils:
   1. Provide indoor and outdoor coils of non-ferrous construction with aluminum fins mechanically bonded to seamless copper tubing with joints brazed.
   2. Dual-circuited coils in units with two compressors.
   3. Protect coils with plywood covers during shipment and installation.
   4. Evaporator Coil Drain Pan: Stainless steel internally sealed and insulated.

F. Natural Gas Heating:
   1. AGA approved for intended application and fuel, completely assembled, wired, piped, and tested with threaded gas connections.
   2. Provide aluminized steel heat exchanger and burners, forced draft combustion blower, and electronic ignition.
   3. Provide full modulation of heating.

G. Fans:
   1. Indoor Fan: Centrifugal type, permanently lubricated, belt driven by a permanently lubricated motor.
   2. Outdoor Fan: Propeller type direct driven by a permanently lubricated motor.

H. Filters:
   1. Provide high efficiency pleated filters.
   2. Provide filter curb when filters cannot be mounted in the unit.
   3. Provide one extra set of filters for each unit.

I. Dampers:
   1. Provide motor-operated outside air and return air dampers with spring-return actuators, capable of supplying 0 percent-100 percent outside air.
   2. Outside air damper minimum position adjustable independently of return damper position.
   3. Maximum leakage rate no greater than 15 CFM per SF. at 2-inches wg.

J. Powered Exhaust: Provide relief air capability equal to 100 percent of supply air with exhaust fan, counterbalanced backdraft damper, and weather hood.

K. Controls: Configure unit for field installation of DDC control panel and sensors as follows:
   1. Provide valves and dampers, actuators, variable frequency drives, starters, compressor capacity controllers, condenser capacity controllers, gas furnace controllers, electric heat staging controllers, and other operating and safety controls for each component. Wire to terminal strip for connection to DDC control panel.
   2. Temperature and pressure sensors and airflow measuring stations will be furnished under Section 23 09 00, Instrumentation and Controls for HVAC for field installation.
   3. Refer to Section 23 09 93, Sequence of Operations for HVAC Controls for HVAC controls for additional information on required controls, control functions and sequences of operation for both field and factory installed controls.

L. Electrical:
   1. Furnish magnetic contactors (starters), separate fusing for compressors, condenser fans, evaporator fans and exhaust fans, and control transformer.
   2. Arrange unit for single point electrical connection with integral unit mounted disconnect.

M. Service Outlet:
   1. Provide 115 VAC circuit with ground fault interrupter electrical outlet mounted in the unit controls cabinet.
   2. Outlet circuit rated at 15A and factory wired to a step down transformer, fuse block, and 115V disconnect.

3. Wire circuit to line side of power block or power switch permitting use of the outlet while power to the unit is shut off.

N. Variable Frequency Drives:
1. Mount integral to unit or in external weatherproof NEMA rated VFD enclosure.
2. Refer to Section 23 05 14, Variable Frequency Drives for HVAC Equipment for additional requirements.

O. Roof Curb:
1. Formed, 16 gauge galvanized steel with wood nailer strip capable of supporting entire unit weight.
2. Account for roof slope to provide level mounting service for equipment.
3. Provide spring isolated roof curbs where indicated or if fans and compressors are not internally isolated.
4. Curb height accounts for roof insulation depth and flashing requirements.

P. Warranty: One-year on parts.

2.03 SPLIT-SYSTEM AIR CONDITIONING UNIT

A. Indoor Unit:
1. Description:
a. Furnish complete unit including cabinet, wall mounting kit and accessories, refrigerant line set, fan and motor assembly, cooling coil and filter.
b. Unit as scheduled on drawing, factory-tested and assembled, factory wired, refrigerant-to-air heat exchanger, fan/motor assembly, compressor, controls and safety devices, control circuit transformer, shipped in one piece with ARI certification and UL listing.
2. Cabinet: 18 gauge steel, removable panels for access to components. Drain connection and return air filter racks.
3. Fan and Motor:
a. Assembly with a turbo fan direct driven by a single motor.
b. Statically and dynamically balanced and run on a motor with permanently lubricated bearings.
c. Fan consists of two speeds:
1) High
2) Low.
4. Controls:
a. Run wiring direct from the indoor unit to the controller with no splices.
b. System capable of automatic restart when power is restored after power interruption
5. Condensate Pump: Provide condensate pump when required; pipe drain to floor drain.

B. Outdoor Unit:
1. Description:
a. Provide air-cooled air conditioner (outdoor unit) designed for outdoor installation with factory-supplied supports, properly assembled, and tested at the factory.
b. Completely weatherproofed and include compressor, condenser coils, condensing fans, motor, refrigerant reservoir, charging valve, controls, and a holding charge of R410A.
c. Provide guards on condenser fans and coil guard.
2. Compressors:
a. Furnish hermetically sealed type with isolation and sound muffling.
b. Overload and inherent winding thermostat protection to prevent burn out.
c. Provide crankcase heater.
d. Manifold multiple compressors for single joint connection on liquid and suction lines.
3. Refrigeration Circuits: Back seating service valve and gauge ports in liquid and suction lines. Provided refrigerant filter-dryer.

4. Condenser Fans and Motors: Direct driven propeller type fans with permanently lubricated motors.
5. Controls:
   a. Provide high and low pressure cutouts, contactors and internal overload protection on motors.
   b. Provide low ambient operation to 20 degrees F outside to maintain condensing temperature on part load operation.
   c. Provide short cycle timer.

C. Electrical:
1. Furnish starters, contactors and disconnects.
2. Arrange for single point electrical connections.
3. Provide power and control wiring.

D. Controls:
1. Provide wall-mounted locally programmable 7-day thermostats with automatic change over, fan on-auto switch, system off-auto switch, and individual set point for heating and cooling with backlit LCD display.
2. Provide minimum of four independent programmable temperature periods per day.
3. Provide retrievable error codes in the event of system abnormality/error.
4. Hand-held remote controller is not acceptable.

PART 3 EXECUTION

3.01 ROOFTOP MOUNTED AIR CONDITIONING UNIT AND HEAT PUMP

A. Installation:
1. Coordinate roof penetration with others.
2. Install curb.
3. Furnish 2-inch thick, 2 pcf density insulation along inside of curb. Installation per Section 23 07 00, Insulation for HVAC.
4. Install unit where shown, with air filters in place before operating unit. Comply with manufacturer’s recommendation.
5. Provide minimum of 3-inch trap seal on condensate drain connections.
6. Keep access door to roof mounted equipment closed to prevent wind and weather damage.

B. Start-Up:
1. General: Comply with manufacturer’s instructions.
2. Start-up of units provided under the direct supervision of the manufacturer’s representative with factory-trained personnel.

C. Testing and Adjusting/Performance Test:
1. Except where initial unit operation clearly shows the performance meets or exceeds the requirements, test to show compliance.
2. Perform tests by the manufacturer’s representative in the presence of the Engineer.

D. SPLIT-SYSTEM AIR CONDITIONING UNIT

E. Installation:
1. Install in location shown on the Drawings. Level unit and secure to structure.
2. Make piping connections and unit installation per manufacturer's recommendations and installation guides.
3. Size and run refrigerant piping between fan coil unit(s) and air-cooled condensing unit(s) per manufacturer's recommendations. Provide traps and double suction and/or discharge risers if recommended by the manufacturer.
4. Insulate refrigerant piping as specified in Section 23 07 00, Insulation for HVAC.
5. Pipe condensate pan to floor drain per manufacturers installation guide.
6. Make refrigerant piping connections, install refrigeration accessories, and charge system. Provide additional refrigerant as required for proper operation at design capacities.

F. Start-up:
   1. General: Comply with manufacturer's instructions.
   2. Install filters before operating unit.
   3. Insure proper refrigerant and airflow before operating unit compressor.

G. Provide interconnecting power and control wiring, routed in conduit from the outdoor unit to the indoor unit, and control panel thermostat. Where unit provided requires separate power connections to the indoor and outdoor units provide at no additional cost. Include branch circuit conduit, wiring, circuit breaker, terminations, etc. as required for complete system. Branch circuit serving indoor unit originates in same panelboard serving outdoor unit.

H. Testing and Adjusting/Performance Test: Except where initial unit operation clearly shows the performance meets or exceeds the requirements, test to show compliance. The manufacturer's representative in the presence of the Engineer to perform tests.

END OF SECTION

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 GENERAL

1.01 SUMMARY

A. The intent of Division 26, Electrical Specifications and Drawings is to provide a complete and workable facility, with complete systems as required by applicable codes, as indicated, and as specified.

B. Include work specified in Division 26, Electrical and as indicated on Drawings. Include appurtenances, connections, fasteners, and accessories required to make a complete working system, whether indicated or not indicated.

C. Refer to Division 01, General Requirements.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

1.03 REFERENCES

A. The latest adopted revisions of the publications listed below apply to these Specifications as referenced:

1.	IBC	International Building Code
2.	NEC	National Electrical Code
3.	NFPA	National Fire Protection Association
4.	NEMA	National Electrical Manufacturers Association
5.	NECA	National Electrical Contractors Association
6.	ANSI	American National Standards Institute
7.	IEEE	Institute of Electrical and Electronic Engineers
8.	UL	Underwriters Laboratories
9.	OAR	Oregon Administrative Rules

1.04 SYSTEM DESCRIPTION

A. Ground Systems:
   1. Provide complete ground systems indicated.
   2. Include conduit system, transformer housings, switchboard frame, and neutral bus, motors, and miscellaneous grounds required by Contract Documents and by applicable codes.

B. System Identification:
   1. Clearly identify elements of the Project electrical system to indicate the loads served, or the function of each item of equipment, connected under this work.
   2. Comply with requirements of Division 26, Electrical, and with applicable codes.

C. Drawings:
   1. Drawings are diagrammatic. They do not show every offset, bend, tee, or elbow, which may be required to install work in the space, provided and avoid conflicts with other construction.
      a. Prior to installing work, take field dimensions, and note conditions available for, installation.
      b. Follow the Drawings as closely as practical to do so, and install additional bends, offsets, and elbows where required by installation conditions.
         1) Additional offsets, bends, and other connectors are subject to approval by Project Engineer.
         2) Install additional offsets, bends, and other connectors without additional cost to Owner.

c. The right to make any reasonable changes in outlet location prior to roughing in is reserved to the Owner's Representative.

2. Luminaire Designations:
   a. Lower case letters adjacent to devices or luminaires indicate switching arrangement or circuit grouping.
   b. Numbers adjacent to devices indicate circuit connection.
3. Circuits and Switching:
   a. Do not change branch circuiting and switching indicated; nor combine homeruns, without Engineer's prior approval.
   b. Do not combine or change feeder runs.
4. Circuit Conductors:
   a. Cross or hash marks on conduit runs indicate quantity of No. 12 copper branch circuit conductors, unless otherwise noted.
   b. Where such marks do not appear, provide quantity of circuit conductors to the outlets shown to perform the control or circuiting indicated.
   c. Include ground, travelers, and switch legs required by the circuiting arrangement indicated.
   d. Provide a dedicated neutral conductor with each circuit. Do not use a shared neutral conductor between phases unless, requested or directed.

1.05 SUBMITTALS

A. Comply with Division 01, General Requirements.

B. Contractor Responsibilities:
   1. Submit submittals one time and in proper order.
   2. Ensure equipment will fit in the space provided.
   3. Deviations from the Drawings and Specifications specifically noted in the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.

C. Shop Drawings and Equipment Data:
   1. Combine electrical shop drawings and equipment data in Submittal binders.
   2. Include in Submittal binders:
      a. Complete index of materials and equipment as required by Specifications to be documented by submittals.
      b. Fully describe equipment furnish per manufacturer's detailed specifications.
      c. All deviations from the Drawings and Specifications, noted on the submittals. Failure to comply will automatically void any implied approval for use of the equipment on this project.

D. Installation Drawings:
   1. Submit prior to starting installation.
   2. Show outlets, devices, terminal cabinets, conduits, wiring, and connections required for the complete system described.

E. Record Drawings:
   1. Keep record drawings up to date as the work progresses.
   2. Show changes, deviations, addendum items, change orders, corrections, and other variations from the Contract Drawings.
   3. Keep record drawings at the jobsite and available for the Architect's review.
   4. At the completion of the work, incorporate all deviations from the installation drawings to indicate as-built conditions.

F. Operation and Maintenance Data:
   1. As specified in Division 01, General Requirements.
   2. Provide a separate manual or chapter for each system as follows:
      a. Low Voltage Distribution System
      b. Fire Alarm System

c. Lighting System
d. Lighting Control System
e. Power Metering And Monitoring System

3. Description of system.
4. Operating Sequence and Procedures:
   a. Step-by-step procedure for system start-up, including a pre-start checklist.
      1) Refer to controls and indicators by nomenclature consistent with that used on panels and in control diagrams.
   b. Detailed instruction in proper sequence, for each mode of operation (i.e., day-night, staging of equipment).
   c. Emergency Operation:
      1) If some functions of the equipment can be operated while other functions are disabled, give instructions for operations under those conditions.
      2) Include here only those alternate methods of operations (from normal) which the operator can follow when there is a partial failure or malfunctioning of components or other unusual condition.
   d. Shutdown Procedure:
      1) Include instructions for stopping and securing the equipment after operation.
      2) If a particular sequence is required, give step-by-step instructions in that order.
5. Preventive Maintenance:
   a. Schedule for preventive maintenance.
      1) State the recommended frequency of performance of each preventive maintenance task such as cleaning, inspection, and scheduled overhauls.
   b. Cleaning: Provide instructions and schedules for all routine cleaning and inspection with recommended lubricants.
   c. Inspection: If periodic inspection of equipment is required for operation, cleaning, or other reasons, indicate the items to be inspected and give the inspection criteria.
   d. Provide instructions for lubrication and adjustments required for preventive maintenance routines. Identify test points and given values for each.
6. Manufacturers' Brochures:
   a. Include manufacturers' descriptive literature covering devices and equipment used in the system, together with illustrations, exploded views, and renewal parts lists.
   b. Clearly define manufacturers' standard brochures so that the information applying to the actual installed equipment.
7. Results of performance testing, as specified in PART 3 of this Section.

G. Submittals Procedures:
   1. Review and recommendations by the Architect or Engineer are not to be construed as change authorizations.
   2. Either if discrepancies are discovered between the materials or equipment submitted, and the Contract Documents, prior to or after the data is processed, the Contract Documents govern.

1.06 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Products and equipment comply with Oregon Revised Statute (ORS) 453.005(7)(e) prohibiting pentabrominated, octabrominated, and decabrominated diphenyl ethers. Where products or equipment within this specification contains these banned substances, provide complying products and equipment from approved manufacturers with equal performance characteristics.
   2. Provide work and materials conforming to:
      a. Local and State codes.
      b. Federal and State laws and regulations.
      c. Other applicable laws and regulations.

3. Obtain and pay for all permits, licenses, and inspection certificates required by authorities having jurisdiction.
4. Pay any other fees required by governing authorities for work of this Division.

B. Install only electrical products listed by a recognized testing laboratory, or approved in writing by the local inspection authority as required by governing codes and ordinances.

1.07 SITE VISITATION

A. Visit the site prior to bidding and become familiar with existing conditions and other factors which may affect the execution of the work. Complete coordination of installation of equipment with prior bid packages previously issued. Include related costs in the initial bid proposal.

1.08 COORDINATION

A. Coordinate Work of This Division with all other trades to ensure proper installation of electrical equipment.
1. Review Drawings of other trades or crafts to avoid conflicts with cabinets, counters, equipment, structural members, and other possible impediments to electrical work.
2. Report potential conflicts to the Architect prior to rough-in.
3. Proceed with rough-in following Architect's directives to resolve conflicts.
4. Architectural Drawings govern.

B. Verify the physical dimension of each item of electrical equipment to fit the available space. Contractor's responsibility includes:
1. Coordination of the equipment to fit into the available space.
2. Access routes through the construction.

C. Layout Drawings:
1. Equipment arrangement shown on Drawings is diagrammatic to indicate general equipment sizing and spatial relationship. Include, as part of distribution equipment submittal, a scaled floor plan, which includes equipment shown with their submitted sizes. Include all feeder conduit routing, both aboveground and underground, including termination points at equipment. Submit for Engineer's review prior to commencing work.
2. Provide additional wiring details at switchboards, motor control centers, and other areas where work is of sufficient complexity to warrant additional detailing for coordination.
3. Submit layout drawings for approval prior to commencing field installation.

D. Where electrical connections are required for equipment provided as Work of other Divisions, coordinate rough in and wiring requirements for that equipment with its supplier and installer prior to commencing work. Notify Architect and Engineer of any discrepancies between the actual rough in and wiring requirements, and those identified on Drawings for resolution prior to installation.

E. Arrange raceways, wiring, and equipment to permit ready access to switches, motors, and control components.
1. Keep doors and access panels clear.

F. Coordinate electrical, telephone, and other utility services with the appropriate serving utility.
1. No additional compensation will be allowed the Contractor for connection fees or additional work or equipment required by the serving utility, but not covered in the Drawings or Specifications.

G. Coordinate underground work with other contractors working on the site.
1. Coordinate particularly with contractors installing storm sewer, sanitary sewer, water, and irrigation lines to avoid conflicts.
2. Common trenches may be used with other trades, providing clearances required by codes and ordinances are maintained.

H. Coordinated Shop Drawings.
1. Prepare in two-dimensional format.

2. Include but are not limited to:
    a. Superplot plans of above ground work with a colored overlay of all trades including, but not limited to, HVAC piping, HVAC equipment, plumbing piping and equipment, sprinklers, lighting, lighting controls, cable tray, fire alarm devices, electrical power conduit, and ceiling system to a minimum of 1/2-inch equals 1-foot scale.
    b. Beam penetration drawings indicating beam penetrations meeting the requirements indicated on the floor plans and on the structural drawings to a minimum of 1/4-inch equals 1-foot scale.
    c. Slab penetration drawings of HVAC, plumbing, sprinklers, lighting and electrical to a minimum of 1/4-inch equals 1-foot scale.
    d. Fabrication drawings of radiant ceiling panels, architectural metal ceiling, including panel penetrations for lighting, sprinkler heads, fire alarm devices, and any other penetrations.

1.09 CHANGE ORDERS

A. Supplemental cost proposals by the Contractor accompanied with a complete itemized breakdown of labor and materials. At the Architect's request, make available estimating sheets for the supplemental cost proposals. Separate and allocate labor for each item of work.

1.010 WARRANTY

A. Provide a written warranty covering the work of this Division as required by the General Conditions.
    1. Incandescent Lamps: Excluded from this warranty.

B. Apparatus:
    1. Free of defects of material and workmanship and in accord with the Contract Documents.
    2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.
    3. Operate at full capacity without objectionable noise or vibration.

C. Include in Contractor's warranty for Work of Division 26, Electrical system damage caused by failures of any system component.

1.011 PRODUCTS

1.012 GENERAL

A. Where specified materials or methods conflict with applicable codes, the more stringent requirement applies.

B. Provide apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.

C. Ensure that entire electrical system operates at full capacity without objectionable noise or vibration.

D. Materials and Equipment:
    1. Use materials and equipment that are:
        a. New
        b. Quality meeting or exceeding specified standards.
        c. Free of faults and defects.
        d. Conforming to Contract Documents.
        e. Of size, make, type, and quality specified.
        f. Suitable for the installation indicated.
        g. Manufactured in accordance with NEMA, ANSI, UL, or other applicable standards.
        h. Otherwise as specified in Division 01, General Requirements.
    2. Equipment not meeting all requirements will not be acceptable, even though specified by name.

3. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer.
   a. Component parts of the entire system need not be products of same manufacturer.
4. Basis of Design:
   a. Consider the Basis of Design equipment scheduled or specified by performance or model number.
   b. If other equipment is provided in lieu of the Basis of Design equipment, assume responsibility for all changes and costs which may be necessary to accommodate this equipment, including, but not limited to:
      1) Different sizes and locations for connections.
      2) Different dimensions.
      3) Different access requirements.
      4) Other differences.

PART 2 EXECUTION

2.01 INSTALLATION

A. General:
   1. Provide a complete properly operating system for each item of equipment specified.
   2. Install materials in a neat and professional manner.
   3. Comply with equipment manufacturer's written instructions, the best industry practices, and the Contract Documents.
   4. Comply with latest published NECA Standard of Installation, and provide competent supervision.

B. Clarification:
   1. Where there is a conflict among manufacturer's instruction, best practice, and the Documents, request clarification from the Architect prior to rough-in.
   2. Architect's decision will be final.
   3. Remove and correct work installed without clarification at no cost to the Owner.

C. Existing concrete, block, or brick walls are considered not accessible and may require use of Surface Mounted Raceway (SMR) if existing concealed raceway and device boxes are not available for reuse or do not meet the intent of the design (i.e., proximity to egress path, point of use, etc.). Coordinate route and installation where SMR is required with the Architect/Engineer prior to rough-in. Responsible for reinstalling SMR routed without such prior approval to the Architect's satisfaction.

D. Existing stud walls (wood or metal) with or without blocking with plaster, plasterboard, or paneling finish are considered accessible with accessible ceiling, attic, tunnel, or crawl space above, below, or adjacent. Remove, patch, and repair finished surface as required to conceal rough in for new device locations. If it is determined that a specific instance will not permit concealment of rough-in due to obstructions such as beams, headers, and other structural elements, prior approval before rough-in from the Architect is required.

2.02 INSTALLATION IN RATED CONSTRUCTION

A. Install intumescent material around ducts, conduits, and other electrical elements penetrating rated construction.

B. Comply with firestop materials manufacturer written instructions to prevent spread of smoke or fire through sleeves or block-outs penetrating rated fire barriers.

C. Provide firestop materials specified in Division 07, and as follows:
   1. Capable of passing a 3-hour test per ASTM E-814 (UL 1479).
   2. Consisting of material capable of expanding nominally eight times when exposed to temperatures of 250 degrees F-350 degrees F.
   3. An alternate method utilizing intumescent materials in caulk or putty complying with Division 07, Thermal and Moisture Protection Section, "Through-Penetration Firestop Systems" may be used.

2.03 EXCAVATION AND BACKFILL

A. Perform all necessary excavation and backfill for the installation of electrical work in compliance with Division 31, Earthwork.

B. Direct Burial Cable or Non-Metallic Conduit:
   1. Minimum 3-inch cover of sand or clean earth fill placed around the cable or conduit on a leveled trench bottom.
   2. Lay steel conduit on a smooth level trench bottom, so that contact is made for its entire length.
   3. Where the electrical conduit is being laid, remove water from trench.

C. Place backfill in layers not exceeding 8-inches deep and compact to 95 percent of maximum density at optimum moisture to preclude settlement.
   1. Interior: Bank sand or pea gravel.
   2. Exterior: Excavated material with final 8-inches clean soil.

D. Following backfilling, grade all trenches to the level of surrounding soil. Dispose excess soil at the site as directed.

E. Provide 6-inches wide vinyl tape marked ELECTRICAL in backfill, 12-inches below finished grade, above all high voltage cable or conduit runs.

F. Coordinate patching of all asphalt or concrete surfaces disturbed by this work with General Contractor.

2.04 NOISE CONTROL

A. Minimize transmission of noise between occupied spaces.

B. Outlet Boxes:
   1. Do not install outlet boxes on opposite sides of partitions back to back.
   2. Do not use straight through outlet boxes, except where indicated.

C. Conduit:
   1. Route conduit along corridors or other “noncritical” space to minimize penetrations through sound rated walls, or through non-sound-rated partitions between occupied spaces.
   2. Grout solid and airtight all penetrations through sound rated partitions.
   3. Use flexible connections or attachments between independent wall structures.
      a. Do not rigidly connect (i.e., bridge) independent wall structures.

D. Do not install contactors, transformers, starters, and similar noise-producing devices on walls that are common to occupied spaces, unless otherwise indicated.
   1. Where such devices are indicated to be mounted on walls common to occupied spaces, use shock mounts, or otherwise isolate them to prevent the transmission of noise to the occupied spaces.

E. Ballasts, contactors, starters, transformers, and like equipment which are found to be noticeably noisier than other similar equipment on the project will be deemed defective and shall be replaced.

2.05 EQUIPMENT CONNECTIONS

A. General:
   1. Provide complete electrical connections for all items of equipment requiring such connections, including incidental wiring, materials, devices, and labor necessary for a finished working installation.
   2. Verify the location and method for connecting to each item of equipment prior to roughing-in.
   3. Check the amperage, maximum overcurrent protection, voltage, phase, and similar attributes of each item of equipment before rough in and connection.

B. Motor Connections:
   1. Make motor connections for the proper direction of rotation.

2. Minimum Size Flex for Mechanical Equipment: 1/2-inch; except at small control devices where 3/8-inch flex may be used.
3. Exposed Motor Wiring: Jacketed metallic flex with minimum 6-inches slack loop.
4. Do not test run pump motors until liquid is in the system.

C. Control devices and wiring relating to the HVAC systems are furnished and installed under Division 23, HVAC; except for provisions or items indicated in Division 26, Electrical Drawings and Specifications.

2.06 EQUIPMENT SUPPORT

A. Minimum Support Capacity:
1. Provide fastening devices and supports for electrical equipment, luminaires, panels, outlets, and cabinets capable of supporting not less than four times the ultimate weight of the object or objects fastened to or suspended from the building structure.

B. Luminaire Supports:
1. Support luminaires from the building structure.
2. Use supports that provide proper alignment and leveling of luminaires.
3. Where permitted at exposed luminaires, install flexible connections neat and straight, without excess slack, and attached to the support device.

C. Support all junction boxes, pull boxes, or other conduit terminating housings located above the suspended ceiling from the floor above, roof, or penthouse floor structure to prevent sagging or swaying.

D. Conduits:
1. Support suspended conduits 1-inch and larger from the overhead structural system with metal ring or trapeze hangers and threaded steel rod having a safety factor of four.
2. Conduits smaller than 1-inch installed in ceiling cavities, may be supported on the mechanical system supports when available space and support capacity has been coordinated with the subcontractor installing the supports.
3. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.

E. Powder actuated or similar shot-in fastening devices will not be permitted for any electrical work except by special permission from the Architect.

2.07 ACCESS DOORS

A. Location and size of access doors is Work of Division 26, Electrical.

B. Furnishing and installation of access doors is work of Division 08, Openings.

2.08 ALIGNMENT

A. Install panels, cabinets, and equipment level and plumb, parallel with structural building lines.

B. Install distribution equipment and electrical enclosures fitted neatly, without gaps, openings, or distortion.

C. Properly and neatly, close unused openings with approved devices.

D. Fit surface panels, devices, and outlets with neat, appropriate, trims, plates, or covers without overhanging edges, protruding corners, or raw edges.

2.09 CUTTING AND PATCHING

A. General:
1. Comply with Division 01, General Requirements.
2. Restore to original condition new or existing work cut or damaged by installation, testing, and removal of electrical Work.
3. Patch and finish spaces around conduits passing through floors and walls to match the adjacent construction, including painting or other finishes.
4. Clean up and remove all dirt and debris.

B. Make additional required openings by drilling or cutting. Use of jackhammer is prohibited.

C. Cut oversize fill holes so that a tight fit is obtained around the objects passing through.
   1. In rated construction, comply with Division 07, Thermal and Moisture Protection.

D. Obtain Architect's permission and direction prior to piercing beams or columns.

E. Where alterations disturb lawns, paving, walks, and other permanent site improvements, repair and refinish surfaces to condition existing prior to commencement of work.

2.010 PROTECTION OF WORK

A. Protect electrical work and equipment installed under this Division against damage by other trades, weather conditions, or any other causes.
   1. Equipment found damaged or in other than new condition will be rejected as defective.

B. Keep switchgear, transformers, panels, luminaires, and electrical equipment covered or closed to exclude dust, dirt, and splashes of plaster, cement, paint, or other construction material spray.
   1. Equipment not free of contamination is not acceptable.

C. Provide enclosures and trims in new condition, free of rust, scratches, and other finish defects.
   1. If damaged, properly refinish in a manner acceptable to the Architect.

2.011 UNINTERRUPTED SERVICE

A. Maintain electrical service to all functioning portions of the building throughout construction.

B. Pre-arrange with Owner outages necessary for new construction.
   1. Comply with Division 01, General Requirements.
   2. Apply for scheduled shutdowns minimum 4 weeks prior to time needed and reconfirm a minimum of 72 hours prior to time needed.
   3. Contractor is liable for any damages resulting from unscheduled outages or for those not confined to the pre-arranged times. Damages include costs incurred by the Owner and by the Owner's tenants.

C. Maintain signal and communication systems and equipment in operation at all times.
   1. Outages of these systems shall be treated the same as electrical power outages.

D. Maintain telephone services in accordance with Division 01, General Requirements.

2.012 DEMOLITION AND SALVAGE

A. General:
   1. Remove or relocate all electrical wiring, equipment, luminaires, etc., as may be encountered in removed or remodeled areas in the existing construction affected by this work.
   2. Disconnect electrical service to hard-wired equipment scheduled for removal under other Divisions of Work.
   3. Wiring which serves usable existing outlets restored and routed clear of the construction or demolition.
   4. Safely cut off and terminate wiring abandoned and removed to leave site clean.

B. Reuse of Existing:
   1. Existing concealed conduits in good condition may be reused for installation of new wiring where available.
   2. Existing undamaged, properly supported surface conduits may be reused where surface conduits are called for, if the installation meets all workmanship requirements of the Specifications.
   3. Where new wiring is added or existing wiring disturbed in existing branch circuit raceways, existing wires replaced with new.

C. Salvage and Disposal:
   1. Removed materials, not containing hazardous waste, not scheduled for reuse shall become the property of the Contractor for removal from the site, except for those items specifically indicated on the Demolition Drawings for salvage or reuse.
   2. Materials containing, or possibly containing, hazardous waste identified for removal and disposal by the Owner's Hazardous Waste Contractor.
   3. Neatly store salvaged items at one location at the site where directed by the Owner's Representative.
   4. Salvage properly operating circuit breakers from panels scheduled for removal and use to replace faulty or inadequate breakers in existing panels scheduled to remain.

2.013 WIRING IN PRECAST CONSTRUCTION

A. Coordinate installation of electrical conduit, boxes, fittings, anchors, and miscellaneous items concealed in precast concrete assemblies with the General Contractor.

B. Where electrical items are required to be installed in concrete assemblies precast off-site, it will be the Electrical Contractor's responsibility to place the electrical items necessary in the concrete at the off-site locations or pay for the General Contractor to make arrangements for the installation of these items in the precast assemblies. Electrical Contractor held responsible for the proper placement and locations of electrical items at the off-site location.

2.014 COMPLETION AND TESTING

A. General:
   1. Comply with Division 01, General Requirements.

B. Upon completion, test systems to show that installed equipment operates as designed and specified, free of faults and unintentional grounds.
   1. Schedule system tests so that several occur on the same day.
   2. Coordinate testing schedule with construction phasing.
   3. Conduct tests in the presence of the Architect or its representative.
   4. Notify Architect of tests 48 hours in advance.

C. Engage a journeyman electrician with required tools to conduct equipment tests. Arrange to have the equipment factory representative present for those tests where the manufacturer's warranty could be impacted by the absence of a factory representative.

D. Perform tests per the requirements of each of the following systems:
   1. Low Voltage Distribution System
   2. Lighting System
   3. Lighting Control System
   4. Power Metering and Monitoring System

E. Provide a written record of performance tests and submit with operation and maintenance data.

END OF SECTION

SECTION 26 05 19

LOW VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Conductors - 600V
   2. Power Limited Wiring
   3. Connectors - 600V and Below

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 26, Grounding and Bonding for Electrical Systems

D. Section 26 05 33, Raceways and Boxes for Electrical Systems

E. Section 26 05 53, Identification for Electrical Systems

F. REFERENCED STANDARDS

G. ASTM: American Society For Testing and Materials:
   1. ASTM B 3 Soft or Annealed Copper Wire
   2. ASTM B 8 Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
   3. ASTM B 33 Tinned Soft or Annealed Copper Wire for Electrical Purposes

H. ICEA: Insulated Cable Engineers Association:
   1. S-95-658 Non-shielded 0-2 kV Cables

I. IEEE: Institute of Electrical and Electronic Engineers:
   1. IEEE 383 Type Test of Class IE Electric Cables, Field Splices, and Connections

J. UL: Underwriters Laboratories:
   1. UL 44 Rubber-Insulated Wires and Cables
   2. UL 83 Thermoplastic-Insulated Wires and Cables
   3. UL 1277 Type TC Power and Control Tray Cable

1.03 SUBMITTALS

A. Submit product data for the following materials:
   1. Single conductor 600V power and control conductors.

B. Submittals of the following materials consist only of a listing of the manufacturer's name and the applicable catalog numbers of the items to be utilized.
   1. Connectors
   2. Branch Circuit Conductor Splices
   3. Splices with Compression Fitting and Heat-Shrinkable Insulator

C. Submit cable test data per testing requirements of PART 3.

1.04 QUALITY ASSURANCE

A. Copper Conductors. Indicated sizes considered minimum for ampacities and voltage drop requirements.

B. Conductors for special systems as recommended by the equipment manufacturer except as noted.

C. Deliver conductors to the job site in cartons, protective covers, or on reels.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conductors - 600V:
   1. General
   2. Essex
   3. Southwire
   4. Or equivalent.

B. Connectors - 600V and Below:
   1. Burndy
   2. Anderson
   3. Or equivalent.

2.02 CONDUCTORS – 600V

A. Type:
   1. Copper: 12 AWG minimum size unless noted otherwise. 12 AWG and 10 AWG, solid or stranded, 8 AWG or larger, Class B concentric or compressed stranded.
   2. Aluminum: Not allowed.

B. Insulation:
   1. THHN/THWN-2 for conductors 6 AWG and smaller.
   2. XHHW-2 for conductors 4 AWG and larger.

C. Thru wiring in fluorescent luminaires rated for 90 degree C minimum.

2.03 POWER LIMITED WIRING

A. Copper, stranded or solid as recommended by the system manufacturer.

B. Insulation appropriate for the system and location used.

2.04 CONNECTORS – 600V AND BELOW

A. Branch Circuit Conductor Splices:
   1. Live spring type, Scotchlok, Ideal Wire Nut, Buchanan B-Cap, or 3M Series 560 self-stripping type.

B. Cable Splices:
   1. Compression tool applied sleeves, Kearney, Burndy, or equivalent with 600V heat shrink insulation.
   2. Submit proposed splice location to the Engineer for review, except where indicated on the plans

C. Terminator Lugs for Stranded Wire:
   1. 10 AWG Wire and Smaller: Spade flared, tool applied.
   2. 8 AWG Wire and Larger: Compression tool applied.
   3. Setscrew type terminator lugs furnished as an integral part of distribution equipment, switches and circuit breakers will be acceptable.

PART 3 EXECUTION

3.01 CONDUCTORS

A. Pulling compounds may be used for pulling conductors. Clean residue from the conductors and raceway entrances after the pull is made.

B. Pulleys or Blocks:
   1. Use for alignment of the conductors when pulling.
   2. Pulling in accordance with manufacturer’s specifications regarding pulling tensions, bending radii of the cable, and compounds.

C. Make up and insulate wiring promptly after installation of conductors. Do not pull wire in until bushings are installed and raceways terminations are completed. Do not pull wire into conduit embedded in concrete until after the concrete poured and forms stripped.

D. Provide a dedicated neutral conductor with each branch circuit, do not use a shared neutral conductor between phases unless specifically requested or directed.

E. For remodel work or where shared neutrals are used by equipment such as systems furniture, provide a breaker handle tie as required for the phases sharing the neutral conductor.

F. CONNECTORS

G. Terminate control and special systems with a tool applied spade flared lug when terminating at a screw connection.

H. Screw and bolt type connectors made up tight and retightened after an 8 hour period.

I. Apply tool applied compression connectors per manufacturer's recommendations and physically checked for tightness.

3.02 COLOR CODING

A. Color code secondary service, feeders, and branch circuit conductors. Phase color code to be consistent at feeder terminations, A-B-C left-to-right, A-B-C top-to-bottom, or A-B-C front-to-back. Color code is as follows:

120/240V 208Y/120V	Phase	480V 480Y/277V
Black	A	Brown
Red	B	Orange
Blue	C	Yellow
White	Neutral	Gray*
Green	Ground**	Green
* or white with colored (other than green) tracer		
**Ground for isolated ground receptacles green with yellow tracer.		

B. Use solid color compound or solid color coating for 12 AWG and 10 AWG branch circuit conductors and neutral sizes.

C. Phase conductors 8 AWG and larger color code using one of the following:
   1. Solid color compound or solid color coating.
   2. Stripes, bands, or hash marks of color specified above.
   3. Colored as specified using 3/4-inch wide tape. Apply tape in half overlapping turns for a minimum of three inches for terminal points and in junction boxes, pull boxes, troughs, manholes, and handholes. Apply the last two laps of tape with no tension to prevent possible unwinding. Apply tags to cable stating size and insulation type where cable markings are tape covered.

D. Switch legs, travelers, etc., consistent with the phases to which, connected or a color distinctive from that listed.

E. Color-coding of the flexible wiring system conductors and connectors.

F. For modifications and additions to existing wiring systems, color-coding conform to the existing wiring system.

3.03 FIELD TESTING

A. 600V Rated Conductors: Test for continuity. Conductors 100A and over in meggered after installation and prior to termination. Provide the megger, rated 1,000V DC, and record and maintain the results, in tabular form, clearly identifying each conductor tested.
   1. Replace cables when test value is less than 1 megohms.
   2. Cable test submittal include results, equipment used, and date.

END OF SECTION

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SECTION 26 05 26
GOUNDING AND BONDING FOR ELECTRICAL SYSTEMS

1.01 SUMMARY

A. This Section includes:
   1. Ground Conductors
   2. Connectors
   3. Ground Pads
   4. Ground Rods

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 33, Raceways and Boxes for Electrical Systems

E. Section 26 05 80, Electrical Testing

F. Section 26 22 00, Low Voltage Transformers

G. Section 26 24 13, Switchboards

H. Section 26 24 16, Panelboards

I. Section 26 27 26, Wiring Devices

J. Section 26 29 00, Motor Controllers

1.03 QUALITY ASSURANCE

A. Provide complete ground systems as indicated. Include conduit system, transformer housings, switchboard frame and neutral bus, motors, and miscellaneous grounds required.

B. Provide 600V insulated main bonding jumper for utility company connection between ground bus in switchgear lineup and ground termination point or service ground in transformer vault as directed by the utility.

C. Provide an insulated ground conductor in every conduit or raceway containing power conductors.

D. Continue existing system as specified herein and shown on the Drawings.

PART 2 PRODUCTS

2.01 GROUND CONDUCTORS

A. Green insulated copper for use in conduits, raceways, and enclosures.

B. Bare copper for ground grids and grounding electrode systems.

2.02 CONNECTORS

A. Cast, set screw, or bolted type.

B. Form poured, exothermic welds.

C. Grounding lugs where provided as standard manufacturer’s items on equipment.

2.03 GROUND PADS

A. Provide a ground pad at each location shown on the Drawings. 1000A rated copper bus nominally 1/4-inch by 4-inch by 12-inch long or as shown on the plans.

B. Provide 1/4-inch and 1/2-inch bolt holes per ANSI TIA/EIA 607 standards for telecom ground bars.

C. Mount ground pads with standoff devices to provide a minimum of 1-1/2 inches free space behind pad for access to lug nuts and washers.

2.04 GROUND RODS

A. Copper-Bonded steel, 5/8-inch by 10-feet long ground rods. Where ground wells are indicated, provide a 12-inch deep, 8-inch diameter precast concrete well with flush lid for accessibility and inspection of welded connections, RCP Vaults 12R12A with 12R12-t cover.

PART 3 EXECUTION

3.01 INSTALLATION

A. Grounding Conductors: Sized in accordance with Article 250, Tables 250.66 and 250.122 of the National Electrical Code.

B. Grounding Conductor Connectors: Make up tight, located for future servicing, and ensure low impedance.

C. Ground the electrical system, the cold-water service, structural steel, and transformers to the building ground grid.

D. Plug-in Receptacles: Bonded to the boxes, raceways, and grounding conductor.

3.02 GROUND RING

A. Provide exterior ground ring/ground grid as indicated, with pigtails for extension as indicated. Exothermic weld connections.

3.03 UFER GROUND

A. Provide a concrete encased building grounding electrode where shown on the Drawings. Grounding electrode consist of a minimum of 20-feet of AWG 4 bare copper conductor cast into the bottom 6-inches of an exterior concrete foundation or footing.

3.04 EQUIPMENT

A. Provide separate green insulated equipment ground conductor in non-metallic and flexible electrical raceways.

B. Ground luminaires, panels, controls, motors, disconnect switches, exterior lighting standards, and noncurrent carrying metallic enclosures. Use bonding jumpers, grounding bushings, lugs, buses, etc., for this purpose.

C. Provide grounding bushings on feeder conduit entrances to panels and equipment enclosures and bond bushings to enclosures with minimum 10 AWG conductor. Connect the equipment ground to the building system ground. Use the same size equipment ground conductors as phase conductors, up through 10 AWG.

3.05 GROUND PADS

A. Drill ground pads as necessary for attachment of grounding conductors as required.

B. Utilize 2-hole lugs for terminating 4/0 AWG and larger ground conductors.

C. Bond ground pads to adjacent structural steel with 4/0 bare copper cable, using form poured exothermic welds.

3.06 GROUND RESISTANCE TEST

A. Accomplish with a ground resistance direct-reading single test meter utilizing the Fall-of-Potential method and two reference electrodes. Perform test prior to interconnection to other grounding systems. Orient the concrete-encased ground electrode to be tested and the two reference electrodes in straight-line spaced 50-feet apart. Drive the two reference electrodes 5-feet deep.

B. Provide test results writing.
   1. Show temperature, humidity, and condition of the soil at the time of the tests.
   2. Where the ground resistance exceeds 5 Ohms, the Engineer will issue additional instructions.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Hangers
   2. Pipe Straps
   3. Support of Open Cabling

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 33, Raceways and Boxes for Electrical Systems

D. Section 26 22 00, Low Voltage Transformers

E. Section 26 24 13, Switchboards

F. Section 26 24 16, Panelboards

G. Section 26 50 00, Lighting

1.03 REFERENCED STANDARDS

A. International Building Code (IBC)

B. Sheet Metal and Air Conditioning Contractors' National Association (SMACNA)

PART 2 PRODUCTS

2.01 HANGERS

A. Kindorf B-905-2A Channel, H-119-D washer, C105 strap, minimum 1/2-inch rod with ceiling flange, or equal.

2.02 PIPE STRAPS

A. Two-hole galvanized or malleable iron.

2.03 SUPPORT OF OPEN CABLING

A. Support of Open Cabling: Label NRTL for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide electrical equipment supports.

B. Install vertical support members for equipment, straight and parallel to building walls.

C. Provide independent supports to structural member for electrical fixtures, materials, or equipment installed in or on ceiling, walls, or in void spaces and/or over furred or suspended ceilings.

D. Do not use other trades' fastening devices to support electrical equipment materials or fixtures.

E. Do not use supports and/or fastening devices to support other than one particular item.

F. Support conduits within 18-inches of outlets, boxes, panels, cabinets, and deflections.

G. Provide complete seismic anchorage and bracing for the vertical and lateral restraint of conduit, cable trays, bus ducts, and electrical equipment as required by IBC Chapter 6 and the most recent version of the SMACNA Seismic Restraint Manual for Seismic Hazard Level (SHL) A. Submit shop drawings of bracing systems to the Architect for review and bear the seal of a professional engineer registered in the State of Oregon.

3.02 LUMINAIRES

A. Light-Duty Ceiling Systems:
   1. Attach 12 gauge hanger wire from each corner of the luminaire to the structure above.
   2. Positively and securely, attach luminaire within 6-inches of each corner to the suspended ceiling-framing member by mechanical means.

B. Intermediate-Duty Ceiling Systems:
   1. Positively and securely, attach luminaire within 6-inches of each corner to the suspended ceiling-framing member by mechanical means.
   2. Attach 12 gauge hanger wire within 3-inches of each corner of each luminaire.
   3. Connect two 12 gauge slack wires from the luminaire housing to the structure above for luminaires weighing less than 56 pounds.
   4. Support luminaries weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.

C. Heavy-Duty Ceiling Systems:
   1. Positively and securely, attach luminaire within 6 inches of each corner to the suspended ceiling-framing member by mechanical means.
   2. Connect two 12-gauge slack wires from the luminaire housing to the structure above for luminaires weighing less than 56 pounds.
   3. Support luminaries weighing 56 pounds or more directly from the structure above with approved hangers attached to each corner of the luminaire.

3.03 PULL AND JUNCTION BOXES

A. Pull and junction boxes installed within the cavity of a suspended ceiling that is not a fire rated assembly may be attached to the suspended ceiling framing members, provided the following criteria are met:
   1. Installation complies with the ceiling system manufacturer's instructions.
   2. Pull or junction box is not larger than 100 cubic inches.
   3. Support to the main runner with two fastening devices designed for framing member application and positively attach or lock to the member.
   4. Serves branch circuits and associated equipment in the area.
   5. Pull or junction box is within 6-feet of the luminaires supplied.
   6. Framing members are not rotated more than 2 degrees after installation.
   7. Install within the cavity of a suspended ceiling may be attached to independent support wires, provided the following criteria are met:
      a. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
      b. No larger than 100 cubic inches.
      c. Secure to the independent support wires by two fastening devices designed for the application.
      d. Independent support wires in a fire-rated ceiling are distinguishable by color, tagging, or other effective means.

3.04 CABLES AND RACEWAY

A. Cables and raceway installed within the cavity of a suspended ceiling may be attached to independent support wires provided the following criteria are met:
   1. Independent support wires are taut and connected at both ends, one end to the ceiling framing member and the other to the structure above.
   2. Raceways no larger than 1-inch trade size and cables and bundled cables are not larger than 1-inch diameter including insulation.

3. Not more than three raceways or cables supported by independent support wire and supported within the top or bottom 12-inches.
4. Cables for telecommunications, data processing, Class 2 power-limited signaling systems, fiber optics, and other power limited systems are securely fastened within 2 feet of each termination and at intervals not to exceed 5-feet or per the manufacturer's installation instructions.
5. Secure raceways at intervals required for the type of raceway installed.
6. Secure cables and raceway to independent support wires by fastening devices and clips designed for the purpose.
7. Independent support wires are distinguishable by color, tagging, or other effective means.

B. Cables and raceway installed within the cavity of a suspended ceiling may be supported with trapezes constructed of steel rods and channels provided the following criteria are met:
1. The size of the rods, channel, and fastening devices are suitable for the anticipated weight.
2. The spacing of the trapezes meets that required for the type of raceway installed.
3. Secure to a trapeze by straps designed for the purpose.
4. Cables and raceway do not support other raceway or cables.
5. An appropriately sized seismic bracing system is installed.

END OF SECTION

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SECTION 26 05 33
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Metallic Conduits
   2. Non-Metallic Conduits
   3. Wireways
   4. Fittings
   5. Metallic Boxes
   6. Non-Metallic Boxes

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 29, Hangers and Supports for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

PART 2 PRODUCTS

2.01 GENERAL

A. Raceways and conduits of specified types for electrical system wiring, except where clearly indicated otherwise.

B. Fittings, boxes, hangers, and appurtenances required for the conduits and raceways.

C. Size raceways and conduits as indicated. Where no size indicated, conduit may be the minimum code permitted size for the quantity of conductors installed, based upon NEC tables for conductors with type THW insulation.

2.02 METALLIC CONDUITS

A. Rigid Metal Conduit (RMC):
   1. Smooth surfaced heavy wall mild steel tube of uniform thickness and temper, reamed and threaded at each end and protected inside and out with galvanizing, sherardizing, or equivalent process.
   2. Comply with NEC Article 344.

B. Intermediate Metallic Conduit (IMC):
   1. Smooth surface, intermediate wall mild steel tube of uniform thickness and temper, reamed and threaded at each end, and protected inside and out with galvanizing, sherardizing, or equivalent process.
   2. Comply with NEC Article 342.

C. Electrical Metallic Tubing (EMT):
   1. Smooth surface, thin wall mild steel tube of uniform thickness and temper, galvanized or sherardized on the outside, and enameled on the interior.
   2. Comply with NEC Article 358.

D. Flexible Conduits (Flex):
   1. Flexible Metallic Conduit:
      a. Interlocking single strip steel construction, galvanized inside and out after fabrication.
      b. Comply with NEC Article 348.

2. Liquid Tight:
   a. Similar to flexible metallic conduit, except encased in a liquid tight polyvinylchloride or equivalent outer jacket over the flexible steel core.
   b. Comply with NEC Article 350.

2.03 NON-METALLIC CONDUITS

A. Rigid Non-Metallic Conduit:
   1. Type II PVC Schedule 40 or 80, suitable for use with 90 degree C rated wire.
   2. Conform to UL Standard 65l and carry appropriate UL listing for above and below ground use.

2.04 WIREWAYS

A. Troughs: Steel, painted, square in cross section, preformed knockouts on standard spacing, screw cover.

B. Fittings: Tees, elbows, couplings as required for configuration shown on the Drawings.

2.05 FITTINGS

A. RMC and IMC:
   1. Threaded Locknuts: Sealing type where used with NEMA 2, 3, 3R, 4, and 12 enclosures.
   2. Threaded Bushings: 1-1/4-inch and larger, insulated, grounding type as required under Section 26 05 26, Grounding and Bonding for Electrical Systems.
   3. Threaded Couplings:
      a. Standard threaded of the same material and as furnished with conduit supplied.
      b. Erickson type couplings may be used where required to complete conduit runs larger than 1-inch.

B. EMT:
   1. Connectors:
      a. Steel compression ring or steel set screw type for conduit termination, with insulated throat, suitable for conditions used.
      b. Use lay-in grounding type bushings where terminating grounding conductors.
   2. Couplings: Steel compression ring or steel set screw type, concrete tight.

C. Threadless: RMC and IMC couplings and box connectors may be steel threadless, compression ring or set screw type for use with conduits 1-inch and smaller where installed in poured concrete locations or where limited working space makes threaded fittings impractical.

D. Weatherproof Connectors: Threaded

E. Expansion Couplings: Equivalent to O.Z. type EX with jumper.

F. Seal-Offs: With filler fiber, compound, and removable cover.

2.06 METALLIC BOXES

A. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears for device ring mounting, knock-out plugs, mounting holes, fixture studs if required, RACO or equivalent.

B. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings; cast steel or aluminum with threaded hubs or bosses for use on walls.

C. Large Boxes:
   1. Boxes exceeding 4-11/16-inches when required welded steel construction with screw cover and painted, steel gauge as required by physical size,
   2. Manufacturers:
      a. Hoffman
      b. Circle AW
      c. Or equivalent.

D. Systems:
   1. Boxes for systems devices as recommended by the systems manufacturer, suitable for the equipment installed.
   2. Equip with grounding lugs, brackets, device rings, etc., as required.

2.07 NON-METALLIC BOXES

A. PVC, molded enclosures, threaded hubs.

PART 3 EXECUTION

3.01 INSTALLATION

A. Conceal conduits in finished spaces. Concealed conduits run in a direct line with long sweep bends and offsets. Where RMC and IMC embedded is in concrete below grade or in damp locations make watertight by painting the entire male thread with Rustoleum metal primer or equivalent before assembly.

B. Route exposed conduit parallel or at right angles to structural building lines and neatly offset into boxes. Conduits attached directly to building surfaces closely follow the surfaces. Conduit fittings used to saddle under beams. Drilling or notching of existing beams, trusses on structural members coordinated with Architect prior to commencing.

C. Rigidly secure RMC and IMC terminations at boxes, cabinets, and general wiring enclosures with double locknuts and bushings or approved fittings. Screw in conduit and engage at least five threads in hub where conduit boxes with threaded hubs or bosses are used. Use insulating bushings for conduits 1-1/4-inches or larger.

D. Keep conduit and raceways closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete, or foreign objects. Clean and dry raceways before installation of wire and at the time of acceptance.

E. Pack spaces around conduits with polyethylene backing rods and seal with polyurethane caulking to prevent entrance of moisture where conduits are installed in sleeves or block-outs penetrating moisture barriers.

3.02 CONDUIT

A. RMC:
   1. Use in areas for wiring systems.
   2. Install for exposed runs of medium voltage circuits outside of the electrical rooms.
   3. Install where subject to mechanical injury.
   4. Install with threaded fittings made up tight.

B. IMC:
   1. Use for medium voltage circuits where concealed or where exposed in the electrical rooms.
   2. Use for circuits rated 600V and less where not in contact with earth or fill.
   3. Install with threaded fittings made up tight.

C. EMT:
   1. Use in other dry protected locations for circuits rated 600V and less.
   2. Securely support and fasten whether exposed or concealed at intervals of nominally every 8-feet and within 24-inches of each outlet, ell, fitting, panel, etc.

D. Flex:
   1. Use for connections to vibration producing equipment and where installation flexibility is required with a minimum 12-inches slack connection.
   2. Limit flex length to 36-inches for exposed equipment connections and 72-inches in concealed ceiling and wall cavities.
   3. Use PVC jacketed flex in wet locations, areas subject to washdown, and exterior locations.

E. PVC:
1. Type II Schedule 40 and 80 PVC may be used underground and in and under interior slabs, poured concrete walls, and where scheduled or noted on the Drawings.
2. Make connections with waterproof solvent cement.
3. Provide RMC at 60 degree and larger bends and where penetrating slabs.

3.03 RACEWAYS

A. Surface metal wireways may be installed at locations to serve motor starters or other control devices where required by a multitude of wiring interconnections or physical layout.

3.04 FITTINGS

A. Assemble continuous and secured metallic raceways and conduits to boxes, panels, etc., with appropriate fittings to maintain electrical continuity. Cut square and reamed smooth conduit joints with fittings drawn up tight.

B. Do not use Crimp-on, tap-on, indenter type, malleable iron, or cast set screw fittings.

3.05 BOXES

A. General:
1. Outlet Boxes: Code required size to accommodate wires, fittings, and devices.
2. Provide multi-gang boxes as required to accept devices installed with no more than one device per gang.
3. Equip metallic boxes with grounding provisions.

B. Size and Type:
1. Flush wall switch and receptacle outlets used with conduit systems 4-inches square, 1-1/2-inches or deeper, with one or two-gang plaster ring, mounted vertically. Where three or more devices are at one location, use one piece multiple gang tile box or gang box with suitable device ring.
2. Wall bracket and ceiling surface mounted luminaire outlets 4-inch octagon 1-1/2-inches deep with 3/8-inch fixture stud where required. Wall bracket outlets have single gang opening where required to accommodate luminaire canopy. Provide larger boxes or extension rings where quantity of wires installed requires more cubic capacity.
3. Junction boxes installed in accessible ceiling or wall cavities or exposed in utility areas minimum of 4-inches square, 1-1/2 inches deep with appropriately marked blank cover.
4. Boxes for the special systems suitable for the equipment installed. Coordinate size and type with the system supplier.

C. Pull Boxes:
1. Provide pull boxes where shown for installation of cable supports or where required to limit the number of bends in conduits to not more than three 90-degree bends.
2. Use galvanized boxes of code-required size with removable covers installed so that covers will be accessible after work is completed.

D. Installation:
1. Mount boxes and outlets at nominal centerline heights shown on the drawings.
2. Adjust heights in concrete masonry unit (CMU) walls to prevent devices or finish plates from spanning masonry joints.
3. Recessed Boxes:
   a. Flush with finished surfaces or not more than 1/8-inch back, level and plumb.
   b. Long screws with spacers or shims for mounting devices will not be acceptable.
   c. No combustible material exposed to wiring at outlets.
4. Covers for flush mounted boxes in finished spaces extend a minimum of 1/4-inch beyond the box edge to provide a finished appearance. Finish edge of cover to match cover face.
5. Boxes installed attached to a stud in sheet rock walls equipped with opposite side box supports equivalent to Caddy 760. Install drywall screw prior to finish taping. Methods used to attach boxes to studs not to cause projections on the face of the stud to prevent full-length contact of sheet rock to the stud face.

3.06 PULL WIRES

A. Install nylon pull lines in empty conduits larger than 1-inch where routing includes 25-feet or more in length or includes 180 degrees or more in bends.

B. Where conduits requiring pull lines are stubbed out and capped, coil a minimum of 36-inches of pull line and tape at termination of conduit for easy future access. Label pull lines as to conduit starting or terminations point and intended future use.

END OF SECTION

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SECTION 26 05 40

SURFACE METALLIC RACEWAY FOR ELECTRICAL SYSTEM

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Raceways

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 53, Identification for Electrical Systems

F. Section 26 27 26, Wiring Devices

1.03 SUBMITTALS

A. Shop Drawing Submittals:
   1. Submit Shop Drawings of the complete system.
   2. Include sizes and lengths of raceways as verified with laboratory furniture Shop Drawings, end caps, raceway cover spacing's, grounding, branch circuiting and wiring including locations of service entrances, receptacle types and manufacturers, receptacle spacing, receptacle labeling with proper voltage, phase, circuit and panelboard designations as indicated on the drawings.
   3. Accompany at the same time of the submittal, by floor plans showing raceway locations, with each piece numbered the same as the corresponding number of the raceway piece number in the submittal.

PART 2 PRODUCTS

2.01 GENERAL

A. Provide a complete surface metallic raceway system for standard receptacles to include receptacles, devices, supports, fittings, and accessories necessary to complete the installations indicated.

B. In the event the Contractor chooses to furnish and install a system or item of equipment of different arrangement from the system herein specified, provide additional labor and material required by the system at no additional cost to the Owner, and obtain prior approval.

C. Tests and operational check determine the suitability for energization.

D. Schedule tests and give a minimum of one week's advance notice of time and date to the Architect and Owner for any major systems tests specified in this Section.

2.02 RACEWAYS

A. Factory pre-assembled complete including bases, covers, end plates, wiring, receptacles, fittings and connections, to exact lengths to match the lengths of the cabinets and shelving as indicated on laboratory furniture Shop Drawings since the lengths shown on electrical drawings are illustrative and diagrammatic only and are not accurate, also see island bench details on the drawings.

B. Receptacle circuits to be prewired for the entire length of the section, leaving 2-foot pigtail for field connection and properly tagged for circuit identification in field.

C. Tap splicing of wires done using Scotchlok 562 self-stripping electrical tap connectors, or equivalent.

D. Raceway base, cover and end plates to be constructed of extruded aluminum 6063-T5, 0.060 inch minimum wall thickness. Finish to be clear anodized AA-C22A31 Architectural Class II.

E. Blank snap-in raceway covers to be precut to 12-inch sections. Each cover plate able to withstand 45 pound cord pull pressure. Regardless, raceway covers stay on when pulling off any receptacle plug. Support receptacles in the raceway from the raceway covers by countersunk screws, and independent of the raceway bases or main body. Covers to be provided with receptacles mounted and identified by means of engraved 3/16 inch black letters indicating receptacle voltage, phase, and amperage for receptacles other than the regular 20A, 120V receptacles (i.e., 208V, 1-phase, 30A) at top of receptacle. Receptacles have panel and circuit designation (i.e., LPA22) at bottom of receptacle. Dedicated 20A, 120V receptacles labeled DEDICATED at top of receptacles.

F. Where raceways are shown connected at right angles to each other, the end plate of the raceway overlapping the faceplate of the other raceway regressed flush with the ends of the raceway base/body.

G. Raceway (where indicated on the drawings) shall be a minimum 6 inches high by 2-1/2 inches deep Series ALA4800 as manufactured by The Wiremold Company ISOduct Prewired Raceway Systems, Post Glover/Halsey Versa-Duct Series 255 with devices mounted to cover plate with countersunk screws. Provide with a barrier to divide the raceway interior into 2 equal sections. Each sections has its own cover. Where raceways are shown on the Drawings with telecom outlets, verify outlet openings configuration at raceway covers in the telecom compartment with the telecom Section of the specifications. Do the same for knockout cutout configuration for future punch-out where no outlets are shown at the raceways on the Drawings (provide one knockout for each raceway length).

PART 3 EXECUTION

3.01 GENERAL

A. Raceway Type A to receive receptacles of type, quantity, and spacing as indicated on Plans.

B. Raceways to be mounted on walls and casework parallel to or at right angles to structure and casework.

C. The number of conductors installed in any raceway not greater than the number for which the raceway is approved.

D. Ground continuity maintained throughout the entire raceway length by means of factory installed separate insulated Code-size grounding conductors. Each equipment grounding conductor in a conduit homerun entering the raceway connected to the ground terminals of the receptacles and to the ground stud in the raceway interior. Bonded receptacle cover plates.

E. Each 20A, 120V circuit of an individual or multi-circuit wiring in a raceway provided with individual 12 AWG neutral conductor for each circuit.

F. In multi-wire branch circuits, the continuity of a grounded conductor (neutral) not dependent upon device connections, such as receptacles, etc., where the removal of such devices would interrupt the continuity.

G. At least 6-inches of free conductors left at each outlet, junction and switch point for splices or the connection of fixtures or devices.

END OF SECTION

SECTION 26 05 45

SEISMIC RESTRAINTS FOR ELECTRICAL RACEWAYS AND EQUIPMENT

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Seismic Bracing
   2. Channel Type Elements
   3. Bolting Accessories

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 29, Hangers and Supports for Electrical Systems

1.03 REFERENCED STANDARDS

A. The following are the referenced standards:

1.	SMACNA	Sheet Metal and Air Conditioning Contractor's National Association
2.	AISC	American Institute of Steel Construction
3.	ASTM	American Society for Testing and Materials
4.	AWS	American Welding Society
5.	IBC	International Building Code
6.	ICC	International Code Council
7.	OSHPD	Office of Statewide Health Planning and Development

1.04 QUALITY ASSURANCE

A. General Requirements:
   1. Provide seismic restraints for equipment, both supported and suspended, conduits, and cable tray systems.
   2. Bracing of conduits and cable trays in accordance with the provisions set forth in the SMACNA seismic restraint manual.
   3. Review and approve structural requirements for restraints, including their attachment to the building structure by a registered structural engineer in the same state as the project.
   4. Attachments to supported or suspended equipment must be coordinated with the equipment manufacturer.

B. Bracing of Conduits:
   1. Provide seismic bracing of conduit as detailed below:
   2. Exception: Conduits suspended by individual hangers 12-inches or less in length, as measured from the top of the conduit to the bottom of the support where the hanger is attached, need not be braced.
      a. Brace electrical conduits 2-1/2 inch nominal diameter or larger.
      b. Brace conduits located in electrical rooms, boiler rooms, mechanical equipment rooms, and refrigeration mechanical rooms that are 1-1/4-inch nominal diameter and larger.

C. Suspended Equipment and Raceways:
   1. Cable Method: The seismic restraint shall consist of a combination of stranded steel aircraft cable with an added nut and neoprene and steel washer.
   2. Cable attachment details, cable size, and the neoprene and steel washers shall be sized by the manufacturer and are to be indicated in the shop drawings.
   3. Provide detailed shop drawings for approval in sufficient time to allow structural attachment work to be incorporated into the normal work sequence.

D. Seismic restraints, including anchors to building structure, designed by a registered professional structural engineer licensed in the state of Oregon. Design includes:
   1. Number, size, capacity, and location of anchors for floor- or roof-mounted equipment. For curb-mounted equipment, provide design of attachment of both the unit to the curb and the curb to the structure. For units weighing greater than 2500 pounds, or curbs more than 10 feet long, provide substantiating calculations the curb can accept the prescribed seismic forces.
   2. Number, size, capacity, and location of seismic restraint devices and anchors for vibration-isolation and suspended equipment. Provide calculations, test data, or California OSHPD approval number verifying the horizontal and vertical ratings of the seismic restraint devices.
   3. Number, size, capacity, and location of braces and anchors for suspended raceways, bus ducts, and cable trays on as-built plan drawings.
      a. Select a single seismic restraint system pre-designed to meet the requirements of the latest edition of the IBC such as the 1999 Mason Industries Seismic Restraint Guidelines for Suspended Piping, Ductwork, and Electrical Systems.
      b. Details or designs from separate seismic restraint guidelines are not acceptable. Installation not addressed by the selected system shall be designed, detailed, and submitted alone with the as-built plan drawings.
      c. Maximum seismic loads shall be indicated on drawings at each brace location. Drawings shall bear the stamp and signature of the registered professional structural engineer licensed in the state of Oregon who designed the layout of the braces.

E. Supports, Hangers, and Anchors: Comply with the requirements of Section 26 05 29, Hangers and Supports for Electrical Systems, except anchor (expansion) bolts used for connection Level 3 have expansion anchor capacities equal to 50 percent of the ICC research report values.

1.05 SUBMITTALS

A. Product Data: Submit product data for products specified herein.

B. Shop Drawings:
   1. Submit shop drawings complying with the requirements of the Quality Assurance article of this Section.
   2. Stamp shop drawings by a professional structural engineer licensed in the state of Oregon.
   3. Approve submittals prior to rack fabrication and installation.

C. Calculations:
   1. Submit seismic calculations indicating restraint loadings resulting from the design seismic forces presented in the Quality Assurance article of this Section.
   2. Include proper anchorage details and when applicable and include consideration of the types of concrete.
   3. Certify by a professional structural engineer licensed in the state of Oregon.

D. Certifications:
   1. Submit certification of seismic restraint's and building structural member's capability to safely accept loads resulting from seismic forces calculated in the previous paragraph.
   2. Tests in three planes clearly showing ultimate strength and appropriate safety factors performed by independent laboratories and certified by a professional structural engineer licensed in the state of Oregon or calculations by a professional structural engineer licensed in the state of Oregon are acceptable.

PART 2 PRODUCTS

2.01 SEISMIC BRACING:

A. Steel fabrication, in accordance with AISC M011 Manual, with structural steel shapes of ASTM A 36 steel.

B. Welding in accordance with AWS D1.1.

C. Design and sizes as required.

D. Fastenings, bracing, and assembly selected by a professional structural engineer licensed in the state of Oregon.

E. Show that the maximum stress in any structural steel member will not exceed 18,000 psi.

2.02 CHANNEL TYPE ELEMENTS

A. 12 gauge formed steel, 1-5/8-inch square prime painted or chromate dip finish. Use spring-in nuts with grooves.

2.03 BOLTING ACCESSORIES

A. Machine bolts with semi-finished nuts.

PART 3 EXECUTION

3.01 INSTALLATION

A. Provide support assemblies to meet the seismic zone indicated. Equipment shall be braced and anchored to conform to the requirements listed under the Quality Assurance article of this Section.

B. Seismically brace raceways, cable trays, and suspended bus duct to conform to the requirements listed under the Quality Assurance article of this Section.

C. Provide pipeline seismic flexible connectors where piping crosses building earthquake joints. Arrange raceways and connectors for the amount of motion required. Maintain continuity of the grounding system for each of the joints.

D. Do not use powder-actuated inserts.

E. Seismic Restraints:
   1. Attach to structural members of the building, which are capable of withstanding the design load of the seismic restraint.
   2. Ensure load capacity of the structural members is greater than or equal to the capacity of the seismic restraint.

END OF SECTION

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SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 PGENERAL

1.01 SUMMARY

A. This Section includes:
   1. Labels

1.02 RELATED SECTIONS

A. Division 01, General Requirements
B. Division 26, Electrical
C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables
D. Section 26 05 33, Raceways and Boxes for Electrical Systems
E. Section 26 09 43, Network Lighting Controls
F. Section 26 22 00, Low Voltage Transformers
G. Section 26 24 13, Switchboards
H. Section 26 24 16, Panelboards
I. Section 26 27 26, Wiring Devices
J. Section 26 29 00, Motor Controllers
K. Section 26 50 00, Lighting
L. Section 28 30 00, Fire Detection and Alarm

PART 2 PRODUCTS

2.01 LABELS

A. Pre-printed:
   1. Permanent material pre-printed with black on white, with adhesive backing.
   2. Manufacturer:
      a. Brady
      b. 3M
      c. Or equal.

B. Engraved Laminated Plastic:
   1. 3-ply laminated plastic, colors indicated herein, with beveled edges, engraved letters, and stainless steel screw attachment.
   2. Nameplate length to suit engraving.
   3. Adhesive attachment is not acceptable.

C. Clear Plastic Tape:
   1. Black (normal) or red (emergency or standby) 12 point Helvetica medium text, clear adhesive backing, field printed with proper equipment for device labeling.
   2. Manufacturers:
      a. Brother P-Touch
      b. Dyno-tape
      c. Kroy
      d. Or equal.

D. Wire Markers:
   1. White with black numbers, adhesive-backed tape on dispenser roll.
   2. Manufacturers:
      a. Brady
      b. 3M
      c. Or equal.

E. Feeder Conduit Marking:
   1. Provide one-piece snap-around vinyl feeder conduit markers for feeder conduits.
   2. Provide custom label, black letters on orange background indicating destination equipment, 1-1/4-inch high letters (minimum) – Seton Setmark Pipe Marker Series.
   3. Provide additional one-piece snap-around vinyl label, black letters on orange background for voltage designation (i.e., 277/480V, 120/208V).
   4. Secure labels to conduits using plastic tie wrap, two per label.

F. Marker Pen: Black permanent marker suitable for writing on metallic surfaces.

PART 3 EXECUTION

3.01 GENERAL

A. Nameplate and text coloring:
   1. Normal Black nameplate with white lettering.
   2. SWITCHGEAR, switchboards, distribution panels, motor control centers

B. Provide engraved laminated plastic nameplates for main and feeder protective devices indicating the function or the load served (e.g., ELEV-5, PANEL 4HA, AHU-5, or SPARE) and the protective device trip rating (i.e., 175A). Text height: 3/8-inch.

C. Provide engraved laminated plastic nameplate for bussed spaces indicating the maximum ampere rating of future breaker, switch, or starter that may be installed (e.g., SPACE (225A)). Text height: 3/8-inch.

D. Provide engraved laminated plastic nameplate on the face of equipment enclosure as follows:
   1. Line 1: Equipment identification (e.g., MDP, SDP, or MCC 4H). Text height: 3/4-inch.
   2. Line 2: Equipment voltage, phase and wire quantity (e.g., 480Y/277V, 3-Phase, 4W). Text height: 1/2-inch.

E. Provide additional engraved laminated plastic nameplate to indicate upstream source and location of upstream source as follows:
   1. Line 1: Upstream source equipment (e.g., FED FROM MDP). Text height: 3/8-inch.
   2. Line 2: Location of upstream source (e.g., MAIN ELEC ROOM 102). Text height: 3/8-inch.
   3. Confirm final room designations with Architect and Owner prior to procurement of nameplates.

3.02 DISTRIBUTION TRANSFORMERS

A. Provide engraved laminated plastic nameplate on the face of the equipment enclosure as follows:
   1. Line 1: Equipment identification (e.g., T-N2P). Text height: 3/4-inch.
   2. Line 2: Equipment kVA rating, primary and secondary voltages (e.g., 150kVA, PRI: 480V, SEC: 208Y/120V). Text height: 1/2-inch.

B. Provide additional engraved laminated plastic nameplate to indicate upstream source and location of upstream source as follows:
   1. Line 1: Upstream source equipment (e.g., FED FROM MDP). Text height: 3/8-inch.
   2. Line 2: Location of upstream source (e.g., MAIN ELEC ROOM 102). Text height: 3/8-inch
   3. Confirm final room designations with Architect and Owner prior to procurement of nameplates.

3.03 BRANCH CIRCUIT PANELBOARDS

A. Provide engraved laminated plastic nameplate on the face of each panelboard centered above the door as follows:
   1. Line 1:
      a. Equipment identification (e.g., PANEL 4HA).
      b. Text height: 1/2-inch.

2. Line 2:
   a. Equipment voltage, phase, and wire quantity (e.g., 480Y/277V, 3PH, 4W).
   b. Text height: 3/8-inch.

B. Indicate feeder source, feeder wire size, and feeder breaker or fuse size with plastic tape labels on the inside of the panel door.

C. Provide typewritten panel directories, with protective, clear transparent covers, accurately accounting for every breaker installed including spares.
   1. Schedules use the actual room designations assigned by name or number near completion of the work and not the space designation on the Drawings. Confirm final room designations with Architect and Owner prior to completion of work.
   2. Each load description includes a room or area designation whether indicated on the Drawings or not.

3.04 EQUIPMENT

A. Provide engraved laminated plastic nameplate on the face of disconnect switches, motor starters, relays, contactors, and etc., indicating equipment served (e.g., AHU-1) and equipment load (e.g., 20 hp). Provide additional engraved laminated plastic nameplate indicating serving panel designation and circuit number.

B. Provide clear plastic tape label for relays, contactors, time switches, and miscellaneous equipment provided under this Division of work indicating equipment served.

3.05 FEEDER CONDUIT

A. Provide feeder conduit marker for electrical feeders.

B. Provide markers when exiting source equipment and located along the entire conduit length 20-feet on centers in exposed areas, above ceilings, and upon entering or leaving an area or room.

3.06 DEVICES

A. Label each receptacle plate with preprinted clear plastic tape indicating serving panel and circuit number (e.g., PANEL 2PA-5). Clean oils, dirt, and foreign materials from plate prior to label application. Label receptacles connected to a GFCI protected circuit downstream from the protecting device.

3.07 RACEWAYS AND BOXES

A. Label pull boxes and junction boxes for systems with paint or marker pen on box cover identifying system. Where box covers are exposed in finished areas, label inside of cover.

B. Color label covers as follows:

1.	480Y/277V wiring	Orange
2.	208Y/120V wiring	Black
3.	Fire Alarm	Red
4.	Communications	Green
5.	Security	Blue

C. Label each end of pull wires left in empty conduits with tags or tape indicating location of other end of wire.

3.08 SYSTEMS

A. Complex control circuits may utilize combination of colors with each conductor identified throughout using wraparound numbers or letters. Use the number or letters shown where the Drawings or operation and maintenance data indicate wiring identification.

B. Label the fire alarm and communication equipment zones, controls, indicators, etc., with machine-printed labels or indicators appropriate for the equipment installed as supplied or recommended by the equipment manufacturer.

3.09 EXISTING EQUIPMENT

A. Provide new nameplates and labels for existing distribution equipment in accordance with panel descriptions shown on the Drawings. Provide new labels for feeder devices where labels are non-existent, incorrect, or confusing on existing distribution panels affected by this work.

B. Equip existing branch circuit panelboards scheduled to remain with new, accurate, typed, circuit directories where circuiting changes are made.

END OF SECTION

SECTION 26 09 13

ELECTRICAL POWER MONITORING AND CONTROL

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Microprocessor-Based Metering Equipment
   2. System Architecture
   3. Metering and Monitoring Functions

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 33, Raceways and Boxes for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

G. Section 26 24 13, Switchboards

H. Section 26 24 16, Panelboards

1.03 REFERENCES

A. Microprocessor metering equipment UL listed, CSA certified and meet IEEE Standard C37.90.1 for surge protection.

1.04 SUBMITTALS

A. Product data:
   1. Microprocessor metering equipment product literature with description of operational capability to perform specified metering functions and software analysis features, and communication protocol.
   2. Published operators' manuals for the microprocessor metering equipment.

B. Operation and Maintenance Manuals:
   1. Final set up and operators' manuals.
   2. Instruction books and/or leaflets.
   3. Recommended renewal parts list.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Cutler-Hammer

B. General Electric

C. Square D Company

D. Siemens

E. Or approved equivalent.

2.02 MICROPROCESSOR-BASED METERING EQUIPMENT

A. General:

1. Provide a complete system consisting of instrument transformers, metering instruments, trip units with metering functions; communications between components; communications with the building computer network; computers; operator interfaces at the switchgear; operator interfaces via networked computers; and other appurtenances as required for a complete system.
   a. Overall system communications TCP/IP over a dedicated Ethernet LAN. The system support a LAN comprised of either Category 5 cable at 10baseT or fiber optics at 100baseFX or a mix thereof.
   b. The system may also utilize Modbus/TCP for communication with field devices over an RS-485 communications link at speeds up to 38.4k baud.
   c. Connection to the building Ethernet network made at a single Ethernet gateway.
2. Configure system wiring so metering instrument can be isolated and removed from the system without the need to deenergize power or protective circuit. This requirement may be met in one of two ways:
   a. Connections to the metering instrument may be made using separable terminal blocks. The terminal blocks for CT circuits short the CT circuit prior to breaking the metering instrument circuit on removal and make the metering instrument circuit prior to unshorting the CT circuit on insertion. CT and PT or line voltage terminals finger safe when left disconnected and energized.
   b. Connections to the metering instrument may be made through test blocks with disconnecting switches for line and neutral voltage circuits and shorting switches for CT circuits.
3. Terminate system wiring on spade or ring terminals, except that only ring terminals utilized on CT circuits. System wiring within switchgear of switchboard assembly type SIS.
4. Alarm and waveform capture set points may be created by the system operator based on the parameters defined below being greater than or less than value selected by the system operator.
5. Display, whether at the local display of a metering instrument or through software, auto range between units, kilo units or Mega units such that the absolute values less than 1,000 read as units, absolute values less than 1,000,000 but not less than 1,000 read as kilo units, and values of 1,000,000 or greater read as Mega units, except that voltage readings in units of Volts and kilovolts not be utilized.
6. Measured values, both instantaneous readings and historical data, available to users on a computer on the Ethernet network in the building without the use of proprietary software, or requiring particular operating system. To facilitate this, each metering device assigned a unique network address and by entering that address or corresponding URL into a web browser, HTML web pages of data available for that device. Specific browser software permitted to be required to access system features beyond the measured values.
7. System settings and operational parameters only accessible through a maximum of five specific user computers, require the use of proprietary software, and fully password protected.
8. Synchronize complete system to a single time base so that events on the system can be compared at different locations on the system using a common time base.
9. Capable of monitoring Modbus devices for which register values are defined.
10. System requirements indicated are minimum requirements, additional features and increased accuracy is permitted.
11. Historical data resides on the system, independent of external personal computers. Industrial computers included as integral components of the system and mounted within a switchgear enclosure may be used to supplement the storage capacity of the various metering devices in the system. Sufficient data storage space included so that each instantaneous value listed can be logged on one minute increments and maintained for 36 hours. After 36 hours, data retained at 15 minute intervals for 35 days. After 35 days, data retained at 1 hour intervals for a minimum of one year.

B. Shared Components:
   1. Permitted to share components with the protective systems specified in Section 26 13 13, Medium-Voltage Circuit Breaker Switchgear and Section 26 11 16, Secondary Unit Substations provided that such sharing does not compromise the protective functions and that such sharing does not compromise the equipment of this section.
   2. It is anticipated that the PTs specified in Section 26 13 13, Medium-Voltage Circuit Breaker Switchgear will be shared and that there will not be separate PTs for the metering of the medium voltage systems.
   3. Where the accuracy of the protective relay metering functions or circuit breaker trip unit metering functions are sufficient to meet the requirements listed below, those metering functions may be used in lieu of separate metering instruments.

2.03 METERING AND MONITORING FUNCTIONS

A. Current Metering: Where current metering is required, the system provides the following values and accuracy:
   1. Three Phase MCCB Breakers:
      a. Provide the following where metering is indicated on the one-line diagram at breakers.
      b. Accuracy: 1.0 percent of reading plus or minus 0.5 percent of full scale.
      c. Values: For each of the following values provide the instantaneous value, the minimum values since the last reset, and the maximum value since the last reset.
         1) Each Phase
         2) Neutral, where present
         3) Ground
         4) Three Phase Average
         5) Percent Unbalanced
         6) Demand, Each Phase
         7) Demand, Three Phase Average
   2. Single Phase MCCB Breakers:
      a. Accuracy: 1.0 percent of reading plus or minus 0.5 percent of full scale.
      b. Values: For each of the following values provide the instantaneous value, the minimum values since the last reset, and the maximum value since the last reset.
         1) Phase

B. Voltage Metering: Where voltage metering is required, the system provide the following values and accuracy:
   1. Three Phase MCCB breakers:
      a. Provide the following where metering is indicated on the one-line diagram at breakers.
      b. Accuracy: 1.0 percent of reading plus or minus 0.5 percent of full scale.
      c. Values: For each of the following values provide the instantaneous value, the minimum values since the last reset, and the maximum value since the last reset.
         1) Line to Line for each phase
         2) Line to Neutral for each phase
         3) Neutral to Ground
         4) Line to Line Three Phase Average
         5) Line to Neutral Three Phase Average
         6) Percent Unbalanced

C. Power Factor: Where power factor metering is required, the system provide the following values and accuracy:
   1. Three Phase MCCB Breakers:
      a. Provide the following where metering is indicated on the one-line diagram at breakers.
      b. Accuracy: Plus or minus 0.02.

c. Values: For each of the following values provide the instantaneous value, the minimum values since the last reset, and the maximum value since the last reset.
1) True Power Factor, Line to Neutral or Line to Ground for each phase
2) True Power Factor, Three Phase

D. Frequency: Where frequency metering is required, the system provide the following values and accuracy:
1. Three Phase MCCB breakers:
a. Provide the following where metering is indicated on the one-line diagram at breakers.
b. Accuracy: Plus or minus 0.01 Hz.
c. Values: For each of the following values provide the instantaneous value, the minimum values since the last reset, and the maximum value since the last reset.
1) Frequency

E. Power Metering: Where power metering is required, the system provide the following values and accuracy:
1. Three Phase MCCB breakers:
a. Provide the following where metering is indicated on the one-line diagram at breakers.
b. Accuracy: 2.0 percent of reading plus or minus 0.5 percent of full scale.
c. Values: For each of the following values provide the instantaneous value, the minimum values since the last reset, and the maximum value since the last reset.
1) Real Power Line to Neutral or Line to Ground, Each Phase
2) Real Power, 3- phase total
3) Reactive Power Line to Neutral or Line to Ground, Each Phase
4) Reactive Power, 3-phase total
5) Apparent Power Line to Neutral or Line to Ground, Each Phase
6) Apparent Power, 3-phase total
7) Demand Real Power Line to Neutral or Line to Ground, Each Phase
8) Demand Real Power, 3-phase total
9) Demand Reactive Power Line to Neutral or Line to Ground, Each Phase
10) Demand Reactive Power, 3-phase total
11) Demand Apparent Power Line to Neutral or Line to Ground, Each Phase
12) Demand Apparent Power, 3-phase total

F. Energy Metering: Where energy metering is required, the system provide the following values and accuracy:
1. Three Phase MCCB breakers:
a. Provide the following where metering is indicated on the one-line diagram at breakers.
b. Accuracy: 2.0 percent of reading plus or minus 0.5 percent of full scale.
c. Values: For each of the following values provide the instantaneous value, the minimum values since the last reset, and the maximum value since the last reset.
1) Real kWH
2) Reactive kVARh
3) Apparent kVAh

PART 3 EXECUTION

3.01 FIELD TESTING

A. Verify complete system operation including hardware, software, and communication devices.

B. Test components per the requirements of Section 26 05 80, Electrical Testing.

3.02 SYSTEM OPERATOR TRAINING

A. Provide onsite training for the Owner's system operations personnel. The training course minimum of 16 hours of classroom instruction and cover system operation and troubleshooting, alarm and waveform capture set points, system programming, web page customization for the user interface, and recommended periodic maintenance.

B. Provide a local or toll-free phone number to provide assistance to the Owner's operations personnel in the operation of the system for a minimum of five years. Costs associated with this assistance included in the original system cost.

3.03 MANUFACTURER'S CERTIFICATION

A. A qualified factory-trained manufacturer's representative certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

B. Provide 4 copies of the manufacturer's representative's certification.

END OF SECTION

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SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Control Stations
   2. Standalone Room Controllers
   3. Occupancy/Vacancy Sensors
   4. Photosensor
   5. Relays, Switchpacks, and Room Controllers
   6. Power Supplies and Transformers
   7. Emergency Lighting Control Relays
   8. Low Voltage Control Wiring
   9. Test Equipment

B. Responsibilities and participation under Division 26, Electrical in the automatic dimming system installation and commissioning process.

C. Installation, connection, adjustment, and testing of the equipment including labor, materials, tools appliances, wire, junction boxes and equipment necessary for and incidental to the delivery, installation and furnishing of a completely operational lighting control system

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 09 43, Network Lighting Controls

D. Section 26 09 93, Sequence of Operations for Lighting Controls

E. Section 26 27 26, Wiring Devices

F. Section 26 50 00, Lighting

1.03 GENERAL REQUIREMENTS

A. Provide qualified personnel for participation in commissioning tests, including seasonal testing required after the initial commissioning.

B. Providing equipment, materials, and labor necessary to correct deficiencies found during the commission process which fulfill contract and warranty requirements.

C. Provide Operating and Maintenance Data and Record Drawings to the Test Engineer for verification, organization, and distribution.

D. Provide assistance to the Test Engineer to develop and edit descriptions of system operation.

E. Providing training for the systems specified in this Division with coordination by the Test Engineer and Commissioning Agent.

1.04 SUBMITTALS

A. Shop drawings:
   1. Submittal drawings with a complete system diagram to show quantity of devices, location in the building, dimensions and required wiring.
   2. Occupancy sensors, show the required quantity to cover the space controlled (note: this may be more than the quantity shown on the drawings.
   3. The locations shown on the drawings are for reference only and coordinated with the manufacturer and Architect for final quantity and location during the bid process to allow for allowance of proper quantity, wiring lengths and installation coordination)
   4. Provide physical samples of user interface devices and visually exposed control devices for approval by Owner and Architect.

B. Product data with wiring schematics for system and user interface components

C. Installation and Record Drawings

D. Operation and Maintenance Manuals:
   1. Include product data of system components, one line diagrams of installed components and their locations throughout the building, a final floor plan noting the locations of devices installed above ceilings, behind access panels or in concealed but accessible spaces and the lighting zones or devices they control.
   2. Final relay schedule with the zone of control, location of control zone, voltage, power feed, time clock setting, photocell set point, switch, or dimmer stations controlling the relay, and sweep function set points will be provided by the contractor.

1.05 DEFINITIONS

A.	BACNET	Protocol for integration with BAS/BMS/EMS
B.	BAS / BMS / EMS	Building Automated System, Building Management System, Energy Management System
C.	CS	Control Station
D.	D	Dimming Wall Switch
E.	DT	Dual Technology (PIR + U)
F.	FC	Footcandles. The metric for measuring light levels / illuminance levels
G.	GUI	Graphic User Interface
H.	LCP	Lighting Control Panel
I.	LED	Light Emitting Diode
J.	LonWorks	Protocol for integration with BAS/BMS/EMS
K.	OS/VS	Occupancy Sensor / Vacancy Sensor,

   1. Occupancy sensors provide automatic on and automatic shut-off.
   2. Vacancy sensors provide automatic shut-off only, and require manual-on.

L.	PC	Photocell
M.	PIR	Passive Infrared Technology
N.	RS	RS-232 Connection for AV Integration
O.	SC	Scene Control
P.	TC	Timeclock, or astronomical timeclock
Q.	U	Ultrasonic Technology
R.	WS	Wall Switch
S.	WS/O	Wallbox Occupancy Sensor Switch

   1. Wall Switch with integrated Occupancy Sensor

1.06 SYSTEM DESCRIPTION

A. Control Stations:
   1. Control Station Types:
      a. Provide control stations for occupant lighting control as scheduled on the drawings and may include and/or combine the following type of individual control type within a single station:
         1) On/Off Switching
         2) Dimming Raise/Lower
         3) Occupancy/Vacancy Sensor

B. Relays, Switchpacks, and Room Controllers:
   1. Analog and Digital: Room controller devices to accept line voltage input as well as input from any combination of control stations, occupancy/vacancy sensors and/or daylight sensors and produce the required effect (switching or dimming) on up to four zones of connected lighting.

C. Occupancy/Vacancy Sensing:
   1. Reduce electric energy consumption by reducing or eliminating lighting energy use in unoccupied spaces by switching lighting off with occupancy and/or vacancy sensors.

D. Photoelectric Daylight Harvesting:
   1. Daylit Areas:
      a. Reduce electric energy consumption during daylight hours by reducing the light output of the electric lighting system via continuous dimming power supply in response to measured lighting levels provided by daylight within the building interior.
      b. Dimming zones will correlate with the distribution of daylight within the space as noted on plans.

E. Emergence Override: Provide automatic load control relay devices for controlling egress lighting circuiting.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Basis of Design Manufacturer:
   1. Blueridge Technologies

B. Products described in this section are to be provided by the single BOD (basis of design), or approved alternate, manufacturer, listed above, or by a compatible, BOD approved third party alternate manufacturer.
   1. Manufacturer series numbers are identified herein to establish the minimum level of quality for each product.
   2. Comparable products that meet the requirements of the specification by other acceptable manufacturers identified herein are acceptable with prior approval.
   3. Other or equivalent Manufacturers and Products: Submit Substitution Request, complying with requirements of Division 00, Procurement and Contracting Requirements.

2.02 CONTROL STATIONS

A. Control Station Types:
   1. On/Off:
      a. Rocker style switch for on and off control of zones indicated.
      b. Controls lighting in entire space if no zones indicated on plans.
   2. Dimming/Raise Lower:
      a. Provide individual pushbuttons for on and off control of zones indicated on plans.
      b. Controls lighting in entire space if no zones indicated on plans.
      c. Dimming accomplished by press and hold the ON and OFF buttons for dimming up and down respectively.
   3. Integral Occupancy:
      a. Automatically switches lighting on when occupant enters space.
      b. Switches lights off after predetermined period of vacancy.
      c. Controls lighting in entire space.
   4. Integral Vacancy:
      a. Includes pushbuttons for occupant manual on/off and dimming control of lighting in space.
      b. Automatically switches lights off after predetermined period of vacancy.
      c. Includes provision to revert to occupancy control in absence of configurable amount of daylight.
      d. Controls lighting in entire space.

B. Line Voltage Dimming Switches:
   1. Architectural grade, line voltage, 20A rated, single pole, preset style, slide up to brighten and down to dim, with on/off rocker style switch, decora style, wattage rating and lamp/power supply compatibility as required.
   2. 0-10V.
   3. Provide 3-way type where shown on plan.
   4. Lutron Diva Series

C. Wallbox Occupancy Sensor Switches:
   1. 180 degree coverage, type as shown on plan (PIR, ultrasonic or dual-technology), configurable automatic-on or manual on operation, 3-wire type, daylight override, adjustable time-out, selectable walk-through mode and override off switch. Single or dual relay type as required or as shown on Drawings.
   2. Provide 3-way type where shown on plan.
   3. WattStopper PW series.

D. Digital Control Stations:
   1. Provide control stations with configuration as indicated or as required to control the loads as indicated.
   2. General Requirements:
      a. Power: Class 2 (low voltage).
      b. UL listed.
      c. Provide faceplates with concealed mounting hardware, with matching finish.
      d. Borders, logos, and graduations to use laser engraving or silk-screened graphic process that chemically bonds graphics to faceplate, resistant to removal by scratching and cleaning. Self-Adhesive labels not permitted.
      e. Finish: As specified for wall controls in this Section.
   3. Single-Zone or Single-Group:
      a. Turn an individual fixture or group of fixtures as shown on plans on and off via button press.
      b. Raise and lower light levels via press and hold button.
         1) Separate buttons for dimming and on/off functions not allowed.
   4. Multi-Scene or Multi-Group:
      a. General Requirements:
         1) Allows control of any devices part of the lighting control system as indicated on plans.
         2) Controls can be programmed with different functionality through system software without any hardware changes. Allows contextual functions based upon button press and press and hold input.
         3) Allows for easy reprogramming without hardware replacement.
         4) System will automatically update programming without direct human interaction upon replacement of any component.
         5) Communications: Utilize RS485 or similar wiring for low-voltage communication.
         6) To help occupants understand how to use the lighting control system, engraving requirements should be included for controls. Engraving details should include text size and style.
         7) Engrave keypads with button, zone, and scene descriptions as indicated on the drawings.
         8) Software Configuration:
            a) Single defined action.
            b) Buttons can be programmed to perform defined action on press and defined action on release.
            c) Buttons can be programmed using conditional logic off of a state variable such as time of day or partition status.
            d) Buttons can be programmed to perform automatic sequence of defined actions.

e) Capable of deactivating select keypads to prevent accidental and/or unwanted changes to light levels and other settings.
f) Buttons can be programmed for raise/lower of defined loads.
g) Buttons can be programmed to toggle defined set of loads on/off.

9) Status LEDs:
a) Upon button press, LEDs to immediately illuminate.
b) Time delays inherent in large systems can cause short delays between button press and system confirmation. To avoid any confusion and prevent multiple button presses, keypads should immediately show that the button has been pressed for visual confirmation.
c) LEDs to reflect the true system status. LEDs to remain illuminated if the button press was properly processed or LEDs to turn off if the button press was not processed.
d) Support logic that defines when LED is illuminated:
(1) Scene logic (logic is true when zones are at defined levels).
(2) Room logic (logic is true when at least one zone is on).
(3) Pathway logic (logic is true when at least one zone is on).
(4) Last scene (logic is true when spaces are in defined scenes).

b. Wired Keypads:
1) Style:
a) Mounting: Wall box or low-voltage mounting bracket; provide wall plates with concealed mounting hardware.
2) Design keypads to allow field-customization of button color, configuration, and engraving using field-changeable replacement kits.
3) Terminal block/connector inputs to be over-voltage and miswire-protected against wire reversals and shorts.
4) LEDs next to each button are used during programming and provide feedback when the buttons are pressed.
5) Available with status LEDs.
6) Available in several button configurations and finishes.

2.03 OCCUPANCY/VACANCY SENSORS

A. General Requirements:
1. Power Failure Memory: Settings and learned parameters to be saved in non-volatile memory and not lost should power be interrupted and subsequently restored.
2. Furnished with necessary mounting hardware and instructions.
3. NEC Class 1 or 2 devices, refer to plans.
4. Ceiling-Mounted Sensors: Indicate viewing directions on mounting bracket.
5. Wall-Mounted Sensors: Provide swivel-mount base.
6. Ceiling-Mounted Sensors: Provide customizable mask to block off unwanted viewing areas.
7. Isolated Relay: Provide ceiling mounted sensors with an internal isolated relay with Normally Open, Normally Closed, and Common outputs rated at 1A at 30VDC/VAC for use with HVAC control, Data Logging and other control options.
8. Line Voltage sensors accept line voltage input and output switched line voltage directly to controlled luminaires.
a. Line voltage sensors must be capable of occupancy or vacancy control. Operation is to be determined by onboard device settings.
b. Sensor configuration to be made by integral pushbutton or dial controls.
c. Types:
1) PIR: utilize invisible light to determine occupancy.
2) Ultrasonic/Microphonic: utilize audible or subaudible sound to determine occupancy.

3) Dual-Tech: utilize a combination of the above technologies to determine occupancy.
a) Detection of vacancy by both ultrasonic and PIR sensors required to turn lights off.

9. Low Voltage sensors are paired with a switch pack or room controller. Provide digital sensors compatible with room controller/switchpack and balance of system.
a. Low voltage sensors must be capable of occupancy or vacancy control. Operation is to be determined by overall system configuration and/or device settings.
b. Sensor configuration to be made by integral pushbutton or dial controls.
c. Types:
1) PIR: utilize invisible light to determine occupancy.
2) Ultrasonic/Microphonic: Utilize audible or sub-audible sound to determine occupancy.
3) Dual-Tech: Utilize a combination of the above technologies to determine occupancy.
a) Detection of vacancy by both ultrasonic and PIR sensors required to turn lights off.

B. Ceiling Mounted: 360 degree coverage:
1. Automatic-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode.
2. Low- or line-voltage as shown on Drawings or described in Section 26 09 93, Sequence of Operations for Lighting Controls,
3. Surface mounted, provide power packs as required.
a. Passive infrared type:
1) Low Voltage: Blueridge Technologies BOS-515 Series.
2) Line Voltage: Blueridge Technologies LOS-509 Series.

C. Provide multiple contacts and/or power packs for Low Voltage occupancy sensors that:
1. Control both normal and emergency lighting and require separation of branch circuit wiring systems. In case of occupancy sensor failure, emergency lighting fail to the on state.
2. Control separate lighting control zones. Unless otherwise noted, occupancy sensors are intended to control light in a designated zone or room. Contractor is responsible for providing the required power packs to insure functionality of the system.
3. Provide UL924 listed relay or power pack for to bypass occupancy sensors in event of power failure. During normal operation, relay to operate lighting in conjunction with adjacent normal power lighting.

D. High Ceiling Occupancy Sensor:
1. Provide low or line voltage occupancy sensors where shown on plans.
2. Automatic-on or manual-on operation, light-level sensing, adjustable time-out, automatic sensing/adjustment for optimal time-out delay setting, selectable walk-through mode.
3. Suitable for mounting heights from 12-feet-40-feet.
4. Surface mounted, provide auxiliary contacts if required.
a. Passive infrared type: Blueridge Technologies

2.04 PHOTOSENSOR

A. General Requirements:
1. Use NEC Class 2 wiring for low voltage communication.
2. Can be replaced without reprogramming.
3. Photopically corrected to approximate human vision.
4. Daylight sensing equipment will be digital, full range type, self or manually calibrated.
5. Provide proper photocell type(s) as required to:
a. Measure light levels entering space through glazing. Illumination contribution to this measured surface will include daylighting only (open-loop system).

6. Independently control single zones of luminaires for maximum energy savings while maintaining even task illumination across the entire area between zones. Refer to drawings for control groupings.
7. Incorporate time delay logic to prevent cycling due to clouds and other short-term influences to lighting levels.
8. Accept indoor, skylight, and outdoor photo sensing heads. Photo sensing control permit the user to specify the actual footcandle level where desired switching occurs.

B. Indoor:
1. Stable output over temperature from 32 degrees F (0 degrees C) to 104 degrees F (40 degrees C).
2. Open Loop:
a. Adjustable aiming angle to accommodate various glazing configurations
b. Provide linear response from 0 to minimum 1000 foot-candles.
c. Mountable on lighting fixtures or recessed acoustical ceiling tiles.
d. Blueridge Technologies LS24OL

C. RELAYS, SWITCHPACKS and ROOM CONTROLLERS

D. Digital:
1. Devices interconnected by contractor terminated cabling.
2. Configurable to produce the following sequences of operation by on-board dip-switch style controls.
a. Occupancy Control:
1) Automatically turns lights on when occupant is detected in space.
2) Automatically turns lights off after a configurable period of vacancy.
b. Vacancy Control: Occupant must manually turn lights in space on, automatically turns lights off after a configurable period of vacancy.
c. Timeclock
d. Daylight Harvesting
1) Occupant must manually turn lights in space on, automatically turns lights off after a set period of vacancy.
2) Accepts input from daylight sensing equipment and adjusts light level settings accordingly.
3. Provides additional capability or accessories to integrate with AV, BAS, HVAC, and/or shade control systems.

2.05 POWER SUPPLIES AND TRANSFORMERS

A. Provide from same manufacturer of equipment served.

B. Compatible with specified photocells and dimming control station protocols.

C. Refer to Section 26 50 00, Lighting, for product specification on luminaire power supplies and transformers.

2.06 EMERGENCY LIGHTING CONTROL RELAYS

A. Manufacturers:
1. Bodine
2. Nine 24
3. Wattstopper
4. Or approved equivalent.

B. General Requirements
1. Comply with UL924 requirements:
a. If controlled off, must turn on automatically.
b. Provide required egress illuminance along entire egress path.
c. Must not be able to be overridden by building occupants.

2. Unless shown otherwise on drawings, load control relay provided is to control egress lighting along with adjacent normal power lighting except in event of power failure fire alarm system alarm status.

C. Description:
1. Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts.
2. UL924 listed for connected load of 10A at 277V or 120V.
3. UL rated N.C. contacts, minimum 10A rating.
4. Integral surge protection.
5. Two separate status emergency lighting indicators for troubleshooting:
   a. Amber LED indicates presence of normal utility power.
   b. Red LED indicates presence of unswitched emergency power.
6. Manual and/or automatic diagnostic testing feature.
7. Self-contained enclosure UL listed for installation in indoor or damp locations.

2.07 LOW VOLTAGE CONTROL WIRING

A. 18 gauge shielded cable or as recommended by the manufacturer.

2.08 TEST EQUIPMENT

A. Provide multi-function digital Illuminance meter with detachable receptor head with the following characteristics:
1. Receptor: Silicon photocell type
2. Illuminance Units: Lux or footcandles (switchable)
3. Measuring range: 0.1 to 19,990 lux, 0.01 to 1,999 footcandles
4. Accuracy: ±4 percent ±1 digit of displayed value
5. Cosine Correction Characteristics: Within ±1 percent at 10 degrees; within ±5 percent at 60 degrees.
6. Measuring functions: Illuminance, integrated illuminance, average illuminance.
7. Temperature/humidity drift: Within ±3 percent ±1 digit (of value displayed at 68 degrees F) within operating temperature/humidity range.
8. Operating conditions: 32 degrees F to 104 degrees F) at less than 85 percent humidity.

B. Provide proof of calibration within 12 months of use. Calibration performed by an independent calibration lab approved by the manufacturer of the meter.

PART 3 EXECUTION

3.01 INSTALLATION

A. Submittal data required prior to ordering and installation.

B. General Testing:
1. Functionally test control devices to ensure that control devices, components, equipment and systems are calibrated, adjusted and operate in accordance with approved drawings, specifications, and manufacturers installation instructions.
2. Prepare and complete report of test procedures and results and file with the Owner.
3. Install items per manufacturers written instructions.

C. Control Stations:
1. Control Stations to be combined wherever possible to minimize quantity of discrete gangs.
2. Combine under common cover plates wherever shown together on plans.

D. Low Voltage Wiring:
1. Install in conduit where running through inaccessible areas. Provide plenum rated wiring in accessible ceiling spaces.
2. Test CAT5/6 cables terminated on site prior to wiring of digital lighting control systems. Provide evidence of successful testing to engineer and owner. Factory pre-terminated cabling is not subject to this requirement.
3. Coordinate low voltage wiring connection and location with luminaires to be controlled.

E. Photocell:
   1. Install surface mounted on recessed junction box in location best suited for accurate measurement. Avoid placement in high traffic or confined spaces.

F. Occupancy Sensors:
   1. For installation of low voltage occupancy sensors in inaccessible ceiling systems, coordinate power pack locations with Architect prior to installation and provide access panels as required, coordinate access panel locations with Architect.
   2. Sensor locations identified on Drawings are diagrammatic and are meant to indicate only that occupancy sensing within a given space is required. Locate sensors as required by the manufacturer to provide maximum coverage of the room, to operate as someone enters the room, and to avoid false operation due to persons outside the room passing an open door.
      a. Provide additional sensing heads as necessary or per manufacturer's recommendation to achieve complete coverage of each room.
   3. Set sensitivity as required to provide small movement coverage throughout the room without extending coverage beyond the room.
   4. System performance testing done with the sensor timing set to the time delay indicated by space type in Section 26 09 93, Sequence of Operations for Lighting Controls.
   5. Upon Completion of installation and prior to turning space over to Owner, Contractor reset occupancy sensor automatic self-adjustment settings to insure proper time delay self-adjustment for Owner occupant schedule and room use.
   6. Allow for up to 24 hours of callback sensor adjustments to be made by the contractor or occupancy sensor manufacturer qualified installer for up to six months after the owner has taken occupancy of the space.

G. Emergency Lighting Control Relays:
   1. Provide unswitched emergency circuit, and unswitched and switched normal circuit to UL924 relay for control of emergency luminaires with remaining room luminaires on normal power.
   2. Install each relay within dedicated 4-11/16-inch junction box with double-gang plaster ring for wall or ceiling flush-mount or in a self-contained enclosure from the manufacture, as indicated on Drawings.
   3. Where location in ceiling would interfere with removal of ceiling tiles, install relay flush-mounted in nearest wall at ceiling level.
   4. Do not locate behind wall switch.

3.02 WORK PRIOR TO COMMISSIONING

A. Complete phases of work so the system can be powered, tested, adjusted, and otherwise commissioned. Under Division 26, Electrical, complete systems, including subsystems, so they are fully functional. This includes the complete installation of equipment, materials, wire, controls, etc., in accordance with the contract documents and related directives, clarifications, change orders, etc.

B. A commissioning plan will be developed by the Test Engineer and approved by the Commissioning Agent. Under Division 26, Electrical, assist the Test Engineer and Commissioning Agent in preparing the commissioning plan by providing necessary information pertaining to the actual equipment and installation. If system modifications and clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner. If Contractor initiated system changes have been made that alter the commissioning process, the Commissioning Agent will notify the Owner.

C. Specific pre-commissioning responsibilities under Division 26, Electrical are as follows:
   1. Factory startup services for the following items of equipment:
      a. Lighting Control System
   2. Normal startup services required to bring each system into a fully operational state. This includes complete installation and cleaning. The Test Engineer will not begin the commissioning process until each system is documented as being installed complete.

D. Begin commissioning after installation of interior and exterior finishes including but not limited to adjacent roofing, finished floor, wall, and ceiling systems including final painting, furniture and book stacks in place, and other building systems which have direct or indirect influence on the performance and distribution of the daylight and electric lighting systems.

E. Start of commissioning before such items are complete will not relieve Contractor from completing those systems in accordance with the Construction Schedule.

3.03 SEQUENCE OF COMMISSIONING

A. Provide to Architect prior to start of commissioning layout drawings indicating proposed location of measurement points. Proceed with commissioning after review and acceptance by Architect.

B. Illuminance measurements oriented horizontal, facing up, at 30-inches above finished floor. Measurements for a control group occurs at the same location. Ensure constancy of local surface reflectance conditions throughout commissioning of each control group.

C. Ensure no personnel or outside influence affects the amount of flux striking the receptor head during the recording session.

D. Document measurements in clearly understandable format for review by the Architect. Include time of measurement, temperature, and relative humidity.

E. Measure illuminance at least two hours after local sunset with full output of electric lighting. Record integrated illuminance and average illuminance for a 2 hour period.

F. During daylight hours, measure illuminance with electric lighting off, including emergency and nightlight circuits. Record integrated illuminance and average illuminance for a two hour period. Document in clearly understandable format for review by the Architect.

G. Set each photocell to 150 percent of electric-only lighting contribution.

H. After initial setpoint has been set, measure illuminance in 10 minute increments from 1 hour before to 1 hour after local sunset.

I. Submit recorded data to Architect for review.

3.04 TESTING FOR SEASONAL VARIATIONS

A. Timing of Commissioning:
   1. Initial Commissioning:
      a. Perform to best suit the current time-of-year and cloud cover conditions.
      b. Conduct as done as soon as contract work is completed regardless of season.
   2. Seasonal Commissioning: Test under full sunlight and full overcast conditions during summer and winter solstice, as well as similar conditions at the spring or fall equinox.
   3. Subsequent Commissioning: Ascertain adequate performance during the four seasons.

3.05 PARTICIPATION IN COMMISSIONING

A. Provide skilled technicians to start up systems within Division 26, Electrical. The same technicians made available to assist the Test Engineer and Commissioning Agent in completing the commissioning program as it relates to each system and their technical specialty. Work schedules, time required for testing, etc., will be requested, and coordinated by the Test Engineer. Under Division 26, Electrical, ensure that the qualified technician(s) are available and present during the agreed upon schedules and for sufficient duration to complete the necessary tests, adjustments, and problem resolutions at no additional cost to the Owner.

B. System problems and discrepancies may require additional technician time, Test Engineer time, Commissioning Agent time, redesign, and reconstruction of systems and system components. The additional technician time made available for the subsequent commissioning periods until the required system performance is obtained at no additional cost to the Owner.

C. Commissioning Agent reserves the right to judge the appropriateness and qualifications of the technicians relative to each item of equipment or system. Qualifications of technicians include expert knowledge relative to the specific equipment involved, adequate documentation and tools to service the commission the equipment, and a willingness to work with the Test Engineer and Commissioning Agent to get the job done. Remove technicians from the project at the request of either the Test Engineer or Commissioning Agent.

3.06 RESOLUTION OF DEFICIENCIES

A. In some systems, misadjustments, misapplied equipment, and deficient performance will result in additional work required to commission the systems.

B. Complete work under the direction of the Architect, with input from the Contractor, equipment supplier, Test Engineer, and Commissioning Agent.

C. Whereas members will have input and the opportunity to discuss the work and resolve problems, the Architect will have final jurisdiction on the necessary work to be done to achieve performance.

D. Complete corrective work in a timely fashion to permit timely completion of the commissioning process.

E. Experimentation to render system performance is permitted. If the Commissioning Agent deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Agent will notify the Owner, indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities.

F. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services, equipment, or both, to resolve the problem.

G. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

3.07 TRAINING

A. Participate in the training of Owner's engineering and maintenance staff, as required in Divisions 01 through 28, on each system and related components.

B. Conduct training in a classroom setting, with system and component documentation, and suitable classroom training aids.

C. Training classroom sessions and file demonstrations will be videotaped and copies of this material will be provided as part of closeout requirements.

D. Training will be conducted jointly by the test engineer, commissioning agent, the contractor, and the equipment suppliers.

E. Test engineer responsible for highlighting system peculiarities specific to this project.

3.08 SYSTEMS DOCUMENTATION

A. In addition to the requirements of Division 01, General Requirements, update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations.

B. Division 26, Electrical, record drawings include architectural floor plans and the individual daylight control systems in relation to actual building layout.

C. Provide in AutoCAD .dwg format for transmittal to the test engineer.

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SECTION 26 09 43
NETWORK LIGHTING CONTROLS

PART 1 PART LEVEL

1.01 NUGENERAL

1.02 SUMMARY

A. This Section includes:
   1. Lighting Control Equipment

1.03 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Division 23, Heating, Ventilation, and Air Conditioning

D. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

E. Section 26 09 23, Lighting Control Devices

F. Section 26 27 26, Wiring Devices

G. Section 26 50 00, Lighting

1.04 QUALITY CONTROL

A. Install by an experienced contractor in the installation of lighting control systems. Provide a factory technician to supervise the installation and installation and make final adjustment and tests of the system.

B. Furnish evidence of an experienced service organization which stocks system parts and is capable of providing repair service within 24 hours.

1.05 SUBMITTALS

A. Shop Drawings

B. Product Data with Wiring Schematics

C. Installation and Record Drawings

D. Operation and Maintenance Manuals

1.06 SYSTEM OPERATION

A. Use a modular component approach, utilizing a central processor, transceivers which activate relays and relay cabinets.

B. Incorporate the following criteria:
   1. Control information from the controller to the transceiver multiplexed over a single pair of wires.
   2. Conform control wiring to NEC Article 725, Class 2.
   3. Components: Standard catalog items available through electrical distributors.
   4. Expandable to control up to 4,000 relays. Relays operable from 2 or 3-wire control systems.
   5. Programmable on site to achieve control functions and be readily updatable to reflect changes without requiring rewiring.

C. Installed system capable of the following control functions:
   1. Automatic Control: Areas to be activated in user dictated patterns (ON-OFF array of relays) according to either a weekly schedule broken into one-minute increments or alternate daily schedules pre-programmed for holidays.
   2. Manual Controls: Control relay or group of relays with either a maintained or momentary switch; activate group of relays to one of ten user determined patterns via a touchtone or pushbutton phone or the controller keyboard.

D. Select, activate, and lock-in lighting pattern from the central controller with provisions to lock out manual and automatic commands.

E. A CRT display capable of displaying:
   1. Pattern schedules and overrides.
   2. Priority manual overrides.
   3. Current state of each relay in system.
   4. Time, day, and date.

F. Indicate to the operator transceiver failure.

G. Internal battery backup of ten hours for memory protection. Store program information on a disc and automatically reload the controller after a power outage longer than the battery backup.

H. Capable of turning on circuits for continued operation should control component fail.

I. A self-diagnostic routine to indicate a malfunction.

1.07 CONNECTION TO EXISTING NETWORK

A. General: Communication between peer-to-peer network lighting control panels via previously established panel system communication protocol within the building (Blueridge

B. Provide software and system integration to seamlessly integrate to the existing server for common system graphics, alarming, paging out of alarms via existing system.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Blueridge Lighting Technologies

2.02 LIGHTING CONTROL EQUIPMENT

A. Main Controller:
   1. Microcomputer pre-programmed for lighting control. Incorporate a 365-day clock and provide minute-by-minute control of the entire lighting system of up to 4,000 separate relays according to a pre-determined schedule.
   2. Accepts the lighting control schedule through a simple keyboard. In addition to the automatic schedule, control lighting circuit manually from the controller keyboard.
   3. Provide monitoring of the system and display the ON/OFF state of each relay.
   4. Capable of driving a standard printer.
      a. CPU: PC class personal computer with memory, cables, and software, factory tested prior to shipment.
      b. Include lighting control system operating software and current version of Windows operating system.
      c. Include Trends and Relay Runtime Analysis software to allow the owner to analyze the operation of specific areas and identify those exceeding normal runtimes. Individual relays may be assigned a kWh weighted value or simply analyzed on a runtime basis. In both cases, the relays may be assigned to logical groups and plotted for the last 30 days or 12 months.

B. Relay/Transceiver Cabinets:
   1. Code gauge steel cabinets, surface, with cover and following interior devices.
      a. 20A, 277V relays with 24V, 2 or 3 wire control, quantities as scheduled with space for 32 minimum.
      b. 277V primary, 24V secondary control transformer.
      c. Plug-in modular electronics to operate multiple relays as schedules, individually or in groups as directed by the controller.
      d. Plug-in modular electronics for inputs which will notify the controller of change in input.
      e. Terminals for system wiring.
      f. Transceivers for input output control.

C. Wire:
   1. BAS System/BACnet router communications: BACnet/MSTP cable between relay panels, control panels, and BAS system
      a. 22AWG, green
      b. Copper, one pair, twisted 100-130 ohm impedance, low capacitance 30pf/ft conductor to conductor or less, shielded.
   2. Control station communications: CANbus Communications
      a. 22AWG, blue
      b. Copper, one pair, twisted 100-130 ohm impedance, low capacitance 30pf/ft conductor to conductor or less, unshielded.
   3. Control station communications: CANbus Power
      a. 22AWG, natural
      b. Copper, one pair, twisted, unshielded.

D. Low Voltage Switch Modules:
   1. Single:
      a. Blueridge Technologies PBS-721/722 or PBD-720 series

E. Photocells:
   1. Accept indoor, skylight, and outdoor photosensing heads.
   2. Photosensing control permits the user to specify the actual footcandle level where desired switching occurs.
   3. An internal deadband timer exist to prevent the lights under photosensor control to toggle inadvertently as the sensor passes through the control threshold.
   4. Provide one analog system photocell.

PART 3 EXECUTION

3.01 DRAWINGS

A. Installation and record drawings called for under submittals consists of reproducible drawings with outlets, devices, terminal cabinets, conduits and wiring shown. Prints of these drawings submitted for approval prior to starting installation. Upon request, the Architect will furnish reproducible floor plans as required for the contractor's use in developing the Installation and Record Drawings.

B. Submit drawings when approved and form the basis for installation.

C. Incorporate at the completion of the work deviations from the installation drawings on the reproducibles to indicate as built conditions. Submit drawings as Record Drawings for the system.

3.02 INSTALLATION

A. Install systems for each section of each floor and connect lighting circuits per relay schedule on drawings.

B. Area control switches able to manually provide 2-level control of lights by area.

C. Provide conduit for wiring, 1/2 inch minimum size.

D. Components for cabinets factory installed.

E. Install cabinets plumb, adjacent to serving lighting panel in electrical rooms as shown on the Drawings.

3.03 INSTRUCTION

A. Without additional expense to the Owner, competent authorized representative personnel gives instruction for the care, adjustment, and operation of all parts of the system to the Owner's representative who is to have charge of the equipment.

B. Each instructor thoroughly familiar with parts of the installation and trained in operating theory as well as in practical operation and system maintenance.

C. Furnish 16 hours of instruction after final acceptance of the system at the dates and times selected by the Owner.

D. Installation, start-up, and maintenance assistance available from the manufacturer on an as-needed basis.

END OF SECTION

SECTION 26 22 00
LOW VOLTAGE TRANSFORMERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Indoor Low Voltage Transformers

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 33, Raceways and Boxes for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

G. SUBMITTALS

H. Shop Drawings with Nameplate Data

I. Product Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Transformers from the same manufacturer as the distribution equipment specified in Section 26 24 13, Switchboards; or approved equivalent.

2.02 INDOOR LOW VOLTAGE TRANSFORMERS

A. Enclosed and ventilated, air cooled type, Class 220 insulation, DOE 2016 Efficiency or NEMA Premium Efficiency. Equip with two 2-1/2 percent FCAN taps and four 2-1/2 percent FCBN taps. Maximum sound level to be NEMA standard with vibration isolators between the core and coil assembly and case.

B. NEMA standard maximum sound level with vibration isolators between the core and coil assembly and case. No metal-to-metal contact between core and coil and the enclosure. Warrant sound levels by the manufacturer not to exceed the following:
   1. 10 to 50 KVA 45 DB
   2. 51 to 150 KVA 50 DB
   3. 151 to 300 KVA 55 DB
   4. 301 to 500 KVA 60 DB
   5. 501 to 700 KVA 62 DB

C. Visibly ground the core of the transformer to enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC Standards.

D. Totally enclose the case with louvers to prevent entry of foreign objects into the interior, manufactured in accordance with NEMA and UL approval standards.

E. Provide grounded isolation shields between the primary and secondary windings where noted or shown on the Drawings to attenuate source of line interference. Insulate shield from the transformer windings and core and ground to transformer enclosure.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install transformers with flexible conduit connections to housing. Make cable and ground wire connections.

B. Floor mount transformers. When necessary to wall or trapeze mount, securely anchor to structure as required for seismic Zone 3.

C. Install with sound isolating vibration dampers between the transformer enclosure and the hanger or building structure.

D. Provide nominally 3-inch deep concrete pads under floor-mounted transformers.

E. Provide seismic restraint for transformers as recommended by SMACNA. Provide shop drawings sealed by a registered Structural Engineer indicating this seismic restraint.

END OF SECTION

SECTION 26 24 13
SWITCHBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Main Distribution Panels (MDP)
   2. Sub-Distribution Panels (SDP)
   3. Fuses
   4. Fuse Cabinets

B. Provide the materials for the complete secondary service and distribution system as indicated.

C. Provide a transformer pad and ground grid for use by the serving utility. Coordinate pad size, openings, type of construction, conduit arrangement, and grounding requirements with the utility prior to construction.

D. Provide utility metering facilities where indicated on the Drawings, complying with the established serving utility requirements. Provide quantity and style of meter sockets and accessories required by the utility.

E. Include metering charges or connection costs charged by the serving utility in the original proposal. Refer to Coordination of Work section of these Specifications.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 53, Identification for Electrical Systems

F. Section 26 09 13, Electrical Power Monitoring and Control

1.03 SUBMITTALS

A. Shop Drawings

B. Product Data:
   1. Detailed component material list.
   2. Voltage rating, amperage rating, bussing material, fault rating, wiring lugs capacity, mounting method, physical size, exterior finish and options.
   3. Equipment one-line diagram.
   4. Equipment elevations and dimensions.
   5. Conduit entry areas.
   6. Individual circuit breaker product data sheets.
   7. Panel schedules; the panel schedules indicate circuit breakers in the same orientation as the construction documents.

C. Equipment Test Reports

D. Operation and Maintenance Data

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Eaton

B. General Electric

C. Siemens

D. Square D

2.02 MAIN DISTRIBUTION PANELS (MDP)

A. General:
1. NEMA Standard PB-2 and UL 891 compliant.
2. Freestanding, rear-aligned, front-accessible, group-mounted circuit breaker type, fully enclosed with bussing and hardware provisions for the addition of future circuit breakers.
3. Circuit breaker trip ratings as indicated on Drawings.
4. Equipment Assembly: Short circuit current rating (SCCR) greater than the maximum available fault current expected at that point in the distribution system.
5. List panel by Underwriters Laboratories and bear a UL label as suitable for use as service equipment.
6. Refer to Drawings for maximum allowable equipment footprint.

B. Construction:
1. Equipment consists of the required number of vertical sections bolted together to form a rigid assembly.
2. Formed edges of front covers or hinged front panels.
3. Provide adequate ventilation within the enclosure.
4. Rear align sections of the equipment with depth as required to accommodate devices shown and necessary conduit entrance for current and future devices.
5. Properly clean and provide exterior and interior steel surfaces with a rust-inhibiting coating.
6. Color and Finish: ANSI 61 light gray

C. Bus Work:
1. Copper or tin-plated aluminum, sized as indicated on Drawings, with a 100 percent capacity neutral bus.
2. Bus sizing based on NEMA standard temperature rise criteria of 149 degrees F above an ambient of 104 degrees F under continuous full load current and rated to withstand the maximum available fault current expected at that point in the distribution system.
3. Include bussing provisions for mounting future devices in spaces called for on Drawings. Where configuration provides additional spaces within a section, bussed to receive future devices.
4. Provide a copper ground bus firmly secured to each vertical section and extending the entire length of the MDP.
5. Fully bus vertical sections.

D. Provide separate vertical section for service entrance conductor drip loop when Main Distribution Panel is installed below finished grade or when susceptible to water intrusion via service conduit. Install drip loop per serving utility requirements, if applicable.

E. Utility Metering:
1. Where indicated on Drawings, provide a separately barriered utility metering compartment complete with hinged sealable door in accordance with utility requirements.
2. Bus work includes provisions for mounting utility company current transformers and potential transformers or potential taps as required by the utility company.

F. Circuit Breakers:
1. Provide main and feeder circuit breakers as shown on Drawings.
2. Molded case, bolt-on type, with inverse time and instantaneous tripping characteristics.
3. Provide with ground fault protection where indicated on Drawings or as required by NEC.
4. Operate by a toggle-type handle and quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Clearly indicated automatic tripping of the breaker by the handle position.
5. Short circuit capacity rating to withstand the maximum short circuit duty that can be expected at the breaker location in the electrical system. Minimum short circuit rating for circuit breaker 10,000 AIC for 120/208V breakers, and 14,000 AIC for 277/480V breakers.
6. Series rating is not permitted.

7. Provide circuit breakers that are 1200 amp and larger rated or can be adjusted to be 1200 amp or larger rated, with an energy reducing maintenance switch adjustment to meet the requirements of NEC 240.87.
8. Provide LSI adjustable trip setting capability for breakers rated 400 amp and larger.
9. Provide LSIG adjustable trip setting capability for breakers rated 1200 amp and larger.

G. Wiring/Terminations:
1. Small wiring, necessary fuse blocks and terminal blocks within the MDP furnished as required. Control or metering components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Provide mechanical-type terminals for line and load terminations suitable for copper or aluminum cable rated for 167 degrees F of the size as indicated on the Drawings.
3. Provide lugs in the incoming line section for connection of the main grounding conductor and other grounding conductors as indicated on Drawings.

H. Where exposed to weather, provide NEMA Type 3R enclosure with interior thermostatically controlled electrical space heater with adequate wattage to prevent the accumulation of moisture. Obtain power for space heater a control power transformer within the MDP assembly.

I. Surge Protection Device (SPD):
1. Mount in a NEMA Type 1 enclosure external to switchboard equipment.
2. Surge protection uses thermally protected MOV technology.
3. Surge current capacity rating as recommended by manufacturer.
4. Dual-colored protection status indicators for each phase.
5. Dual-colored protection status indicators for the N-G protection mode.
6. Audible alarm with silence button.
7. Form C relay contact.

J. Electronic Customer-Metering:
1. Provide microprocessor based electronic meter to monitor electrical power distribution system in a real time mode. The system consists of a meter and display integral to the MDP in a separate customer-metering compartment with front-hinged door.
2. At a minimum, provide a meter for the incoming electrical service. Where shown on Drawings, provide additional meters for other equipment and feeder devices within Main Distribution Panel.
3. Where multiple meters are required, provide single LCD display capable of accepting inputs from meters shown.
4. Current transformers for each meter wiring to shorting-type terminal blocks within customer metering compartment.
5. Provide potential transformers including primary and secondary fuses with disconnecting means.
6. Accept input from industry standard instrument transformers (120VAC secondary PT's and 5A secondary CT's.)
7. The current and voltage signals digitally sampled at a rate high enough to provide accurate RMS sensing and valid data for waveform analysis beyond the 30th harmonic (fundamental frequency of 60 HZ).
8. Setup parameters required by the meter stored in nonvolatile memory (no battery backup) and retained in the event of a control power interruption.
9. The meter maintains in nonvolatile memory a maximum and minimum value for each of the instantaneous values reported as well as the time and date of the highest peak for peak demand readings.
10. Accurate to +1 percent voltage and current sensing.
11. Minimum readings reported by the meter:
    a. Energy: real (kWh), reactive (kVARh).
    b. Current, per phase RMS +1 percent

c. Current, 3-phase average RMS +1 percent
d. Voltage, phase-to-phase and phase-to-neutral +1 percent
e. Power factor, per phase +2 percent
f. Power factor, 3-phase total +2 percent
g. Frequency +0.5 percent

12. The following demand readings reported by the meter:
    a. Average demand current, per phase.
    b. Peak demand current, per phase.
13. Communications: Provide with RS-485 and Modbus RTU output capability.

2.03 SUB-DISTRIBUTION PANELS (SDP)

A. General:
1. Similar in manufacture as the Main Distribution Panel.
2. Freestanding, rear-aligned, front-accessible, group-mounted circuit breaker type, fully enclosed with bussing and hardware provisions for the addition of future circuit breakers. Assemblies rated 800A or below may be wall-mounted.
3. Circuit breaker trip ratings as indicated on Drawings.
4. Equipment assembly has a short circuit current rating (SCCR) greater than the maximum available fault current expected at that point in the distribution system.
5. Listed by Underwriters' Laboratories and bear a UL label.
6. Refer to Drawings for maximum allowable equipment footprint.

B. Construction:
1. Equipment consists of the required number of vertical sections bolted together to form a rigid assembly.
2. Formed edges of front covers or hinged front panels.
3. Provide adequate ventilation within the enclosure.
4. Sections of the equipment rear-aligned with depth as required to accommodate devices shown and necessary conduit entrance for current and future devices.
5. Exterior and interior steel surfaces properly cleaned and provide with a rust-inhibiting coating. Color and finish ANSI 61 light gray.

C. Bus Work:
1. Copper or tin-plated aluminum, sized as indicated, with a 100 percent capacity neutral bus.
2. Bus sizing based on NEMA standard temperature rise criteria of 149 degrees F above an ambient of 104 degrees F under continuous full load current and rated to withstand the maximum available fault current expected at that point in the distribution system.
3. Include bussing provisions for mounting future devices in spaces called for on Drawings. Where panel configuration provides additional spaces within a section, these spaces bussed to receive future devices.
4. Provide a copper ground bus firmly secured to each vertical section and extending the entire length of the SDP.
5. Fully bus vertical sections.

D. Circuit Breakers:
1. Provide main and feeder circuit breakers as shown on Drawings.
2. Molded case, bolt-on type, with inverse time and instantaneous tripping characteristics.
3. Provide with ground fault protection where indicated on Drawings or as required by NEC.
4. Operated by a toggle-type handle and quick-make/quick-break over-center switching mechanism that is mechanically trip-free. Automatic tripping of the breaker clearly indicated by the handle position.
5. Short circuit capacity rating to withstand the maximum short circuit duty that can be expected at the breaker location in the electrical system. Minimum short circuit rating for circuit breaker 10,000 AIC for 120/208V breakers, and 14,000 AIC for 277/480V breakers.
6. Series rating is not permitted.

7. Provide circuit breakers that are 1200 amp and larger rated or can be adjusted to be 1200 amp or larger rated, with an energy reducing maintenance switch adjustment to meet the requirements of NEC 240.87.
8. Provide LSI adjustable trip setting capability for breakers rated 400 amp and larger.
9. Provide LSIG adjustable trip setting capability for breakers rated 1200 amp and larger.

E. Wiring/Terminations:
1. Small wiring, necessary fuse blocks and terminal blocks within the SDP furnished as required. Control or metering components mounted within the assembly, such as fuse blocks, relays, pushbuttons, switches, etc., suitably marked for identification corresponding to appropriate designations on manufacturer's wiring diagrams.
2. Mechanical-type terminals provided for line and load terminations suitable for copper or aluminum cable rated for 167 degrees F of the size as indicated on the Drawings.
3. Provide lugs in the incoming line section for connection of the main grounding conductor and other grounding conductors as indicated on Drawings.

F. Where exposed to weather, provide NEMA Type 3R enclosure with interior thermostatically controlled electrical space heater with adequate wattage to prevent the accumulation of moisture. Power for space heater obtained from a control power transformer within the SDP assembly.

G. Surge Protection Device (SPD):
1. Mount in a NEMA Type 1 enclosure external to SDP equipment.
2. Use thermally protected MOV technology.
3. Surge current capacity rated as recommended by manufacturer.
4. Dual-colored protection status indicators for each phase.
5. Dual-colored protection status indicators for the N-G protection mode.
6. Audible alarm with silence button.
7. Form C relay contact.

H. Electronic Customer-Metering, where shown on Drawings:
1. Provide microprocessor based electronic meter to monitor electrical power distribution system in a real time mode. The system consists of a meter and display integral to the SDP in a separate customer-metering compartment with front-hinged door.
2. Where multiple meters are required, provide single LCD display capable of accepting inputs from meters shown.
3. Current transformers for each meter wiring to shorting-type terminal blocks within customer metering compartment.
4. Potential transformers including primary and secondary fuses with disconnecting means provided.
5. The electronic meter accept input from industry standard instrument transformers (120 VAC secondary PT's and 5A secondary CT's.)
6. The current and voltage signals digitally sampled at a rate high enough to provide accurate RMS sensing and valid data for waveform analysis beyond the 30th harmonic (fundamental frequency of 60 HZ).
7. Setup parameters required by the meter stored in nonvolatile memory (no battery backup) and retained in the event of a control power interruption.
8. Maintain in nonvolatile memory a maximum and minimum value for each of the instantaneous values reported as well as the time and date of the highest peak of the peak demand readings.
9. Accurate to +1 percent voltage and current sensing.
10. The following minimum readings reported by the meter:
    a. Energy: real (kWh), reactive (kVARh).
    b. Current, per phase RMS +1 percent
    c. Current, 3-phase average RMS +1 percent
    d. Voltage, phase-to-phase and phase-to-neutral +1 percent
    e. Power factor, per phase +2 percent

f. Power factor, 3-phase total +2 percent
g. Frequency +0.5 percent

11. The following demand readings reported by the meter:
    a. Average demand current, per phase.
    b. Peak demand current, per phase.
12. Communications: Provide with RS-485 and Modbus RTU output capability.

2.04 FUSES

A. Fuse each active fusible switch with non-renewable type, dual element, and current-limiting fuses of such characteristics as shown on the Drawings.

B. Capable of holding 500 percent of rated current for a minimum of 10 seconds, and carry a UL listed interrupting rating of 200,000A rms symmetrical.
    1. Up to 600A: UL Class RK-1, time delay
    2. Above 600A: UL Class L, time delay

C. Ampere rating permanently stamped or etched into the metal cap.

D. Manufacturer:
    1. Bussman
    2. Littelfuse
    3. Or approved equal.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install the distribution system assemblies and equipment as shown on the Drawings, parallel and square with the building lines.

B. Attach distribution equipment to building structure; refer to Section 26 05 29, Hangers and Supports for Electrical Systems.

C. Neatly lace and secure the conductors of the feeder circuits individually at maximum 2-foot intervals. Cable lugs not to support the weight of the cables.

D. Where fusible distribution panels are provided, mount a spare fuse cabinet adjacent to each fusible distribution panel. Equip cabinet with one complete set of spare fuses of each size and type installed in the panel with appropriate fuse pullers.

E. Concrete Pads: Provide minimum 3.5-inch thick concrete housekeeping pads under freestanding pieces of distribution equipment. Pads extend a minimum of 2-inches beyond the edges of the equipment.

F. Adjust breaker settings per recommendation of coordination study and test ground fault settings as required by NEC.

G. Equipment Tests:
    1. Provide acceptance testing for equipment in accordance with NETA Acceptance Testing Specifications. Record results and submit with final warranty.
    2. Where ground fault protection is provided, perform tests on the ground fault protection system in accordance with the manufacturer's instructions. Record results and submit with final warranty.
    3. If tested equipment is found defective during testing sequence, replace it without additional cost to the Owner. Test replaced equipment until satisfactory results are obtained.

H. Cleaning: Upon completion of installation, inspect interior and exterior of distribution equipment. Remove paint splatters or other spots. Vacuum dirt and debris; do not use compressed air to clean. Repair exposed surface to match original finish.

END OF SECTION

SECTION 26 24 16
PANELBOARDS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Branch Panelboards
   2. Identification

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 33, Raceways and Boxes for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

G. Section 26 43 13, Surge Protective Devices

1.03 SUBMITTALS

A. Shop Drawings

B. Product Data
   1. Detailed component material list.
   2. Voltage rating, amperage rating, bussing material, fault rating, wiring lugs capacity, mounting method, physical size, exterior finish and options.
   3. Individual circuit breaker product data sheets.
   4. Panel schedules indicate circuit breakers in the same orientation as the construction documents.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Panelboards use the same manufacturer as the distribution equipment specified in Section 26 24 13, Switchboards.

B. BRANCH PANELBOARDS

C. Branch Circuit Panels:
   1. Bolt-on circuit breaker type fitted with metallic flush lift latches and locks keyed alike.
   2. Deliver panel keys to the Owner at completion of the project.

D. Short Circuit Current Rating (SCCR):
   1. Fully rated at a value greater than the maximum available short circuit current that can be expected at the panelboard location in the electrical system.
   2. Series rating is not permitted.

E. Cabinets:
   1. Cabinet rough-in boxes code gauge steel, with dead front covers.
   2. Flush panels have flush doors with concealed hinges and mounting clamps.
   3. Surface panels have metal face trims with no sharp edges or corners.
   4. Surface panel cabinets fabricated without knockouts and finished to match face trim.
   5. Panels have door in door hinged trim fronts that provides full access to wiring compartment.

F. Wiring Gutters:
   1. Minimum of 4-inches wide except where feeder conductors enter where a minimum of 6-inches clear.
   2. Feeder conductors to enter directly in line with lug terminals wherever practicable.

3. Provide separate feeder studs for each feeder conductor compression lug.

G. Bussing:
1. Provide one continuous bus bar per phase.
2. Provide copper or electrical grade aluminum alloy sized as indicated on the drawings and in accordance with UL standards to limit temperature rise on current carrying part to a maximum of 149 degrees F above an ambient temperature of 104 degrees F maximum.
3. Full size insulated neutral bars included for panels indicated to have a neutral.
4. Bus bar taps for panels with single pole branches arranged for sequence phasing of the branch circuit devices.

H. Ground Bus: Provide in each panelboard and include the following:
1. Have the same rating as the neutral bus.
2. Contain a ground conductor terminal for each available circuit in the panelboard.
3. Size terminals for branch circuit equipment grounding conductors.

I. Isolated Ground Bus: Provide in each panelboard as indicated and included the following:
1. Insulate from the panelboard enclosure.
2. Same rating as the neutral bus.
3. Contain a ground conductor terminal for each available circuit in the panelboard.
4. Have terminals sized for the branch circuit equipment grounding conductors.

J. Interiors:
1. Main lug only unless otherwise indicated, with dead front shield covering the bus, and bus connectors, with mounting hardware and bussing for spaces indicated for future installation of devices.
2. Dead front construction for interior trim.
3. Cover unused mounting spaces with preformed knockouts.

K. Main Circuit Breaker:
1. Where indicated, equip panels indicated with main circuit breakers sized as scheduled and mounted behind door at top of panel for top entrance feeders, and bottom of panel for bottom entrance feeders.
2. Where main circuit breaker size is not indicated, ampere rating match feeder ampacity, or panelboard rating, whichever is less.
    a. Molded case, thermal magnetic bolt-on type and sized as indicated on the Drawings. Circuit breaker have an over center, trip-free, toggle mechanism that provide quick-make, quick-break contact action. Indicate open, closed, or tripped by handle position, with common internal trip crossbar to provide simultaneous tripping for poles.
    b. Circuit breakers have a permanent trip action with thermal and magnetic trip elements in each pole. Each thermal element factory calibrated to operate in a 104 degrees F ambient environment. Thermal elements ambient compensating above 104 degrees F.
    c. Provide the main circuit breaker with a padlock-able lock-off device to provide capability to be locked in the open position.

L. Branch Circuit Breakers:
1. Provide with amperage rating, and number of poles as indicated in the Panelboard Schedules.
2. Bolt-on type circuit breakers.
3. Over center toggle mechanism that provide quick-make, quick-break contact action. Circuit breakers have thermal and magnetic trip elements in each pole. Two and three pole circuit breakers have an internal common trip crossbar to provide simultaneous tripping.
4. Exposed faceplates of circuit breakers flush with one another.

5. Short circuit capacity rating to withstand the maximum short circuit duty that can be expected at the breaker location in the electrical system. Minimum short circuit rating for circuit breakers: 10,000 AIC for 120V and 208V breakers, 14,000 AIC for 277V and 480V breakers.
6. Circuit breakers used for switching duty UL listed for that purpose and marked SWD.
7. Provide each branch circuit breaker with a factory padlock-able lock-off provisions.

M. Provide shunt trips, alarms, and auxiliary switches as shown on the Drawings.

N. Provide Arc Fault Circuit Interrupter (AFCI) breakers as shown on the Drawings or as required by Code.

O. Provide Ground Fault Interrupter (GFI) Circuit breakers as shown on the drawings or as required by Code. GFI breakers serving heat trace circuits 30 ma ground fault trip rating.

P. Surge Protective Device (SPD): Provide an integral or separate SPD with panelboards that are part of an emergency NEC 700 required system. Refer to Section 26 43 13, Surge Protective Devices for requirements.

2.02 IDENTIFICATION

A. Identify branch circuit breakers with individual circuit numbers adjacent to each breaker with a typewritten card to identify the load controlled by that breaker.

B. Provided with complete schedules of panelboards as designed prior to start of construction. Schedules will include circuit breaker arrangement, load schedules, and ratings for use in identification of circuits and coordination.

C. Refer to Section 26 05 53, Identification of Electrical Systems for additional requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install panelboards in accordance with manufacturer's recommendations.

B. Install panelboards plumb and level, located as shown on the Drawings up 6-feet – 6-inches to top unless noted otherwise.

C. Keep area above panelboard clear of equipment foreign to the electrical installation. Coordinate installation with other trades.

D. Provide identification and panel schedules as specified in Section 26 05 53, Identification of Electrical Systems.

E. Provide the required SPD and associated overcurrent device for emergency NEC 700 systems, install per manufacturers recommendations.

3.02 SALVAGE

A. Utilize circuit breakers/fusing in existing panels that are to remain. Where faulty or inadequate breakers/fusing are found in these panels, replace with suitable breakers from panels removed during demolition.

3.03 SPARE CONDUITS

A. Install a spare 3/4-inch conduit from flush panels for each three single pole breakers or spaces provided. Terminate conduits above accessible ceiling or as directed.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Line Voltage Wall Switches
   2. Receptacles
   3. Plates

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 05 33, Raceways and Boxes for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

G. Section 26 09 23, Lighting Control Devices

1.03 SUBMITTALS

A. Product Data

B. PRODUCTS

1.04 MANUFACTURERS

A. Line Voltage Wall Switches:
   1. Hubbell
   2. Leviton
   3. Arrow-Hart
   4. Pass & Seymour

B. Receptacles:
   1. Use same manufacture as the Line Voltage Wall Switches.
   2. Hubbell
   3. Leviton
   4. Arrow-Hart
   5. Pass & Seymour

C. Plates:
   1. Hubbell
   2. Leviton
   3. Arrow-Hart
   4. Pass & Seymour

1.05 MATERIALS

A. Extra heavy duty grade wiring devices, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed. Device of same grade and manufacture as specified below. Furnish a matching plug connector for special purpose devices that do not have the common 120V NEMA 5-20R configuration.

B. Lighting switches and duplex receptacles installed have similar appearance characteristics unless noted otherwise.

1.06 LINE VOLTAGE WALL SWITCHES

A. Line Voltage Switches:
   1. 20A rated, 277V, quiet type, extra heavy duty, heavy duty nylon toggle handle, back, and side wired with screw terminal connections.
   2. As noted on the drawings provide:
      a. Pilot light switch: lighted clear toggle.
      b. Momentary Contact Switches: 15A, SPDT, center off.
      c. Key Switches: 20A, 277V, back and side wired with screw terminal connections.

B. Except as noted herein, device exposed finish color as follows:
   1. Normal Power: As selected by Architect

1.07 RECEPTACLES

A. Standard Straight Blade Duplex Receptacle:
   1. 3-wire, 2-pole with grounding, extra heavy duty, 20A rated, NEMA 5-20R configuration, back and side wired with screw terminal connections.
      a. Provide tamper-resistant as noted on the drawings or NEC required.
      b. Provide isolated ground as noted on the drawings or NEC required.
   2. Ground Fault Interrupting straight blade duplex receptacle:
      a. Heavy duty, 3-wire, 2 pole with grounding, self-testing, green “ON” LED to indicate power, red “ON” LED to indicate ground fault condition, 20A rated, NEMA 5-20R configuration, back and side wired with screw terminal connections.
         1) Provide tamper-resistant as noted on the drawings or where NEC required.
         2) Provide weather-resistant rating at exterior locations as required by NEC.

B. Clock Outlets: As noted on the drawings and compatible with the specified clock system.

C. Special Purpose Receptacles: As noted on Drawings with NEMA configurations.

D. Exposed Device Color, unless otherwise noted, is as follows:
   1. Normal power: Gray or as selected by Architect.

1.08 PLATES

A. Flush Finish Plates:
   1. Coordinated with Architect.
   2. 0.04-inch thick, Type 302 stainless steel, brush finish.

B. Surface Covers:
   1. Galvanized or cadmium plated steel, 1/2-inch raised industrial type with openings appropriate for device installed.

C. Weatherproof:
   1. Extra-Duty while in use covers, UL 514D listed, commercial quality die cast aluminum construction, NEMA 3R rated, gasketed, built-in padlock provisions, built-in cord strain relief provisions, gray powder-coated finish, vertical mounting as required for application or other covers of similar construction for other receptacle configurations.

D. Identification:
   1. Identify receptacle plates with a pre-printed label indicating serving panel and branch circuit number.
   2. Refer to Section 26 05 53, Identification for Electrical Systems.

PART 2 EXECUTION

2.01 INSTALLATION

A. Devices and finish plates installed plumb with building lines. Install wall mounted receptacles vertically at centerline height shown on the Drawings.

B. Finish plates and devices are not installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.

C. Switches, receptacles and/or other devices ganged into a common enclosure provided with a separation barrier between devices where the combined circuit voltages within the enclosure exceeds 300V.

D. Provide GFCI receptacles as shown on the drawings or as NEC required. Provide a GFCI type duplex receptacle in each required location, do not sub-feed normal receptacles downstream of the GFCI receptacle to obtain the GFCI rating.

E. Provide receptacles with GFCI, tamperproof, weather-resistant or hospital grade ratings as shown on the drawings, appropriate for the installation or required by NEC.

2.02 CORD CAPS

A. Special plugs provided with the receptacles given to the Owner in their cartons with a letter stating the date and the Owner's representative that received the materials.

2.03 COORDINATION

A. Electrical Drawings indicate the approximate location of devices. Refer to Architectural elevations, sections, and details for exact locations.

B. Coordinate with equipment installer the locations and methods of connection to devices mounted in cabinets, counters, work benches, service pedestals, and similar equipment.

2.04 TESTING

A. Test receptacles for line to neutral, line to ground and neutral to ground faults. Correct defective wiring.

END OF SECTION

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SECTION 26 29 00
MOTOR CONTROLLERS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Motor Control Centers
   2. Motor Starters
   3. Disconnects
   4. Fuses
   5. Related Sections

B. Division 01, General Requirements

C. Division 26, Electrical

D. Section 26 05 19, Low Voltage Electrical Power Conductors and Cable

E. Section 26 05 26, Grounding and Bonding for Electrical Systems

F. Section 26 05 53, Identification for Electrical Systems

G. Section 26 05 73, Overcurrent Protective Device Coordination Study

H. Section 26 05 80, Electrical Testing

1.02 SUBMITTALS

A. Shop drawings, including the following information.
   1. Field Dimensions
   2. Description of Materials and Finishes
   3. Component Connections
   4. Anchorage Methods.
   5. Installation Procedures

B. Product Data

C. Operating and Maintenance Data

D. Overload (Heater) Sizing: A final listing of motors and the heater size installed for that motor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Motor Control Centers, Motor Starters and Visible Blade Disconnects:
   1. Same manufacture as the distribution equipment specified in Section 26 24 13, Switchboards.
   2. Allen Bradley
   3. Or approved equivalent.

B. Horsepower Rated Toggle Switches:
   1. Arrow Hart
   2. General Electric
   3. Hubbell
   4. Pass & Seymour

2.02 GENERAL

A. Provide manual or magnetic motor starters of the proper characteristics for equipment as indicated.

B. Provide motor control centers as indicated.

C. Provide switches of proper characteristics as disconnecting means.

2.03 MOTOR CONTROL CENTERS

A. NEMA Class 1, Type B, plug-in construction, floor mounted free standing, 15-inches deep, 20-inch width as required, complete with devices scheduled, terminal boards, wireways, control circuit transformers, fuses, ground bus and neutral bus where indicated.

B. Steel parts, except those used for ground connections, painted with an acrylic baked enamel finish. Multi-step treatment process followed by the finish coat.

C. Paint color:
   1. ANSI standard 49 medium light gray.

D. Bussing tin plated copper:
   1. Braced for 65,000A minimum fault current with main bus rating as shown on the Drawings.
   2. Based on 149 degrees F maximum temperature rise in a 104 degrees F ambient.

E. Vertical Bussing:
   1. Copper
   2. Securely bolted to the main bus.
   3. Provide with provisions for future extension to addition sections.
   4. Connect directly to the main horizontal bus without the use of risers or other intervening connectors.
   5. When a back-to-back arrangement is utilized, separate vertical bus provided for both the front and rear units.

F. Provide tin plated copper ground bus the entire length of the motor control center. The ground bus have a minimum rating of 300 Amperes, unless otherwise indicated on the drawings. Minimum of six holes for each vertical section to accept ground lugs for each load in that section.

G. Each vertical section has a vertical ground bus that is connected to the horizontal ground bus, and installed such that the plug-in units in the section engages the ground bus prior to engagement of the power stabs, and disengage only after the power stabs are disconnected upon removal of the plug-in unit. Brace bussing 42,000A minimum fault current with main bus rating as shown on the Drawings with bussing for future extension.

H. Circuit breakers molded case, bolt-in magnetic type where in combination with a motor starter. Where breakers are used for branch circuit or distribution functions, thermal magnetic type. Short circuit capacity rating to withstand the maximum short circuit duty that can be expected at the breaker location in the electrical system. Minimum short circuit rating for circuit breaker 10,000 A.I.C. for 120V and 208V breakers, 14,000 A.I.C. for 277V and 480V breakers.

I. Fusible switches quick-make quick-break, horsepower rated, general duty, rated to withstand 100,000A fault current.

J. Provide wireways with no less than 6 inches of height at the top and not less than 9 inches at the bottom. Sub-base may be provided. Do not obstruct wireways by neutral bussing, terminals, or other devices unless additional space is provided. Provide vertical wireways for wiring to starter compartments for load and control conductors.

K. Future provisions include bussing and mounting provisions for future starters in every space provided in the assembly by the manufacturer.

L. Power bussing and splice connections isolated from the unit compartments and the wireways. The horizontal bus isolated from the top wireway with a removable barrier to allow access to the bus and connections for maintenance.

M. Starter units with circuit breaker type disconnects through 250A frame size connects to the vertical bus through a spring reinforced stab-on connector. Units with larger disconnects connect directly to the vertical bus. Stabs to plug-in units solidly bussed to the unit disconnect. Cabled stab assemblies are not permitted.

N. Motor control center starters utilizes disconnect. A magnetic only circuit breaker may be used. Disconnect specified for combination type starters. Sizing as indicated. Starters utilized NEMA rated contactors. Provide starters with a three-pole, external manual reset, and overload relays in phases and a running indicating light.

O. Indicating Lights:
   1. LED type.
   2. Color to be green for run, red for stopped unless otherwise indicated.

P. Each Motor Control Center and each unit within the Motor Control Center identified with an engraved nameplate as specified in Section 26 05 53, Identification for Electrical Systems.

2.04 MOTOR STARTERS

A. Manual Starters:
   1. NEMA ICS 2, AC general purpose Class A manually operated toggle type full voltage controller for fractional horsepower induction motors, quick-make, quick-break, with thermal overload protection and suitable enclosures.

B. Magnetic Starters, Non-reversing:
   1. NEMA ICS 2, AC general purpose, full voltage across the line non-reversing type, 120V coils, overload relays in each leg, running pilot lights, one normally closed and one normally open auxiliary contacts, 120V control transformers and suitable enclosures.
   2. Overload relays ambient compensated bimetallic type with interchangeable heater pacts.
   3. Overload adjustable, have single-phase sensitivity, and manual or automatic reset.
   4. Suitable for the addition of at least four auxiliary contacts of arrangement normally open or normally closed.
   5. Provide with a NO and a NC auxiliary contacts.
   6. Minimum fault interrupting rating of 10,000A.

C. Magnetic Starters, Reversing:
   1. NEMA ICS 2, AC general purpose.
   2. Reversing starters consist of two contactors and a single overload relays assembly.
   3. Include electrical interlock and integral adjustable time delay transition between FORWARD and REVERSE rotation.
   4. Starters electrically and mechanically interlocked to prohibit line shorts and both starters being energized simultaneously.

D. Magnetic Starters, Two Speed:
   1. NEMA ICS 2, AC general purpose.
   2. Include electrical interlock and integral adjustable time delay transition between SLOW and FAST speeds.
   3. Electrically and mechanically interlocked to prohibit both starters being energized simultaneously.

E. Combination Starter/Disconnect, (Circuit Breaker):
   1. Combine magnetic motor starter as described above and thermal magnetic circuit breaker disconnect in a common enclosure.

F. Motor Circuit Protector:
   1. NEMA AB 1, circuit breaker with integral instantaneous magnetic trip in each pole.
   2. Externally operated handle, giving positive visual indication of its ON-OFF position.

G. Thermal Magnetic Circuit Breaker:
   1. NEMA AB 1, with integral thermal and instantaneous magnetic trip in each pole.
   2. Circuit protector externally operated handle, giving positive visual indication of its ON-OFF position.

H. Combination Starter/Disconnect, Disconnect Switch Type:
   1. Combine magnetic motor starter as described above and non-fused or fused disconnect switch in a common enclosure. Switch type as indicated on the drawings. Switch has an externally operated handle that gives positive visual indication of its ON-OFF position.

2. Non-fused Switch Assemblies:
   a. NEMA KS 1, enclosed knife switch with enclosed, but visible blades. Switch rated as indicated on the drawings.
3. Fused Switch Assemblies:
   a. NEMA KS 1, enclosed knife switch. Fuse clips accept Class R fuses. Switch and fuse sizes as indicated on the drawings.

I. Starter Contacts:
1. Totally enclosed, double break, silver-cadmium-oxide power contacts.
2. Contact inspection or replacement possible without disturbing line or load wiring.

J. Overload Relay:
1. NEMA ICS with one-piece thermal unit construction.
2. Interchangeable thermal units.
3. Replaceable overload relay control circuit contact.
4. Thermal units required for starter to operate.

K. Enclosure:
1. NSI/NEMA ICS 6, Type 1 as indicated, or as required to meet the conditions of installation.

L. Equip starters with H-O-A selector switches, start-stop stations, or other auxiliary control device listed. Where no auxiliary devices are listed, equip each starter with an H-O-A switch.

M. Provide a control circuit transformer in each starter. Size transformer to accommodate the contactor(s) and control circuit loads. Include primary and secondary fuses in ungrounded conductors.
1. Provide one normally open and one normally closed auxiliary contacts in each starter, unless additional auxiliary contacts are required. NEMA ICS 2.

N. Provide starter units with control terminal blocks. Terminal blocks rated at 20-Amperes and accessible from inside the unit with the unit door is opened.

O. Push Buttons: Unguarded, recessed type

P. Indicating Lights, LED type:
1. Green for run.
2. Red for stopped unless otherwise indicated.

2.05 DISCONNECTS

A. Safety and disconnect switches NEMA type HD (heavy duty), quick-make, quick-break, dual rated with electrical characteristics as required by the system voltage and the load served. Equip switches with defeatable cover interlock.

B. Enclosures NEMA l for indoor use, unless specifically noted otherwise and NEMA 3R where installed exposed to the weather or designated by the subscript WP.

C. Fusible or non-fusible as designated on Drawings.

2.06 FUSES

A. UL Class RK-5 dual element, time delay, current limiting type. The overload thermal time delay element spring actuated soldered copper assembly in a separate sand free compartment. The short circuit current limiting section copper alloy links encased in quartz sand.

B. Capable of holding 500 percent of rated current for a minimum of 10 seconds, and carry a UL listed minimum interrupting rating of 200,000A rms symmetrical.

PART 3 EXECUTION

3.01 MOTOR STARTERS

A. Provide the motor starting equipment as shown on the Drawings and coordinate motor overload starter relays.

B. Install the starters at the respective equipment unless shown otherwise.

C. Install freestanding starters on metal channel support structure.

D. Starters that are installed on exterior walls installed with minimum 1/2-inch channel on wall to allow air space between starter and wall.

E. Where fusible units are provided, install fuses as indicated on the drawings.

F. Install thermal overloads (heaters) in each starter in accordance with the manufacturer's recommendations for that motor and the type of associated load. Coordinate proper size when individual power factor capacitors are utilized at the motor.

3.02 DISCONNECT SWITCHES

A. Provide code required disconnect switches under this work.

B. Non-fusible disconnect switches required when equipment is not in sight of the branch circuit panel or starter may be horsepower rated, toggle type in suitable enclosure, mounted at or on the equipment.

3.03 MOTOR CONTROL CENTERS

A. Install motor control centers parallel with structural building line. Sections fit neatly without gaps, openings, or distortions. Install level and plumb sections.

B. Seismic Restraint:
   1. Provide seismic restraint for electrical equipment as recommended by SMACNA.
   2. Provide shop drawings sealed by a registered Structural Engineer indicating this seismic restraint.

C. Securely tie wiring at intervals not to exceed two feet in wireways.

D. Arrange conduits and raceways entering the assemblies to avoid obstruction of the wireways. Conduits enter the assembly close to the associated starter section, avoiding crisscrossing and congestion in the wireways.

E. Provide a nominally 2-inch deep concrete pad for motor control centers.

F. Identification on each starter and motor control center provided as specified in Section 26 05 53, Identification for Electrical Systems and as indicated in this section.

3.04 FUSES

A. Install fuses for motor protection to best protect the motor without nuisance tripping. Should fuse sizes require changing from what is shown due to variance between the original design information and actual equipment installed, fuses sized in accordance with NEC. Do not size fuses smaller than the starter heaters on motor circuits.

B. Provide one complete set of spare fuses of each amperage used on this project. Store spare fuses in the spare fuse cabinet.

3.05 COORDINATION

A. Verify the characteristics and the motor full load current for each motor installed, using the actual motor nameplate data. Select and install the proper running overload devices in the starter as per the manufacturer's instructions. Provide the proper overload protection is a part of this Division of the work.

B. Prepare table of motor full load currents and installed overload devices and submit to the Architect.

END OF SECTION

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SECTION 26 43 13
SURGE PROTECTIVE DEVICES

PART 1 GENERAL

1.01 SUMMARY

A. The Sections includes:
   1. Surge Protective Devices
   2. Enclosure

B. Surge Protective Devices (SPD) for low voltage power equipment and provide effective high energy protection against transient surges, temporary over-voltages, voltage swells and high frequency noise attenuation.

C. This Section describes the materials and installation requirements for Surge Protective Devices (SPD). SPD's are used for the protection of AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

D. This specification also describes the mechanical and the electrical requirements for the SPD. Suitable for application in both category B and C environments as described in ANSI/IEEE C62.41- 2002.

E. Furnish and install the Surge Protective Devices having the electrical characteristics, ratings and modifications as specified herein and as shown on the contract documents. Provide related hardware (i.e. flush mounting kits, mounting brackets, etc.) as required for the installation of the SPD system suitable for the application.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 23 13, Switchboards

D. Section 26 24 16, Panelboards

1.03 REFERENCE STANDARDS

A. UL Underwriters Laboratories
   1. ANSI/UL 1449 Standard for Safety for Surge Protective Devices.

B. ANSI American National Standards Institute
   1. ANSI C84.1 American National Standard for Electric Power Systems and Equipment - Voltage Ratings (60 Hz).

C. IEEE Institute of Electrical and Electronics Engineers
   1. IEEE C62.41.1 Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits.
   2. IEEE C62.41.2 Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits.
   3. IEEE C62.45 IEEE Recommended Practice on Surge Testing for Equipment Connected to Low-Voltage (1000 V and Less) AC Power Circuits.
   4. IEEE 142 IEEE Recommended Practice for Grounding of Industrial and Commercial Power Systems (Green Book).
   5. IEEE 1100 IEEE Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (Emerald Book).

D. ISO International Organization for Standardization
   1. ISO 9001 Quality Systems – Quality Management System

E. MIL Standard 220 (Department of Defense) - Test Method Standard, Method of Insertion-loss Measurement.

F. NFPA 70 (National Fire Protection Association) - National Electrical Code.

G. UL 1283 (Underwriters Laboratories) - Standard for Safety for Electromagnetic Interference Filters.

1.04 SUBMITTALS

A. Include written specification response referencing each specification section and sub-section indicating compliance or non-compliance. If manufacturer cannot fully comply with specification section, this must be stated in the response along with a full description of the variance.

B. Submit the following information, indexed by response and test results. Receive a minimum of 2 weeks in advance of the date the submittal evaluation needs to be completed for the project.
   1. Specification compliance response sheet referencing each specification section.
   2. Proof of compliance to the current edition of UL1449 from a Nationally Recognized Test Lab (NRTL) accepted by local authority having jurisdiction. UL1449 Nominal Discharge Current Rating and Voltage Protection Ratings provided.
   3. UL1283 filter compliance documentation.
   4. Published specifications, cut sheets and product data with appropriate IEEE C62.41 and UL1449 (current edition) performance ratings for intended installation locations.
   5. Electrical and Mechanical Shop Drawings
   6. Installation Requirements/Instructions
   7. Operations and Maintenance Manuals
   8. Performance/Warranty Information

C. The Engineer reserves the right to accept or reject any or all submittals, to request additional information as deemed necessary or to request submittals for a different unit deemed more appropriate for this installation.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Manuals

B. Warranty Documentation

C. Notes to Record Drawings

1.06 QUALIFICATIONS

A. UL1449 (current edition) compliance and listing from Nationally Recognized Test Lab (NRTL) accepted by local authority having jurisdiction. Type 1 compliance required for SPD intended for installation before (or after) Main Service Disconnect or Type 2 compliance for installation after Main Service Disconnect. Provide published UL1449 (current edition) Nominal Discharge Current Rating and Voltage Protection Rating.

B. Local representation and distribution within 400 miles of the project location to provide technical, warranty claim, and installation support for the project.

C. Manufacturer/vendor must be capable of supplying SPD for project within 30 days of receipt of order for orders of 25 units and less for models submitted in response to this specification.

D. Certified to latest ISO 9001 standard and registered for the design and manufacturing of SPD devices.

E. Provide access to a readily available factory engineer for answering questions about this product.

F. Only firms regularly engaged in the manufacture of SPD products for category C locations (ANSI/IEEE C62.41.1-2002), and whose products have been providing satisfactory service for not less than five years, considered. Upon request, provide a customer reference list, with a minimum of five contact names and current phone numbers.

G. Provide manufacturer qualifications as part of the submittal.

H. The successful manufacturer/vendor to assign a technical contact person for SPD application, installation, and warranty questions. Contact available to provide a response to a technical question within a maximum of two business days.

I. Single manufacturer capable of providing power system SPD's.

1.07 DELIVERY, STORAGE AND HANDLING

A. Inspect for damage and replace any damaged device.

B. Store in a clean, dry space suitable for equipment and protect against damage.

C. Clean equipment and touch up minor scratches using suitable materials.

1.08 OPERATION AND MAINTENANCE MANUALS

A. Provide equipment operation and maintenance manuals with each assembly shipped and include instruction leaflets and bulletins for the complete assembly and each major component.

1.09 WARRANTY

A. Minimum requirements:
   1. Period: 10 years from the date of substantial completion of service and activation of the system to which the SPD is attached.
   2. Full replacement of a suppressor which is damaged or fails to meet manufacturers published specifications and specifications provided within, without pro-rating value.
   3. No exclusions from failure or damage from any system anomaly (over-voltage, single phasing, lightning strike, etc. (IEEE 62.41.1).
      a. Exceptions: Failure caused by wiring error, loose, or missing Neutral to Ground Bond or Meggar Testing with SPD connected to power system.
   4. Factory or third party testing not required.
   5. Warranty applies independent of facility ownership / purchaser.
   6. Replacement unit to be at facility within 7 business days of receipt of written notification of failure at no cost to the customer (exception – custom configuration or special order units).
   7. Replacements: same make, model and configuration as original unit unless otherwise requested or approved.
   8. Manufacturer site visit for validation of warranty claim: manufacturer/vendor must visit site within 3 days of notification at no cost. This section does not modify 1.12 (A) (6).
   9. No shipping, handling, examination or other fees are allowed.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Same as manufacturers listed in Section 26 24 13, Switchboards.

2.02 GENERAL DESIGN AND PERFORMANCE REQUIREMENTS

A. Performance and Ratings:
   1. Minimum durability and performance requirements are described below in accordance with test procedures outlined in ANSI/IEEE C62.45 and UL1449 (current edition). Provide test documentation as part of the submittal package. Provide information in a format which is easily to analyze and review. Submit the following test data as manufacturer published literature:
      a. Provide Peak Surge Current (Single Pulse Rated, 8/20µS, by mode, Amperes) with submittals document for each SPD proposed. For electrical equipment located at Service Entrance or Category C locations, Surge current rating a minimum of 160kA per phase / 80kA per mode for IEEE C62.41.1-2002 - Category C Low Exposure locations and 300kA per phase / 150kA per mode for IEEE C62.41.1-2002-Category C High Exposure locations or critical locations.
      b. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G and N-G) with submittals.
      c. Surge Current Rating: Minimum of 80kA per phase / 40kA per mode in low exposure locations or 120kA per phase / 60kA per mode for distribution switchboards or motor control centers in medium and high exposure / critical equipment locations and for IEEE C62.41.1-2002 - Category B and C Switchboard and Motor Control Center Locations.
      d. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G and N-G) with submittals.

e. Surge Current Rating:
   1) Minimum of 80kA per phase / 40kA per mode for branch panel models in low, medium and high exposure areas and for IEEE C62.41.1-2002 - Category B and C Panel and Sub-Panel Locations.
f. Provide surge current ratings for each applicable protection mode (L-L, L-N, L-G and N-G) with submittals.
g. For each SPD proposed, provide published durability test data utilizing the ANSI/IEEE C62.41-1991, Category C3, 20kV/10kA, 1.2 x 50 µS - 8x20 µS combination waveform for SPD durability tests with (as a minimum), the ANSI/IEEE C62.41-1991, Category C1, 6kV/3kA, 1.2 x 50 µS - 8x20 µS combination waveform used for pre and posttest measurement of let through performance variation. Provide test data with submittals, including test setup information.
h. SPD devices withstand a minimum of 15,000 IEEE C3 20kV/10kA hits delivered at a rate not exceeding one pulse per minute without failure or degradation exceeding 5 percent using IEEE B3 6kV/3kA combination waveform for pre and post durability let through measurement evaluation. Lead length for testing and let through measurements, 6-inchs.
i. UL Third Edition Nominal Discharge Current Ratings a minimum of 20kA per mode for SPD's to be installed at the Service Entrance (or where direct lightning strike potential exists on outdoor feeder or branch circuit conductors serving electrical equipment) and a minimum of 10kA per mode for all other locations.
j. Provide EMI/RFI Attenuation as per Mil Std-220. Attenuation 40dB at 100 kHz.

2.03 SURGE PROTECTIVE DEVICES

A. Compatible with the electrical system voltage, current, system configuration and intended applications and NRTL listed for such application.

B. Parallel design only with individual protection components:
   1. Line to Ground and Line to Line for Delta and High Resistance Grounded systems.
   2. Line to Ground, Line to Neutral and Neutral to Ground for Wye and Single Phase distribution systems.

C. Utilize Metal-Oxide Varistors (MOV) components as primary energy mitigation. Selenium cell, air gaps, gas tubes are not allowed.

D. Maximum continuous operating voltage (MCOV) of components (based on ANSI C84.1 standard voltages), not less than 125 percent for 120/208 volt systems and 115 percent for other systems.

E. Short Circuit Current Ratings (SCCR): Suitable for location SPD is to be installed.

F. Visual indication of protection status on each phase, visible from the front of the equipment.

G. Protection Status:
   1. Normally open and normally closed contacts for remote monitoring.
   2. Rated a minimum of .5A, AC or DC.
   3. Change state upon device failure or loss of power.

H. As a minimum, Branch Panel, Sub-Panel and series installed (branch circuit) SPD includes a passive circuit which allows the SPD to actively follow the voltage waveform and provide a clamping envelope to limit low level IEEE C62.41 Category A ring waves (of either polarity) at all locations on the sine wave. Circuit to perform in the Neutral to Ground Mode.

I. Provide complete, comprehensive installation instructions.

2.04 ENCLOSURE

A. NEMA rated metal enclosure appropriate for environmental conditions and exposure at point of installation.

B. Designed to allow connection of the SPD without sharp bends in the conductors.

C. Metal flush kits for flush mount installations (external devices) on new and retrofit applications for panels. Include supports for fastening to structural members and include a faceplate matching SPD finish. Retrofit kits capable of being installed next to the panel after drywall has been installed without the need for patching or refinishing of the wall.

PART 3 EXECUTION

3.01 GENERAL

A. General Application and Installation Requirements
   1. Per the manufacturer's installation instructions.
   2. Per Installation Checklist.
   3. NFPA 70 (NEC) Requirements.
   4. Per IEEE C62.41.2, 141, 142 and 1100.
   5. Local Authority Having Jurisdiction
   6. Project Engineer

B. Tap directly to the bus without upstream over-current protection unless tap conductors are protected at their termination by NRTL listed Disconnect, Over-current and Short Circuit Protective Devices (Fuse with Disconnect and/or Circuit Breaker) properly rated for conductor and SPD Device Protection as per NRTL listing and NEC requirements.

C. Provide qualified personnel to provide one hour of on-site installation training for contractor.

D. Clean SPD units and flush mount covers and touch up with matching paint as necessary.

E. Inspect and test SPD devices as per manufacturer specification and installation guidelines.

F. Project Engineer or their appointed representative may perform inspection of the installed suppressors. Engineer reserves the right to require corrections to the installation to comply with manufacturer installation requirements and project specifications.

3.02 TESTING

A. Complete installation checks according to the manufacturers written instructions.

B. Remove and replace malfunctioning units and retest.

3.03 SERVICE ENTRANCE

A. Service Entrance Installation Requirements
   1. One primary suppressor at each utility service entrance to the facility or as indicated on the drawings.
   2. Connect suppressors to properly rated disconnect with overcurrent and short circuit protective device connected on the load side of the service entrance disconnecting means in accordance with NEC requirements.
   3. Conductors between suppressor and point of attachment kept as short and straight as possible and group together (via tie wrap) where possible. Lead length of connecting conductor not to exceed 2-feet without written permission of the Engineer.
   4. Bond suppressor's ground to enclosure frame and the service entrance ground bus, and conduit between the SPD and the switchboard must provide secure electrical/mechanical connections.

END OF SECTION

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SECTION 26 50 00
LIGHTING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Lenses
   2. Reflector Cones
   3. Housings
   4. Finish
   5. Suspension
   6. Lamps and Sockets
   7. Power Supplies
   8. Emergency LED Drivers
   9. Transformers
   10. Exterior Luminaires
   11. Extra Material
   12. Disposal and Replacement

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 26, Electrical

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 26, Grounding and Bonding for Electrical Systems

E. Section 26 09 23, Lighting Control Devices

F. Section 26 09 43, Network Lighting Controls

G. Section 26 09 93, Sequence of Operations for Lighting Control

H. Section 26 27 26, Wiring Devices

1.03 DEFINITIONS

A. BACNET Protocol for integration with BAS/BMS/EMS

B. BAS / BMS / EMS Building Automated System, Building Management System, Energy Management System

C. CCT Correlated Color Temperature

D. CRI Color Rendering Index

E. CS Control Station

F. D Dimming Wall Switch

G. DT Dual Technology (PIR + U)

H. FC Footcandles
   1. The metric for measuring illuminance light levels

I. GUI Graphic User Interface

J. LCP Lighting Control Panel

K. LED Light Emitting Diode

L. LonWorks Protocol for integration with BAS/BMS/EMS

M. MTBF Minimum Time Between Failures
   1. Total hours of testing / Number of failures

N. OS/VS Occupancy Sensor / Vacancy Sensor,
   1. Occupancy sensors provide automatic on and automatic shut-off.

2. Vacancy sensors provide automatic shut-off only, and require manual-on.

O. PC Photocell

P. PIR Passive Infrared Technology

Q. Power Supply Ballasts and LED drivers

R. RS RS-232 Connection for AV Integration

S. SC Scene Control

T. TC Timeclock, or astronomical timeclock

U. U Ultrasonic Technology

V. WS Wall Switch

W. WS/O Wallbox Occupancy Sensor Switch

1. Wall Switch with integrated Occupancy Sensor

1.04 QUALITY ASSURANCE

A. The lighting design for this project was based on luminaire types and manufacturers as specified.

B. Basis of Design manufacturers are pre-qualified to bid on products where specified. Inclusion of manufacturer and product series does not relieve specified manufacturer from providing product as described in luminaire schedule; modifications to standard product, if required, include with initial bid.

C. Alternate manufacturers listed in the Luminaire Schedule do not require prior approval but included with the shop drawing submittal. Inclusion of manufacturer and product series as an alternate does not relieve the manufacturer from providing product equivalent to the basis of design as described in luminaire schedule; modifications to standard product, if required, include with initial bid.

D. Or Approved or Pre-Bid Approved Equal:

1. Submit Substitution Request prior to bid, complying with requirements of Division 01, General Requirements.
2. Approval determined by review of the following luminaire characteristics where applicable. Lack of pertinent data on characteristic constitutes justification for rejection of the submittal.
    a. Performance:
        1) Distribution
        2) Utilization
        3) Average brightness/maximum brightness.
        4) Spacing to mounting height ratio.
        5) Visual comfort probability.
    b. Construction:
        1) Engineering
        2) Workmanship
        3) Rigidity
        4) Permanence of materials and finishes.
    c. Installation Ease:
        1) Captive parts and captive hardware.
        2) Provision for leveling.
        3) Through-wiring ease.
    d. Maintenance:
        1) Relamping ease.
        2) Ease of replacement of ballast and lamp sockets.
    e. Appearance:
        1) Architectural integration.
        2) Light tightness.

3) Neat, trim styling.
4) Conformance with design intent.

1.05 GENERAL REQUIREMENTS:

A. Provide lighting outlets indicated on the Drawings with a luminaire of the type designated and appropriate for the location.

B. Where a luminaire type designation has been omitted and cannot be determined by the Contractor, request a clarification from the Architect in writing and provide a suitable luminaire type as directed.

C. Coordinate installation of luminaires with the ceiling installation and other trades to provide a total system that is neat and orderly in appearance.

D. Luminaires located in fire rated assemblies rated for use in such assemblies or have assembly maintained by the installer through the use of appropriate construction techniques to maintain the assembly rating. It is the responsibility of the contractor to maintain the assembly rating and provide required components during construction. Coordinate luminaires impacted with Division 01, General Requirements, and life safety documents.

E. Install remote power supplies and transformers in enclosures as required by luminaire specified. Locate remote power supplies and transformers as shown on drawings; where no location is shown, provide recommendation for approval prior to commencing field installation. Remote mounted power supplies and transformers located within the distance limitations specified by the manufacturer.

F. Exterior pole lights have an appropriated pole base as part of the assembly. For pole lights in pedestrian areas, use a flush pole base. Pole lights in parking areas a raised base used. Pole bases, footings, and structural components reviewed and approved by a state licensed structural engineer prior to ordering and installation.

G. Linear lighting elements installed on building exterior, in coves, soffits, panels and other architectural materials are the longest sections available to meet the intent of the design and centered in the available space. Other items required to make the lights function installed out of site and coordinated with Architect, Landscape Architect, Lighting designer and Electrical engineer of record. Transformers, drivers, and ballasts in suitable enclosures. Required connection points are the minimum box or connector available from the manufacturer. No standard electrical boxes are allowed to produce linear runs in architectural coves. Ancillary material required is concealed from view. Coordinate final ceiling material, dimensions, and limitations with the ceiling manufacturer prior to ordering and installation.

H. Coordinate voltage requirements to each luminaire as indicated on drawings.

I. Verify luminaires carry a valid UL or ETL listing. Luminaires located in outdoor locations carry and appropriate wet or damp listing as required for the mounting application.

J. Procure luminaires through a distributor located within 200 miles of the project site with a valid business license in the state the project is located.

K. Upon request of the Architect, Engineer, or Owner, provide back-up pricing in a unit cost breakdown per luminaire. Back-up pricing includes distributor net pricing, contractor net pricing, final owner pricing and mark-ups and discounts (lot price or all-or-none) associated with the luminaires.

L. Lighting related change orders include back-up pricing noted above for review by the engineer and lighting designer.

M. Provide manufacturer’s warranty covering 5 years on drivers from date of purchase. Luminaire manufacture to operate driver at or below the required driver warranty temperature. Luminaire manufacturers failing to operate the driver, at the project required ambient temperature, within the driver manufacturer warranty parameters will be responsible for driver warranty related costs over the warranty period.

N. Minimum 80 percent of the luminaire material by weight should be recyclable at end of life. Design luminaire for ease of component replacement and end-of-life disassembly.

1.06 SUBMITTALS

A. Submit the following in accordance with Section 26 05 00, Common Work Results for Electrical:
   1. Shop Drawings, to include:
      a. Product Data.
         1) Provide manufacturer's published product data information.
         2) This information is to be relevant to the specified product only.
         3) Submittals limited to not more than three sheets for each type specified.
         4) They are specifically not to have configurations available included for review.
         5) Submittals that contain information that is not relevant to the product specified will be rejected in total and resubmission will be required.
      b. Luminaire dimensions on a fully dimensioned line drawing.
      c. Lamp information, including array configuration:
         1) For LED lamps: proof of conformance with the following: ANSI C78.377-2015, IES LM 79-2008, IES LM 80-2008, IES LM 82-2012, IES LM 84-14, IES LM 85-14, IES TM 21-2011, IES TM 28-14 and special certifications required by the contract documents.
      d. Lamp socket information.
      e. Power supply and transformer information using ballast manufacturers published product data information. Multiple power supplies or transformers may be submitted for single luminaire if compatible with specification included in contract documents. Include certification of lamp and power supply and transformer compatibility for submitted.
      f. Mounting details including clips, canopies, supports, and methods for attachment to structure. Provide equipment required for row configurations.
      g. UL/ETL Labeling Information
      h. Manufacturer's Warranty
      i. Photometric Reports consisting of the following:
         1) Candlepower distribution curves: Provide five plane candlepower distribution data at no more than 5 degree vertical angle increments.
         2) Coefficient of utilization table.
         3) Zonal lumen summary including overall luminaire efficiency.
         4) Luminaire luminance: Provide measured maximum brightness data for luminaires with reflectors and average brightness data for luminaires with refractors.
         5) Spacing to mounting height ratio. If parallel and perpendicular ratios differ, provide data on each plane.
         6) Pole information to include maximum supported effective projected area (EPA) and weight for the design wind speed, as well as structural calculations for each pole proposed.
         7) VCP calculations (where applicable): For general office lighting luminaires, provide typical VCP calculations for ceiling heights between 9-feet and 12-feet at 1-foot increments, for room sizes 20-feet by 20-feet and 30-feet by 30-feet.
      j. Special requirements of the specification.
   2. Operation and Maintenance Data:
      a. Prepare two copies of a Lighting Systems Maintenance Manual consisting of the following in a hard-cover binder for review. After review, Architect will deliver one copy to Owner.
         1) One complete set of final submittals of actual product installed, including product data and shop drawings. Include product data for actual power supply and transformer installed where applicable.
         2) List of lamps used in Project, cross-referenced to fixture types, with specific manufacturer's names and ordering codes.
         3) Re-lamping instructions for lamps that require special precautions (LED, tungsten halogen, metal halide, etc.).

4) Lighting fixture cleaning instruction, including chemicals to be used or avoided.
5) Parts list of major luminaire components and ordering information for replacement
6) Copies of manufacturer warranties on product.

3. Certificates for Poles and Accessories: Manufacturer's documentation that products are suitable for the luminaires to be installed and comply with designated structural design criteria.
4. Manufacturer's Installation Instructions:
   a. Indicate application conditions and limitations of use stipulated by product testing agency.
   b. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of product.
5. Closeout Submittals:
   a. Project Record Documents: Record actual connections and locations of pole foundations, luminaires, and any pull or junction boxes.
   b. Operation and Maintenance Data: Instructions for each product including information on replacement parts.
   c. Maintenance Materials: Furnish for Owner's use in maintenance of project.

PART 2 PRODUCTS

2.01 GENERAL

A. Luminaires new and complete with mounting accessories, junction boxes, trims, and lamps.

B. Luminaire assemblies UL listed.

C. Luminaires UL listed appropriate to mounting conditions and application.

D. Each luminaire family type (downlights, troffers, etc.) supplied by only one manufacturer.

E. Recessed luminaires installed in fire rated ceilings and using a fire rated protective cover thermally protected for this application and carry a fire rated listing.

F. Luminaires installed under canopies, roofs, or open areas and similar damp or wet locations UL listed and labeled as suitable for damp or wet locations.

2.02 LENSES

A. Mechanically secured from within the housing.

B. Interior linear prisms with smooth exterior.

C. Prismatic Acrylic:
   1. As specified in the Luminaire Schedule.

D. Opal Acrylic:
   1. Extruded or injection molded of virgin acrylic plastic, 0.08-inch minimum overall thickness.
   2. As specified in the Luminaire Schedule.

E. Opal Acrylic Overlay: High transmittance type, extruded of virgin acrylic plastic, 0.04-inch overall thickness, with minimum 80 percent light transmittance.

2.03 REFLECTOR CONES

A. Spun of uniform gauge aluminum, free of spinning marks or other defects.

B. Integral trim flange.

C. Color and finish as specified in Luminaire Schedule.

D. White Reflectors:
   1. Steel or aluminum, minimum 22 gauge, with hard baked white enamel finish with minimum 85 percent reflectance.

E. Alzak Reflectors:
   1. Low iridescent specular or as indicated in the luminaire schedule, Alzak or Coilzak with minimum reflectance of 90 percent.

2. Supply luminaires using Alzak reflector cones by the same manufacturer unless directed otherwise in Luminaire Schedule.

2.04 HOUSINGS

A. Dimensions:
   1. Proper for the various wattage noted on the plans and as recommended by the luminaire manufacturer or as specified in the luminaire schedule.

B. Extruded Aluminum Housing:
   1. One piece housing of AA 6063 T5 extruded aluminum with 0.14 minimum thickness smooth and free of tooling lines in one uninterrupted section of 1-foot to 24-foot with the cross sectional dimensions as indicated in the Luminaire Schedule.
   2. Section lengths as shown on the drawings and able to be transported into and out of the installation location after final construction without building demolition being required.

C. Steel Housing:
   1. 20 gauge minimum, free of dents, scratches, or other defects.
   2. Fill and sand exposed weld marks, joints, and seams smooth before finishing. Clean and dress edges to remove sharp edges or burrs.
   3. Section lengths as shown on the drawings comprised of 1-foot to 12-foot lengths.

D. Sheet Metal Housings:
   1. Minimum 22 gauge cold-rolled steel, with welded joints. Exposed weld marks and seams filled and ground smooth.

E. Door Frames for lensed luminaires:
   1. White painted, flat aluminum with mitered corners, [rotary cam] [spring assisted] latches to hinge from either side.

F. End Plates:
   1. Mechanical attach die cast end plates without exposed fasteners. End caps, minimum 0.125-inch thick.

G. Provide an internal alignment spline where housing sections are joined together to form a continuous row.

H. Recessed Luminaires
   1. Rated for use in recessed applications.
   2. If required by the owner or design team, the manufacturer must produce test data proving the product is rated for use in recessed applications.
   3. Equip with through wire junction box. Box, power supply, and replaceable components accessible from the ceiling opening of the luminaire.

I. Luminaires used as air-handling registers for HVAC systems meet the requirements of NFPA 90A.

J. For wet and damp use, LED-based luminaire to be sealed, rated, and tested for appropriate environmental conditions and may not be accomplished by using an additional housing or enclosure

2.05 FINISH

A. Visible surfaces to be of color and texture as directed in Luminaire Schedule.
   1. Baked white dry polyester powder, if not specified, with a minimum average reflectance of 85 percent on exposed and light reflecting surfaces.

B. Concealed interior and exterior luminaire surfaces to be Matte black or as recommended by the luminaire manufacturer.

C. Prepare steel components for finishing with a 5-step zinc phosphating process prior to painting.

D. Exposed steel surfaces:
   1. Treat with acid wash and clear water rinse, then prime coat.
   2. Electrostatically paint or powder coat and oven bake in the color indicated in the Luminaire Schedule.

2.06 SUSPENSION

A. Suspension Devices, type as specified in the Luminaire Schedule:
   1. Aircraft Cable:
      a. Stainless steel type - 3/32-inch nominal diameter, stranded, with positive pressure, field adjustable clamp at fixture connection.
   2. Rigid Pendant:
      a. 1/2-inch nominal diameter or as specifically shown on drawings.
      b. Supplied by fixture manufacturer when available as standard product.
      c. At fixture end of stems, provide earthquake type swivel fitting to permit 45 degree swing in any direction away from vertical.
      d. Flat canopy to permit splice inspection after installation.
   3. Chain Hangers:
      a. Length to suit fixture mounting height if shown or as field conditions dictate.
      b. Use two heavy duty chains with S hooks at each suspension point.
      c. Length to suit mounting height as shown on Drawings.
   4. Suspension system must permit ±1/2-inch minimum vertical adjustment after installation.

B. Supports:
   1. Provide internal safety cable from fixture body to structure.
   2. Carry fixture weight to structure and provide horizontal bracing from suspension points to ceiling framing to prevent sideways shifting. Provide diagonal seismic restraint wires per code.

C. Feed Point:
   1. Flat-plate canopy to cover outlet box, with holes for support cable and power cord, concealed fasteners to permit splice inspection after installation.
   2. At the electrified connection provide straight cord feed. Provide a separate feed point where emergency feed is required.
   3. Power Cord:
      a. White multi-conductor cord, parallel to support cable (aircraft cable); within pendant (rigid pendant); or flexible conduit (chain hanger).
   4. Provide a separate fee point where emergency feed is required.

D. Non-feed Points:
   1. 1/2-inch OD polished chrome end sleeve, inside threaded 1/4-inch-20, with 2 –inch diameter. Flat white plate to cover hole in ceiling. Top of cable with ball swaged on end, to fit inside sleeve.
   2. Provide support above ceiling as required.

E. Suspension method allows adjustment to be made in hanging length to allow for variance in ceiling height.

F. Exposed paintable suspension components have the same finish and color as the luminaire housing.

2.07 LAMPS AND SOCKETS

A. Lamp each luminaire with the suitable lamp cataloged for the specific luminaire type and as indicated by the manufacturer, or as specifically indicated in the Luminaire Schedule, or as specified herein.

B. Lamps to be field replaceable.

C. Lamp sockets to be of configuration and design to accept standard LED lamps and circuit boards.

D. LED lamps to meet or exceed 50,000 hours as defined by LM-80-08 based on both the ambient temperature listed and the LEDs B10L70 performance curve as published by the LED lamp manufacturer.

E. LED lamps to be high brightness and proven quality from established and reputable LED manufacturers, including:
   1. Nichia
   2. Osram-SemiOpto
   3. Cree
   4. Philips Lumileds
   5. Seoul Semiconductor
   6. Bridgelux
   7. General Electric Gelcore
   8. Xicato
   9. Osram

F. Replacement Lamps
   1. Sorra
   2. Toshiba

G. LED lamps that are integral into the housing; light bars, diodes, boards and other, to be rated and tested for use in the fixture specified and compatible with the driver tested and compatible with that fixture.

H. Screw-In Base Replacement LED Lamps
   1. Manufacturer to provide wattage restriction label on socket, equivalent to specified wattage on LED replacement lamp.
   2. LED replacement lamps not to be placed in air-tight enclosures or in insulated air tight (ICAT) rated luminaire enclosures without dedicated heat dissipation and thermal management of the luminaire system.

I. Color Rendering Index (CRI):
   1. 80 or higher for ambient lighting in common spaces

J. Correlated Color Temperature (CCT) per luminaire schedule.
   1. Color consistency not to exceed a +/- tolerance of greater than two MacAdam Ellipses over the life of the luminaire.

K. Adjustable Lamp Mechanisms: To have aiming stops which can be permanently set to position lamp vertically and rotationally.

L. High power LED luminaire thermally protected using one or more of the following thermal management techniques: metal core board, gap pad, and/or internal monitoring firmware

M. Operating Temperature: -22 degrees F to 115 degrees F.
   1. Operate below manufacturer's published die junction temperatures when operated at 1W at 350 mA in an elevated ambient of 46 degrees C.

N. Utilize quick-connect connections to replaceable boards to meet ANSI and UL/ETL and NEMA requirements.

2.08 POWER SUPPLIES

A. UL recognized under the component program and modular for simple field replacement.

B. Rate for use with the LED array specified.
   1. Warranty array and driver as an assembly.
   2. 5 year full replacement, non-pro-rated warranty is required on electronic components.

C. Luminaires requiring more than one driver are not permitted, unless specified in the luminaire schedule.

D. Power supplies used in enclosed and gasketed luminaires listed for use in wet locations, Type 1 construction.

E. Rate for the expected ambient temperature in which they are installed.
   1. Exterior installed power supplies rated to start the lamps at 0 degrees F.

F. Operate for a (+/- 10 percent) supply voltage of 120V through 277VAC at 60Hz.

G. Power Factor: 0.9 minimum

H. Lifetime minimum
   1. 50,000 hours at full load and 77 degrees F ambient
   2. Ten-year expected life while operating at maximum case temperature and 90 percent non-condensing relative humidity.

I. Minimum time between failures (MTBF) greater than 300,000 hours at full load and 77 degrees F ambient, in accordance with MIL-HDBK-217.

J. Driver and luminaire electronics deliver illumination that is free from objectionable flicker as measured by flicker index (ANSI/IES RP-16-10).
   1. Flicker index to be less than 5 percent at frequencies below 1000 Hz.

K. Label systems using tandem wired luminaires be labeled accordingly. Locate label in the lamp compartment of each luminaire and identify the function of that luminaire. Do not make the label visible from room.

L. Total Harmonic Distortion less than 20 percent and meet ANSI C82.11 maximum allowable THD requirements at full output. At no point in the dimming curve allow imbalance current to exceed full output THD.

M. Meet or exceed $30mA^2s$ at 277VAC for up to 50Ws of load and 75A at 240us at 277VAC for 100 watts of load.

N. Withstand up to a 1,000V surge without impairment of performance as defined by ANSI C62.41 Category A.

O. Housing have circuit diagrams and lamp connections applied thereto.

P. Must be Reduction of Hazardous Substances (RoHS) compliant

Q. Provide no light output when the analog control signal drops below 0.5 V, or the DALI/DMX digital signal calls for light to be extinguished and consume 0.5 watts or less in this standby. Control deadband between 0.5V and 0.65V included to allow for voltage variation of incoming signal without causing noticeable variation in fixture to fixture output.

R. Support automatic adaptation, allowing for future luminaire upgrades and enhancements and deliver improved performance:
   1. Adjustment of forward LED voltage, supporting 3V through 55V.
   2. Adjustment of LED current from 200mA to 1.05A at the 100 percent control input point in increments of 1mA
   3. Adjustment for operating hours to maintain constant lumens (within 5 percent) over the 50,000 hour design life of the system, and deliver up to 20 percent energy savings early in the life cycle.

S. Remote: Driver may be remote mounted up to 300-feet depending on power level and wire gauge.

T. Dimming Drivers:
   1. Dimming power supplies controlled by a common controller provided by the same manufacturer.
   2. Manufacturer to have minimum 5 years' experience in manufacturing of dimmable electronic lighting drivers.

3. LED dimming to be equal in range and quality to a commercial grade incandescent dimmer. Quality of dimming to be defined by dimming range, freedom from perceived flicker or visible stroboscopic flicker, smooth and continuous change in level (no visible steps in transitions), natural square law response to control input, and stable when input voltage conditions fluctuate over what is typically experience in a commercial environment.
    a. Demonstration of this compliance to dimming performance will be necessary for substitutions or prior approval.
4. Provide step-free, continuous dimming to black from 100 percent to 0.1 percent and 0 percent relative light output, or 100 – 1 percent light output and step to 0 percent where indicated. Driver responds similarly when raising from 0 percent to 100 percent.
    a. Driver to be capable of 20 bit dimming resolution for white light LED drivers or 15 bit resolution for RGBW LED drivers.
5. Track evenly across multiple fixtures at light levels, and provide input signal to output light level that allow smooth adjustment over the entire dimming range.
6. Limit inrush current.
7. No visible change in light output with a variation of plus/minus 10 percent line voltage input.
8. Ability to configure a linear or logarithmic dimming curve, allowing fine grained resolution at low light levels
9. Basis of Design Product: eldoLED or subject to compliance and prior approval with specified requirements of this section, one of the following:
    a. eldoLED
    b. Philips
    c. Osram Sylvania
    d. Tridonic
    e. General Electric
10. Dimming Protocols:
    a. If not otherwise noted on the luminaire schedule, dimming LED drivers to be 0-10V.
    b. 4-Wire (0-10V DC Voltage Controlled) Dimming Drivers
        1) Must meet IEC 60929 Annex E for General White Lighting LED drivers
        2) Connect to devices compatible with 0 to 10V Analog Control Protocol, Class 2, capable of sinking 0.6 ma per driver at a low end of 0.3V. Limit the number of drivers on each 0-10V control output based on voltage drop and control capacity.
        3) Must meet ESTA E1.3 for RGBW LED drivers
        4) 0-10V input protected from line voltage miswire, and immune and output unresponsive to induced AC voltage on the control leads.

2.09 EMERGENCY LED DRIVERS

A. Consist of a high-temperature, replaceable maintenance-free nickel cadmium battery, integral charger, and electronic circuitry enclosed in single compact case. Provide solid-state charging indicator light to monitor the charger and battery, a double-pole test switch, and installation hardware.

B. Emergency driver operates lamps for a minimum of 90 minutes in the emergency mode. Lumen output at end of 90 minutes, 60 percent of initial lumen output per UL924.

C. UL listed for installation either inside or on top of the luminaire and be warranted for a full five years from date of installation.

D. Install and wire by the luminaire manufacturer unless specified for field installation in the Luminaire Schedule.

E. Wire as either Nightlight (always on) or switchable (with power failure sensing feed) as shown on the drawings.

F. Mount in accordance with manufacturer’s installation requirements.

G. Initial lumen output to be full output of the luminaire rating.

2.010 TRANSFORMERS

A. Provide proper lamp voltage to low voltage lamps.
   1. Integral:
      a. Electronic: Do not provide electronic transformers unless directed in the Luminaire Schedule.

2.011 EXTERIOR LUMINAIRES

A. Label fixtures from the factory for use in the designed installation. It is the responsibility of the contractor to verify labeling and installation requirements with the NEC and applicable codes and standards.
   1. External Label: ANSI C136.15
   2. Luminaires must have locality-appropriate governing mark and certification.

B. The luminaire must be subjected to 100,000 cycles of 2 Gs at the resonant frequency of the luminaire (between 5 and 30 Hz) applied at the center of gravity of the luminaire on three primary axes per ANSI C136.31 without damage to the luminaire. Fully functional luminaire upon completing the test.

C. Luminaire must be IP and/or UL-listed for damp or wet locations, as appropriate for exterior application, and wiring cavity must be field accessible for service or repair needs.

D. Provide luminaires fully assembled and electrically tested before shipment from factory.

E. Optical cavity must be a minimum IEC 60529/IP65.

F. Rate luminaires for -4 degrees F to 104 degrees F operation.

G. The coating must be capable of surviving ASTM B117 Salt Fog environment for 500 hour minimum without blistering or peeling. The coating must demonstrate gloss retention of greater than or equal to 90 percent for 500 hour exposure QUV test per ASTM G53 UVB313, 4 hour UV-B 140 degrees F/4 hour condensation 122 degrees F.

H. Provide luminaires with a NEMA distribution pattern as indicated in the luminaire schedule.

I. Water feature and fountain lighting to meet applicable codes and regulations.

J. Project Conditions Coordination:
   1. Coordinate placement of poles and associated foundations with utilities, curbs, sidewalks, trees, walls, fences, striping, etc. installed under Work of Other Sections, or by others.
   2. Coordinate elevation to obtain specified foundation height.
   3. Notify Owner of conflicts or deviations; obtain direction prior to proceeding with Work.

K. Exterior Lenses
   1. In-grade lenses drive-over and cool touch rated
   2. For lenses not integral to the LED lamp, construct the luminaire optical enclosure (lens/window) of clear and UV-resistant polycarbonate, acrylic, or glass.

L. Unless otherwise indicated, provide cast-in-place embedded style concrete foundations with constructed forms for square foundations or round foundations with spirally wrapped treated paper forms. Provide concrete, anchor bolts, and reinforcing steel as indicated in the Drawings.

M. Poles:
   1. Provide poles of material and form as indicated in the luminaire schedule. Provide poles able to withstand winds of not less than 100 mph and a gust factor of 1.3 with an ice load criteria up to 1/2-inch thick without damage to the pole and attached luminaire.
   2. Provide poles with a hand-hole and removable hand-hole coverplate that matches the material and finish of the pole. Install covers with vandal resistant bolts. Locate hand-hole located approximately 18-inches above the pole base.

3. Provide poles with provisions for installation of Owner provided and installed security cameras. Provide hand-hole with removable hand-hole coverplate that matches the material and finish of the pole. Locate hand-hole based on Owner design of security cameras.
4. Provide poles with an internal ground lug easily accessible from the hand-hole.
5. Provide poles with a base plate welded to the pole utilizing a backup ring and full-penetration welded connection.
6. Provide a one piece base cover to completely cover foundation hardware.
7. Aluminum Poles:
    a. Seamless extruded aluminum shafts fully welded to a cast aluminum anchor base assembly.
        1) Provide shaft square, straight, and meeting requirements of AASHTO Standard Specifications.
        2) Pole Height: As indicated in the Luminaire Schedule.
8. Pole Finish:
    a. Provide external surfaces of the pole, base cover, support arms, and luminaires finished in the same material and color.
    b. Provide poles chemically cleaned, rinsed, phosphatized, sealed, and dried.
    c. Apply an electrostatic application of polyester-power paint to external surfaces.
    d. Oven-bake complete unit to form a homogeneous, non-porous surface. Provide completed finish with no sags, drips, oxidation, or runs.
9. Anchor Bolts: Provided by pole manufacturer of size and length and quantity as recommended by pole manufacturer.
    a. Fabricate anchor bolts from hot rolled carbon steel bar with an L bend on one end.
    b. Provide galvanized anchor bolts with a minimum of 12-inches on the threaded end.
    c. Provide bolt circle and bolt projection dimensions with manufacturer's Shop Drawings.
10. Wrap poles in a protective material for shipment to the Project site.

2.012 EXTRA MATERIAL

A. Furnish extra materials described below that match product installed and that are packaged with protective covering for storage and identified with labels describing contents.
    1. Glass and plastic lenses, covers, louvers, globes, guards, and other removable fixture parts: 5 percent or one dozen (whichever is less) of each type and rating installed. Furnish at least one of each type.
    2. Control gear: 5 percent or one dozen (whichever is less) of each field-replaceable control module, driver, ballast, or individual fixture transformer. For fixtures with non-easily replaceable control gear provide 5 percent or one dozen (whichever is less) extra fixtures. Confirm non-replaceable products during submittal process.
    3. Adjustable accent lights (track, recessed, or surface mounted): 10 percent of each beam angle lens (or removable lens accessory), 10 percent or one dozen (whichever is less) additional accessory lenses, color filters, louvers, and other accessories specified for use during final focusing.
    4. For non-decorative LED lights, provide 2 percent additional fixtures, or minimum two fixtures.

2.013 DISPOSAL AND REPLACEMENT

A. LED manufacturer is responsible for the disposal of expired LED arrays and heat sinks. Clearly label fixture with return information, disposal procedures and manufacturer disposal contact information.

B. Owner will pay for shipping.

C. Manufacturer is required to inform the owner of new power requirements and /or lumen output values if new replacement components prior to shipping replacement parts.

D. Label disposal and replacement information inside the luminaire and in the project operation and maintenance manuals along with O&M requirements listed in Division 01, General Requirements.

PART 3 EXECUTION

3.01 INSTALLATION

A. Meet general requirements of NFPA 70, National Electric Code.

B. Mounting heights specified on drawings:
   1. Wall Mounted Luminaires:
      a. Centerline of luminaire.
   2. Pendant Mounted Luminaires:
      a. Bottom of luminaire unless specifically identified in the Luminaire Schedule or on drawings.

C. Support:
   1. Support by separate means from the building structure and not from the ceiling system, ductwork, piping, or other systems.
   2. Final decision as to adequacy of support and alignment will be given by the Architect.

D. Power Supplies:
   1. Do not install equipment until following conditions can be maintained in spaces to receive equipment:
      a. Ambient temperature: -4 degrees to 122 degrees F.
      b. Relative humidity: Maximum 90 percent, non-condensing.
      c. Protected from dust and excess moisture during installation.
   2. Install per manufacturers prescribed methods.
   3. Located remote mounted power supplies and transformers within the distance limitations specified by the power supply manufacturer.

E. Level luminaires, align in straight lines, and locate as shown on the architectural elevations and reflected ceiling plan.

F. Manufacturer's labels or monograms not visible after luminaire is installed, but must be included for future reference.

G. Recessed Luminaires:
   1. Trims which fit neatly and tightly to the surfaces in which they are installed without light leaks or gaps.
   2. Install heat resistant non-rubber gaskets to prevent light leaks or moisture from entering between luminaires trim and the surface to which they are mounted.

H. Pole Luminaires:
   1. Provide cast-in-place concrete foundations for pole mounted luminaires.
   2. Concrete: As specified in Division 03, Concrete.
   3. Foundation Forms: As indicated.
   4. Place anchor bolts in foundation as recommended by manufacturer in the required bolt circle size.
   5. Tie reinforcing steel in foundation to the anchor bolts to form a solid cage.
   6. Tamp wet concrete during pouring to assure complete coverage below, around and within the cage and form.
   7. Hand finish top of foundation to produce a smooth, level surface.
   8. Provide a minimum 10-foot copper-clad steel ground rod at each pole base. Connect from ground rod to the ground lug in the pole with minimum AWG 8 copper conductor.
   9. Install pole mounted luminaires plumb with luminaires level, and with reflector distribution in the direction indicated in the Drawings.
      a. Grout around the pole base at the foundation to close openings.
      b. Install pole base cover over exposed installation hardware.

3.02 COORDINATION OF WORK

A. Architectural Reflected Ceiling Plans take preference as to the exact placement of the luminaires in the ceiling.

B. Determine ceiling types in each area and provide suitable accessories and mounting frames where required for recessed luminaires. Luminaire catalog numbers do not necessarily denote specific mounting accessories for type of ceiling in which a luminaire may be installed.

3.03 AIMING

A. Aim luminaires with proper lamps installed.

B. Aim directional luminaires, including but not limited to luminaires described in the Contract Documents or by the luminaire manufacturer as aimable, adjustable, or asymmetric as follows:
   1. Provide the lighting pattern for which the luminaire is designed.
   2. Provide the lighting pattern as shown on the drawings.
   3. Predetermined aiming points as shown on the drawings.
   4. Where aiming cannot be determined, request, in writing, clarification from the Architect, indicating luminaires needing clarification.

C. Re-aim luminaires as determined by Architect during final project walkthrough.

D. Install adjustable luminaires with dead zone of rotation away from intended aiming point

3.04 PROJECT CLOSEOUT

A. Leave luminaires clean at the time of acceptance of the work. If luminaires are deemed dirty by the Architect at completion of the work, clean them at no additional cost. Protective plastic wrap is to be removed from parabolic luminaires just prior to owner acceptance.

B. Provide fixtures with new lamps operating at time of final acceptance. Exception: For fluorescent dimming fixtures, provide minimum 100 hour/maximum 200 hour, continuously lit lamps or per ballast manufacturer's recommendations.

C. Where incandescent lamps are used for construction lighting, replace the lamps with new lamps just prior to occupancy by the owner.

END OF SECTION

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 GENERAL

1.01 SUMMARY

A. Work included in Section 27 05 00 applies to Division 27, Communications work to provide materials, labor, tools, permits, incidentals, and other services to provide and make ready for Owner's use of communications systems for proposed project:

B. Contract Documents include, but are not limited to, Specifications including Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, Drawings, Addenda, Owner/Architect Agreement, and Owner/Contractor Agreement. Confirm requirements before commencement of work.

C. Additional conditions apply to this Division including, but not limited to:
1. Specifications including General and Supplementary Conditions and Division 01, General Requirements.
2. Drawings
3. General provisions of the Contract
4. Addenda
5. Owner/Architect Agreement
6. Owner/Contractor Agreement
7. Codes, Standards, Public Ordinances and Permits

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 27, Communications

C. Section 26 05 33, Raceways and Boxes for Electrical Systems

1.03 REFERENCES

A. References, Codes and Standards per Division 00, Procurement and Contracting Requirements and Division 01, General Requirements, individual Division 27 Sections and those listed in this section.

B. Supervisors and Lead Installers:
1. Working knowledge and understanding of the following documents and codes or their most recent updates and familiar with the requirements that pertain to this installation.
2. Installers familiar with and have practical working knowledge of the requirements that pertain to this installation.

C. Codes:
1. Comply with applicable sections of the most recent editions and addenda of following for interior and exterior installations.
2. Codes to include latest adopted editions, including current amendments, supplements and local jurisdiction requirements in effect as of the date of the Contract Documents, of/from:
   a. IBC International Building Code
   b. NEC/NFPA 70 National Electrical Code
   c. NEXC IEEE National Electrical Safety Code
3. State of Oregon:
   a. OAR Oregon Administrative Rules
   b. OESC Oregon Electrical Specialty Code
   c. OFC Oregon Fire Code
   d. OSSC Oregon Structural Specialty Code
   e. OEESC Oregon Energy Efficiency Specialty Code

D. Standards:
1. Comply with applicable sections of the most recent editions and addenda of the following for installations and testing of communications cabling, connectors, and related hardware.
2. Reference standards and guidelines include but are not limited to the latest adopted editions from the following:
   a. ANSI American National Standards Institute
   b. NEMA National Electrical Manufacturers Association
   c. TIA Telecommunications Industries Association
      1) TIA TSB-125 Guidelines for Maintaining Optical Fiber Polarity Through Reverse-Pair Positioning
      2) TIA TSB-140 Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems
      3) TIA-526-7 Measurement of Optical Power Loss of Installed Single-Mode Fiber Cable Plant – OFSTP-7
      4) T-526-14-A Optical Power Loss Measurements of Installed Multimode Fiber Cable Plant – SFSTP-14
      5) ANSI/TIA-568.0-D Generic Telecommunications Cabling for Customer Premises
      6) ANSI/TIA-568.1-D Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
      7) ANSI/TIA-568-C.2 Commercial Building Telecommunications Cabling Standard—Part 2: Balanced Twisted Pair Cabling Components
      8) ANSI/TIA-568-3-D Optical Fiber Cabling Components Standard
      9) ANSI/TIA-569-C Commercial Building Standards for Telecommunications Pathways and Spaces
      10) ANSI/TIA-598-C Optical Fiber Cable Color Coding
      11) ANSI/TIA-604.2-A FOCIS 2—Fiber Optic Connector Intermateablility Standard
      12) ANSI/TIA-606 Administration Standard for Commercial Telecommunications Infrastructures
      13) ANSI/TIA/607-C Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications
      14) ANSI/TIA-758-A Customer-owned Outside Plant Telecommunications Infrastructure Standard
      15) ANSI/TIA-854 A Full Duplex Ethernet Specification for 1000 Mb/s (1000BASE-TX) Operating over Category 6 Balanced Twisted-Pair Cabling
      16) ANSI/TIA-862-B Structured Cabling Infrastructure Standard for Intelligent Building Systems
      17) ANSI/TIA-4994 Standard for Sustainable Information Communications Technology
      18) ANSI/NECA/BICSI 568-2006 Standard for Installing Telecommunications Systems
   d. Other Reference Materials
      1) ANSI/NECA/GICSI-568-2006, Standard, Installing Commercial Building Telecommunications Cabling
      2) COOSP BICSI - Outside Plant Design Reference Manual
      3) ESSDRM BICSI - Electronic Safety and Security Reference Manual
      4) ITSIM BICSI - Information Transport Systems Installation Methods Manual
      5) NDRM BICSI - Network Design Reference Manual
      6) TDDM BICSI - Telecommunications Distribution Methods Manual
      7) WDRM BICSI - Wireless Design Reference Manual

8) IEEE Institute of Electrical and Electronic Engineers
9) NEMA National Electrical Manufacturers Association
10) UL Underwriters Laboratories Cable Certification and Follow Up Program
11) ASA American Standards Association

1.04 QUALITY ASSURANCE

A. Perform work in accordance with contract documents and governing codes and standards.

B. Personnel performing the work of this Section thoroughly familiar with the cabling methods set forth in the latest release of the TDMM.

C. RCDD reviews required work prior to commencing. Oversee the installation and will have the end responsibility for the quality of the installation work performed. Submitted designs and or changes to the design must be approved and signed off by the RCDD.

D. Installed cabling systems not to generate nor be susceptible to harmful electromagnetic emission, radiation, or induction that degrades cabling systems.

E. Expansion Capability: Unless otherwise indicated, provide spare positions in wall fields, cross connects, and patch panels, as well as space in distribution and riser pathways to accommodate minimum 15 percent future growth.

F. Backward Compatibility: The provided solution backward compatible with lower category ratings such that if higher category components are used with lower category components, the permanent link and channel measures meet or exceed the lower channel's specified parameters.

G. Component Compliance: The provided solution's components each meet the minimum transmission specifications listed herein such that no individual component will be less than specifications for permanent and channel, regardless of the fact that tests for permanent and channel ultimately meet required specifications.

H. Visibly damaged goods are to be returned to the supplier and replaced at no additional cost to the Owner.

1.05 CONTRACTOR RESPONSIBILITY AND QUALIFICATIONS

A. Provide components, materials, services, and labor essential for a complete and functional structured cabling system.

B. Comply with local, state, and federal laws and regulations applicable to the work to be performed although said law, rule, or regulation is not identified herein.

C. Examination of building and site responsibility:
1. Examine site and building prior to installation to determine conditions affecting the scope of work.
2. Contact Owner representative for arrangements.
3. Systems and cabling are assumed working and in good condition unless Contractor documents exceptions.

D. Respect and protect the privacy and confidentiality of Owner, its employees, processes, products, and intellectual property to the extent necessary, consistent with the legal responsibilities of the State of Oregon and Owner policies.

E. Use of Sub-Contractors:
1. Inform in writing to Owner's representative and General Contractor about the intention to use sub-contractors and the scope of work for which they are being hired.
2. Owner's representative prior to the sub-contractor's hiring and start of work must approve the use of sub-contractors in writing.

F. Provide a sufficient number of technicians for this project to stay on schedule.

G. Contractor Qualifications:
1. Fully conversant and capable in the cabling and equipment installation of communications systems including, but not limited to:
   a. Data/Voice Structured Cabling
   b. Audio and Video System Types
2. Minimum of five years' experience in the design, installation, testing, and maintenance of communications systems.
3. Must employ at least one full time BICSI certified RCDD who is involved in reviewing work performed by contractor on this project.
4. Verification of current BICSI Certified Installer, or equivalent.
5. Personnel trained in the installation of pathways and support for housing horizontal and backbone cabling.
6. Installers: Only technicians certified by approved equipment manufacturer are approved.
7. Maintain a local service facility which stocks spare devices and/or components for servicing systems.
8. Have performed successful installation and maintenance of at least three projects similar in scope and size. Provide project references for these three projects, including scope of Work, project type, Owner/user contact name and telephone number.

1.06 MANUFACTURERS

A. Equipment in these Sections are the standard products of a manufacturer regularly engaged in the manufacture of such products unless specified otherwise. Components used in the system commercial products that comply with these Specifications.

B. Each component of equipment identifies the manufacturer's name, model, and applicable serial number. The Owner's authorized representative retains the right to reject products that reflect, in their opinion, sub-standard design practices, manufacturing procedures, support services, or warranty policies.

1.07 CHANGE ORDERS

A. Supplemental cost proposals by the Contractor accompanied with a complete itemized breakdown of labor and materials. At the Architect's request, Contractor's estimating sheets for the supplemental cost proposals made available to the Architect.

B. Separate and allocate labor for each item of work.

1.08 WARRANTY

A. The chosen Communications Contractor provide a minimum 1 year warranty on material, installation, and workmanship.

B. Provide a written warranty covering the work of this Division as required by the General Conditions.

C. Apparatus:
1. Free of defects of material and workmanship and in accord with the Contract Documents.
2. Built and installed to deliver its full rated capacity at the efficiency for which it was designed.

D. Include in Contractor's warranty for Work of Division 27, Communications system damage caused by failures of system component.

1.09 GENERAL

A. Meet or exceed applicable referenced standards, federal, state, and local requirements and conform to codes and ordinances of authorities having jurisdiction.

1.010 SUBMITTALS

A. General:
1. Guidelines set forth in this Section pertain to Division 27, Communications specifications included in this project.

2. Submit the following deliverables to the Owner and Design Team prior to ordering equipment or installation of equipment.
3. Partial submittals will not be considered, reviewed, or stored, and such submittals will not be returned.
4. Materials and equipment listed that are not in accordance with specification requirements and/or not prior approved may be rejected.
5. The approval of material, equipment, systems, and shop drawings is a general approval subject to the Drawings, Specifications, and verification of measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. Carefully check and correct shop drawings prior to submission for approval.

B. Informational Submittals:
1. Field Test Reports:
   a. Submit sample cable test reports showing report format and parameters tested.
   b. Submit minimum of 2 weeks prior to final punch walkthrough. Maintain test equipment on-site during punch for sample proof-of-performance tests.
2. Proposed test forms for fiber backbone, copper backbone, and horizontal UTP cable.
3. Certificates:
   a. Certify that field tests have been performed and that work meets or exceeds specified requirements.
   b. Certify that factory tests have been performed and that work meets or exceeds specified requirements. Certificates may be based on recent or previous test results, provided material or products tested are identical to those proposed for this Project.
   c. Optical loss budget calculations for each optical fiber run.
   d. Calibration report of test equipment for fiber and copper. Last calibration date should not be older than one year from the first day of testing.
   e. Name(s) and copy of installer's certificates as it pertains to the system design (e.g. RCDD, CTS, NICET, etc.).

C. Shop Drawings:
1. Original bid contract documents are not to be used as shop drawings. Generate their original shop drawings utilizing CAD software (i.e. AutoCAD, Revit, etc.)
2. Shop drawings that appear to be traces or overlays of original bid contract documents immediately rejected.
3. Where scope is distributed among multiple sub-contractors, each sub-contractor's submittal makes reference the other submittal where connections to equipment provided by other sub-contractors is required.
   a. Example: Contractor A provides System X shop drawings. Contractor B provides System Y shop drawings. Both sets of shop drawings must make references to each other where systems X or Y are interdependent on each other to function.
4. General Requirements:
   a. Clear and legible
   b. Utilize the same sheet size as the contract drawings.
   c. Use minimum of 1/8-inch text height for text, symbol text, and subscript text.
   d. Plan drawings utilize the same scale as issued in the contract documents.
   e. Plan drawings utilize the same sheet order as issued in the contract documents.
   f. Plan drawings utilize the same grid-line locations relative to the sheet as issued in the contract document (this is to aid overlay and checking of shop drawings vs. contract documents and to aid the as-built documentation).
   g. Sheets, including the cover sheet include a title block containing the following information:
      1) System specific sheet number
      2) Project name, specification section number, and Section title name
      3) Floor name, area, and/or floor description matching that of the contract drawings.

h. Include architectural information on the shop drawings including, but not limited to the following:
    1) Match Lines
    2) Grid Lines
    3) Grid Bubbles
    4) Key Plans
    5) Enlarged Floor Plan Callouts

5. Cover Sheet:
    a. The first page of shop drawings includes a coversheet containing the following information:
        1) Site Information:
            a) Name of Site
            b) Address
            c) City
            d) Zip Code
        2) Installing Contractor's Information:
            a) Business Name
            b) Local Office Address
            c) Phone Number
            d) Website
            e) Primary Contact Person:
                (1) Name
                (2) Phone Number
                (3) Email Address
    b. Provide sheet index on the coversheet.
6. Legends:
    a. Symbols:
        1) Shop drawings include an associated symbol for each device used on the symbol legend, including but not limited to the following:
            a) Symbol Name
            b) Device Description
            c) Rough-in Requirements
            d) Applicable Manufacturer
            e) Manufacturer's Model Number
    b. Wiring:
        1) Shop drawings include an associated symbol for each wire used on the symbol legend, including but not limited to the following:
            a) Cable Designator
            b) Cable Manufacturer
            c) Model Number
            d) Cable Rating (e.g. CMP, CMR, OSP, etc.)
            e) Size of Conductors
            f) Quantity of Conductors
        2) Each cable type has a different designation.
7. Plans and Elevations:
    a. Plan Views:
        1) Devices, cabinets, racks, and termination blocks.
        2) Raceways (conduits, cable trays, ladder racks, floor ducts, junction boxes, pull boxes, splice boxes, manholes, and associated supports).
        3) Field devices with their respective address number.
        4) IP addresses for TCP/IP devices included in the system.
        5) Equipment clearances for racks/cabinets.
    b. Elevation Views:
        1) Termination blocks, patch panels, wire managers, and other devices.

2) Vertical and horizontal offsets and transitions.
3) Vertical elevation of cable trays above the floor or bottom of ceiling structure.
4) Clearances for access above and to side of cable trays.
5) Rack Layouts
a) Intended equipment layout within the racks.
b) Blank filler plates in spaces where equipment is not installed.
c) Areas within the rack for equipment furnished by or reserved by others.
d) Indicate rack unit size of equipment, and total rack units available in the rack.

8. Details and Diagrams:
a. Details:
1) Mounting details for head-end equipment, racks, and field devices.
b. Diagrams:
1) Associated one-line or riser diagram showing connections between devices and connections to equipment provided in other systems.
2) Indicate cable type, sizes, and quantities between each TR for backbone copper and fiber cabling.
3) Show field devices with their respective room names/numbers and connections to their associated equipment.
4) Show field devices with their respective address number.
5) Show IP addresses for TCP/IP devices included in the system.
9. System Labeling Schedules:
a. Electronic copy of labeling schedules, in software and format selected by Owner.
10. Deferred Submittals:
a. Mounting Details:
1) Provide engineering analysis, calculations, and drawing details of device restraints and supports for maximum loading in compliance with Code and coordinated with all trades.
2) Details to show loads, connection type/materials, dimensions, etc., specific to each unique installation instance.
3) Details to indicate both expected and maximum loads.
4) Analysis to adhere to seismic bracing requirements in the jurisdiction specific to the project.
5) Details to be stamped and signed by an Engineer licensed for the applicable work in the project's area of jurisdiction.
6) Provide details for:
a) Floor mounted equipment racks, including raised floor supports.
b) Cable tray, runway, and wire-basket tray.
c) Ceiling and Wall:
(1) Supported flat panel displays.
(2) Supported projectors and projection screens.
d) Roof-mount devices, braced to withstand maximum wind gusts and uplift pressures.
e) Conduit and junction boxes infrastructure systems.
f) Antennas and satellite dishes.
g) Other ceiling and wall supported devices weighing more than 20 pounds.

D. Equipment/Product Data Submittals:
1. Submit a single package of the related submittals for the products called out in Division 27, Communications Specifications.
2. Two indexed sets of manufacturer's technical data for each product including product description, specifications including labeling or listing by an agency acceptable to the Owner, and storage requirements.

3. Submitted digitally (e.g. in PDF) and have digital bookmarks for navigating the document set, organized as follows:
    a. Primary division (e.g. 27)
        1) Submittal section (e.g. 271500)
            a) Product name (e.g. “PATCH PANELS”)
4. For each applicable section within the Division 27, Communications, organize as follows:
    a. Cover sheet for each applicable section number.
        1) Include the contractor’s contact information
    b. Table of contents with the following information per line:
        1) Equipment Type
        2) Manufacturer
        3) Model Number
        4) Page Number (with hyperlink to product data sheet’s page)
    c. Apply header to each page of each sections submittals including the following:
        1) Title of division 27 section the products fall under (e.g. 271500 Communications Horizontal Cabling).
    d. Apply footer to the bottom of each submittal package including the following:
        1) Clearly labeled page numbers
        2) Date of submittal (YYYY-MM-DD)
5. Where more than one product is called out on the same sheet, clearly highlight or mark which product is proposed for use.

E. Project Closeout:
1. Manufacturer's Installation, Start-Up, and Adjustment Instructions.
2. Operation and Maintenance Data.
    a. Update to the Equipment/Product Data Submittals with identical document structure and digital document requirements.
    b. Include digital copy in both of the following:
        1) Archival quality DVD-R
        2) USB flash drive
    c. Include full manuals of equipment provided (data sheets alone not acceptable).
    d. Include test data and reports.
    e. Include original software configuration files and programming software for head-end equipment.
        1) Software files consist of both the original “un-compiled” file used for creating the system, as well as the compiled firmware/instructions that are loaded onto the head-end equipment/device. This includes, but is not limited to, the following typical systems:
            a) Access Control
            b) Audio-Visual
            c) Clock
            d) Intercom
            e) Intrusion Alarm
            f) Public Address
            g) Video Surveillance
            h) Master/Community/Satellite Antenna Television
            i) Information Display / Digital Signage
3. Special Warranty:
    a. Do not offer a special warranty to Owner to supplement the standard warranty requirement covered in this Specification.
        1) With respect to the installation of Approved Manufacturer’s Cabling System, furnish Approved Manufacturer’s Cabling System application / system standard warranty.

1.011 PRODUCT ASSURANCE

A. UL and/or ETL approved and labeled in accordance with NEC for products where labeling service normally applies.

B. Label materials and equipment requiring UL 94, 149, or 1863. Modification of products that nullifies UL labels is not permitted.

C. Materials and equipment provided by standard Commercial-Off-The-Shelf (COTS) products of a manufacture engaged in the manufacture of such products.

D. Typical commercial designs that comply with the requirements specified. Materials and equipment readily available through manufacturers and/or distributors. Supply equipment complete with optional items required for proper installation.

E. Materials or Manufactures not listed in this Division 27, Communications but are required materials to provide a complete and functioning cable infrastructure system have cut sheets and product data included in the material and procedures submittal package.

F. Coordinate the features of materials and equipment so they form an integrated system. Match components and interconnections for optimum future performance and backward compatibility.

G. Test fiber cable while on the reel prior to installation of the cable. Assume liability for replacement of cable should it be found defective at this time or a later date prior to customer acceptance.

1.012 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment with Architect, Communication Design Professional or Owner Information Technology Team:
   1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
   2. To provide the most efficient pathway for structured cabling endpoint devices such that the cabling never exceeds the 295-feet permanent link distance. Pathways must be shown on shop drawings for review prior to installation.
   3. To provide for ease of disconnecting the equipment with minimum interference to other installations.
   4. To allow right-of-way for piping and conduit installed at required slope.
      a. Racks and Communication Cabinets: 3-foot minimum.
      b. Open Pathways – Cable Tray, J-Hooks: 12-inch clear on working side; 3-inch clear from ceiling tiles.
      c. Closed Pathways – Conduit (Above and Below Grade):
         1) 3-inch clear from electrical pathways concrete encased.
         2) 12-inch clear in electrical pathways in dirt.
         3) 48-inch clear electrical Motors and transformers.

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

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08, Openings.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07, Thermal and Moisture Protection.

E. Responsible for coordination with all trades, to include required scheduling of materials and/or equipment with Owner and/or General Contractor for delivery, storage, and protection of equipment as required.

F. Finishes: Where specific device finishes have not been identified, selected by Owner or Architect, finish to match surrounding surfaces.

1.013 PRE-INSTALLATION CONFERENCE

A. Arrange and schedule pre-installation conference prior to beginning work of this Section Division 27, Communications.

B. Agenda: Clarify questions in writing related to work to be performed, scheduling, coordination, etc., with Consultant and/or Project Manager/Owner representative.

C. Individuals, who will be in an on-site supervisory capacity, are required to attend the pre-installation conference. This includes project managers, site supervisor, and lead installers. Individuals who do not attend the conference will not be permitted to supervise the personnel that install, terminate, or test communications cables on the project. Oversee the installation is required to attend the pre-installation conference.

D. The manufacturer that will be providing the extended warranty is required to have a representative attend the pre-installation conference.

1.014 FIELD QUALITY CONTROL

A. Perform the following field inspections during installation and commissioning:
1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings.
2. Visually inspect cabling placements, pathways, and terminations in communications equipment rooms, telecommunications rooms, and work areas for compliance with standards and codes.
3. Visually inspect grounding and bonding for compliance with standards and codes.
4. Visually inspect installed cable trays, cable pathways, and wall penetrations for compliance with standards and codes.

B. Responsible for field inspections and will submit a signed weekly inspection report to Owner.

1.015 ALTERNATES, SUBSTITUTIONS, AND CHANGE ORDERS

A. If a proposed alternate material submitted as an “or approved equal” to or exceeds specified requirements, provide manufacturer’s specifications in writing for written approval prior to purchase and installation of proposed materials. The proposed material substitution not void or change manufacturer’s warranty.

B. Provide a complete cabling infrastructure according to these written specifications and drawings. Changes from the Owner changes the scope of work to be performed by the Contractor, put in writing. Respond to changes with a complete material list, labor, and taxes in writing presented to the Owner for approval. Do not proceed with additional scope of work without a signed approval by the Owner.

C. Additional work performed by the Contractor will not be paid by Owner without signed approval of these changes prior to implementing changes. Submit a copy of signed change order upon billing.

D. Refer to Technology Drawings for detailed information relating to the appropriate alternates.

1.016 PROJECT MANAGEMENT

A. Designate a project manager to act as the single point of contact. Project manager to oversee work performed to ensure a quality installation compliant with specifications as outlined in documents (which includes specifications and drawings). Owner or Consulting Engineer will review a copy of the resume of the on-site project managers and each on-site team.

B. Contractor project manager/supervisor to attend meetings arranged by General Contractor, Architect, Owner’s representatives, and/or other parties affected by work of this specification.

1.017 DELIVERY AND STORAGE

A. Assume custody and responsibility for the items upon delivery and determining that the contents are complete and in satisfactory condition for installation.

B. Delivery, loss, storage, and protection: Materials and equipment delivered and placed in storage stored with protection from the weather, humidity, and temperature variation, dirt, and dust or other contaminants.

C. Coordinate deliveries and submittals with the General Contractor/Owner to ensure a timely scheduled installation.

D. Responsible for handling and control of cabling equipment and liable for material loss due to delivery and storage problems.

E. No equipment or materials delivered to the job site more than three weeks prior to the commencement of its installation. Coordinate with General Contractor/Owner on location of storage materials.

1.018 AS-BUILTS

A. Record copy and as-built drawings.

1. Provide record copy drawings periodically throughout the project as requested by the General Contractor or Owner, and at end of the project on CD-ROM. Record copy drawings at the end of the project in AutoCAD format and include notations reflecting the as built conditions of additions to or variation from the drawings provided such as, but not limited to, cable paths and termination points. AutoCAD drawings are to incorporate test data imported from the test instruments.
2. As built drawings include, but are not limited to: block diagrams, frame and cable labeling, cable termination points, equipment room layouts, rack elevations, and frame installation details. The as-built drawings includes field changes made up to construction completion:
   a. Field directed changes to cross connect and patching schedule.
   b. Horizontal cable routing changes.
   c. Backbone cable routing or location changes, inclusive outside plant physical pathways (if within scope of this project).
   d. Associated detail drawings.

1.019 CLEANING

A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, dust, and construction debris and repair damaged finish, including chips, scratches, and abrasions. This includes touching up paint removed for grounding.

B. Provide a clean work environment, free from trash/rubbish accumulated during and after cabling installation.

C. Maintain construction materials and refuse within the area of work. Clean the work area at the end of each day.

D. Keep liquids off finished floors, carpets, tiles, racks, and equipment. If liquid damages finishes or equipment, provide professional services to clean or repair scratched/soiled finishes or damaged equipment at the Contractors own expense.

1.020 PAINTING

A. Certain Division 27, Communications Sections contain the requirement of painting, it is the responsibility of the Contractor to coordinate the requirements and labor involved to complete this work with the General Contractor.

B. Touch up marred and bared surfaces of primed, galvanized, and finish painted equipment, materials, and accessories installed.

C. Restore patched surfaces as close to the original condition and finish as reasonably possible. Where patching occurs in smooth painted surface, extend final paint coat over entire unbroken surface containing patch, after patched area has received two coats of primer and two coats of finished paint.

PART 2 PRODUCTS

2.01 GENERAL

A. Where specified materials or methods conflict with applicable codes, the more stringent requirement applies.

B. Provide apparatus built and installed to deliver its full rated capacity at the efficiency for which it was designed.

C. Materials and Equipment:
   1. Use materials and equipment that are:
      a. New
      b. Of quality meeting or exceeding specified standards.
      c. Free of faults and defects.
      d. Conforming to Contract Documents.
      e. Of size, make, type, and quality specified.
      f. Suitable for the installation indicated.
      g. Manufactured in accordance with NEMA, ANSI, UL, or other applicable standards.
      h. Otherwise as specified in Division 01, General Requirements.
   2. Where two or more units of the same class of equipment are furnished, use products of the same manufacturer.
      a. Component parts of the entire system need not be products of same manufacturer.

D. Basis of Design:
   1. First listed manufacturer specified by performance or model number considered the Basis of Design.
   2. If other equipment is provided in lieu of the Basis of Design equipment, assume responsibility for changes and costs which may be necessary to accommodate this equipment, including, but not limited to:
      a. Different sizes and locations for connections.
      b. Different dimensions.
      c. Different access requirements.
      d. Different configurations of connected equipment.
      e. Other differences.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
   1. Full and complete compliance with standards and guidelines set forth in this and subsequent specifications.
   2. Field verify existing conditions prior to installation and make note of conflicts and discrepancies between these specifications and construction drawings to the Owner immediately.
      a. Field discrepancies not noted to the Owner or Design Team prior to installation commencement the responsibility of the Contractor and repaired at no cost to the Owner.
   3. Provide a complete and properly operating system for each item of equipment specified.
   4. Install materials in a neat and professional manner.
   5. Comply with equipment manufacturer's written instructions, the best industry practices, and the Contract Documents.

B. Clarification:
   1. Where there is a conflict among manufacturer's instruction, best practice, and the Documents, request clarification from the Architect prior to rough-in.
   2. Architect's decision will be final.
   3. Remove and correct work installed without clarification by the Contractor at no cost to the Owner.

C. Existing concrete, block, or brick walls are considered not accessible and may require use of Surface Mounted Raceway (SMR) if existing concealed raceway and device boxes are not available for reuse or do not meet the intent of the design. Coordinate route and installation where SMR is required with the Architect/Engineer prior to rough-in. Responsible for reinstalling SMR routed without such prior approval to the Architect's satisfaction.

D. Existing stud walls (wood or metal) with or without blocking with plaster, plasterboard, or paneling finish are considered accessible with accessible ceiling, attic, tunnel, or crawl space above, below, or adjacent. Remove, patch, and repair finished surface as required to conceal rough-in for new device locations. If it is determined that a specific instance will not permit concealment of rough-in due to obstructions such as beams, headers, and other structural elements, prior approval before rough-in from the Architect is required.

3.02 INSTALLATION IN RATED CONSTRUCTION

A. Install intumescent material around ducts, conduits, and other telecommunications elements penetrating rated construction.

B. Comply with firestop materials manufacturer's written instructions to prevent spread of smoke or fire through sleeves or block-outs penetrating rated fire barriers.

C. Provide firestop materials specified in Division 07, Thermal and Moisture Protection, and as follows:
1. Capable of passing a 3-hour test per ASTM E-814 (UL 1479).
2. Consisting of material capable of expanding nominally eight times when exposed to temperatures of 250 degrees F – 350 degrees F.
3. An alternate method utilizing intumescent materials in caulk or putty complying with Division 07, Thermal and Moisture Protection may be used.

3.03 EQUIPMENT SUPPORT

A. Minimum Support Capacity:
1. Provide fastening devices and supports for equipment, panels, outlets, and cabinets capable of supporting not less than four times the ultimate weight of the object or objects fastened to or suspended from the building structure.

B. Support junction boxes, pull boxes, or other conduit terminating housings located above the suspended ceiling from the floor above, roof, or penthouse floor structure to prevent sagging or swaying.

C. Conduits:
1. Support suspended conduits 1-inch and larger from the overhead structural system with metal ring or trapeze hangers and threaded steel rod having a safety factor of four.
2. Conduits smaller than one 1-inch installed in ceiling cavities may be supported on the mechanical system supports when available space and support capacity has been coordinated with the sub-contractor installing the supports.
3. Anchor conduit installed in poured concrete to the steel reinforcing with 14 AWG black iron wire.

D. Powder actuated or similar shot-in fastening devices will not be permitted for technology work except by review from the project structural engineer.

3.04 ALIGNMENT

A. Install panels, cabinets, and equipment level and plumb, parallel with structural building lines.

B. Install equipment and enclosures fitted neatly, without gaps, openings, or distortion.

C. Properly and neatly close unused openings with approved devices.

D. Fit surface panels, devices, and outlets with neat, appropriate, trims, plates, or covers without overhanging edges, protruding corners, or raw edges.

3.05 CUTTING AND PATCHING

A. General:
1. Comply with Division 01, General Requirements.
2. Restore to original condition new or existing work cut or damaged by installation, testing, and removal of work.
3. Patch and finish spaces around conduits passing through floors and walls to match the adjacent construction, including painting or other finishes.
4. Clean up and remove dirt and debris.

B. Make additional required openings by drilling or cutting. Use of jackhammer is prohibited.

C. Fill holes that are cut oversize so that a tight fit is obtained around the objects passing through.
1. In rated construction, comply with Division 07, Thermal and Moisture Protection.

D. Obtain Architect's permission and direction prior to piercing beams or columns.

E. Where alterations disturb lawns, paving, walks, and other permanent site improvements, repair and refinish surfaces to condition existing prior to commencement of work.

3.06 PROTECTION OF WORK

A. Protect telecommunication work and equipment installed under this Division against damage by other trades, weather conditions, or other causes.
1. Equipment found damaged or in other than new condition will be rejected as defective.

B. Keep equipment, panels, outlets, and related telecommunication equipment covered or closed to exclude dust, dirt, and splashes of plaster, cement, paint, or other construction material spray.
1. Equipment not free of contamination is not acceptable.

C. Provide enclosures and trims in new condition, free of rust, scratches, and other finish defects.
1. If damaged, properly refinish in a manner acceptable to the Architect.

3.07 COMPLETION AND TESTING

A. General:
1. Comply with Division 01, General Requirements.

B. Upon completion, test systems to show that installed equipment operates as designed and specified, free of faults.
1. Schedule system tests so that several occur on the same day.
2. Coordinate testing schedule with construction phasing.
3. Submit systems test reports for Design Team review and feedback.
4. Schedule proof-of-performance testing with Design Team representative and/or Owner's representative.

C. A qualified contractor with required tools to conduct cable and equipment tests. Arrange to have the equipment factory representative present for those tests where the manufacturer's warranty could be impacted by the absence of a factory representative.

D. Perform tests per the requirements of each of the following systems:
1. Horizontal data/voice structured cabling system.
2. Backbone data/voice cabling system.
3. Audio/video systems.

E. Software and Programming
1. Software, firmware, web-based GUI, and other systems with username and login credentials given unique passwords from the factory defaults.
2. Maintaining factory default credentials is not acceptable.
3. Document username/passwords for equipment in the as-built/O&M manuals.

END OF SECTION

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Conductors
   2. Grounding Busbars
   3. Compression Lugs
   4. Taps

B. Work covered by this Section consists of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified for a complete grounding (earthing) and bonding system for the communications systems.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 27, Communications

C. Section 26 05 26, Grounding and Bonding for Electrical Systems

1.03 REFERENCES

A. References, Codes and Standards as required by Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.

1.04 QUALITY ASSURANCE

A. Conform to the quality assurance requirements of Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.

1.05 SUBMITTALS

A. Including, but not limited to: Product Data Sheets, Shop Drawings, etc.

B. General:
   1. Submit in accordance with Section 270500, Common Work Results for Communications submittal requirements.

C. Closeout Submittals:
   1. Submit in accordance with Section 270500, Common Work Results for Communications submittal requirements.

1.06 DEFINITIONS

A. Backbone: A facility (e.g., pathway, cable, or conductors) between telecommunications rooms or floor distribution terminals, entrance facilities, and equipment rooms within or between buildings.

B. Bonding: The permanent joining of metallic parts to form an electrically conductive path that will assure electrical continuity and the capacity to conduct safely current likely to be imposed.

C. Common Bonding Network (CBN):
   1. The principal means for effecting bonding and grounding inside a telecommunication building.
   2. It is the set of metallic components that are intentionally or incidentally interconnected to form the principal bonding network (BN) in a building.
   3. These components include structural steel or reinforcing rods, plumbing, alternating current (AC) power conduit, AC equipment grounding conductors (ACEGs), cable racks, and bonding conductors.
   4. CBN always has a mesh topology and is connected to the grounding electrode system.

D. EMI (Electromagnetic Interference): The interference in signal transmission or reception resulting from the radiation of electrical or magnetic fields.

E. Entrance Facility (telecommunications): An entrance to a building for both public and private network service cables (including antennae) including the entrance point at the building wall and continuing to the entrance room or space.

F. Equipment Room (telecommunications):
   1. A centralized space for telecommunications equipment that serves the occupants of the building.
   2. An equipment room is considered distinct from a telecommunications room because of the nature or complexity of the equipment.

G. Exothermic Weld: A method of permanently bonding two metals together by a controlled heat reaction resulting in a molecular bond.

H. Ground: A conducting connection, whether intentional or incidental, between an electrical circuit or equipment and the earth or to some conducting body that serves in place of the earth.

I. Telecommunications Bonding Conductor (TBC): The conductor used to connect the grounding electrode to the equipment grounding conductor, to the grounded conductor, or both of the circuits at the service equipment, or at the source of a separately derived system.

J. Mesh Bonding Network (Mesh-BN): A bonding network to which associated equipment (e.g., cabinets, frames, racks, trays, pathways) are connected using a bonding grid, which is connected to multiple points on the common bonding network.

K. Primary Bonding Busbar (PBB): A busbar placed in a convenient and accessible location and bonded, by means of the telecommunications bonding conductor (TBC), to the building service equipment (power) ground.

L. Primary Protector: A surge protective device placed on telecommunications entrance conductors in accordance with ANSI/NFPA 70 and ANSI/ATIS 0600318 and listed under ANSI/UL 497.

M. Rack Bonding Conductor (RBC): A bonding conductor used to connect the rack/cabinet directly to the PBB/SBB/Mesh

N. Rack Bonding Busbar (RBB): A

O. Secondary Bonding Busbar (SBB):
   1. The interface to the building telecommunications bonding system generally located in a telecommunications room.
   2. A common point of connection for telecommunications system and equipment bonding to ground and located in the telecommunications room or equipment room.

P. Telecommunications Room (TR): An enclosed space for housing telecommunications equipment, cable terminations, and cross-connect cabling, that is the recognized location of the cross-connect between the backbone and the horizontal facilities.

Q. Telecommunications Bonding Backbone (TBB): A conductor that interconnects the primary bonding busbar (PBB) to the secondary bonding busbar (SBB).

R. Backbone Bonding Conductor (BBC):
   1. When there are multiple TBBs, the BBC is employed to interconnect them through the associated busbars, either on the same floor in a multi-story building or in the same general area of a single story building.
   2. Referred to as a Grounding Equalizer (GE).

S. Telecommunications Equipment Bonding Conductor (TEBC): A conductor that connects the primary bonding busbar (PBB) or secondary bonding busbar (SBB) to equipment racks or cabinets.

T. Unit Bonding Conductor (UBC): A bonding conductor used to connect rack/cabinet mounted equipment unit to the grounding structure (i.e., conductor, busbar) utilized in that rack/cabinet.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conductors:
1. Cooper B-Line
2. Erico
3. Panduit
4. Or approved equal.

B. Grounding Busbars:
1. Primary Bonding Busbar:
   a. CPI
   b. Panduit
   c. Hubbell
   d. Or approved equal.
2. Secondary Bonding Busbar:
   a. CPI
   b. Panduit
   c. Hubbell
   d. Or approved equal.
3. Horizontal Cabinet or Equipment Rack Busbar – 19 inches:
   a. CPI
   b. Cooper B-Line
   c. Or approved equal.

C. Compression Lugs:
1. Cooper B-Line
2. Panduit
3. Thomas & Betts
4. Or approved equal.

D. Taps:
1. Thomas & Betts
2. Burndy
3. Or approved equal.

2.02 CONDUCTORS

A. The telecommunications backbone insulated copper conductor.

B. Rated to meet installed environment. Bare copper is not permitted for use in communications installations.

C. Jumpers: Compression ring terminal at both ends.

D. Size cables per table in PART 3.

2.03 GROUNDING BUSBARS

A. Primary Bonding Busbar (PBB):
1. Pre-drilled copper with holes to accommodate lug mounting holes.
2. 1/4-inch thick by 4-inch wide with 20-inch length.
3. Sized for current applications and future growth.
4. Insulated from its support.
5. Maintain a 2-inch minimum clearance from wall.

B. Secondary Bonding Busbar (SBB):
1. Pre-drilled copper with holes to accommodate lug mounting holes.
2. 1/4-inch thick by 4-inch wide with 12-inch length.

3. Sized for current applications and future growth.
4. Insulated from its support.
5. Maintain a 2-inch minimum clearance from wall.

C. Horizontal Cabinet or Equipment Rack Busbar – 19 inches.
1. Provide as shown on the contract documents or as directed by Owner.
2. Mounts to standard 19-inch Rack or Frame.
3. Capacity: Eight 6-32 tapped lug mounting holes and four 5/16-inch mounting holes.
4. Size and Material: 3/4-inch by 19-inch by 0.1875-inch – Copper.

2.04 COMPRESSION LUGS

A. Grounding conductor terminations (lugs) listed compression type, two-hole, long barrel with window lug with a minimum of two crimps. Crimp according to manufacturer's recommendation.

B. UL and CSA listed

C. Able to accept 6 AWG to 3/0 AWG.

D. Compression type

E. Two holes with various hole spacings to fit the busbar.

F. Long barrel that will allow a minimum of two crimps with standard industry colors.

G. An inspection window to verify that the conductor is fully seated in the lug.

H. Have a traceable feature to ensure proper die size was used to make the crimp.

I. Crimped according to manufacturer’s recommendation.

2.05 TAPS

A. Connections made with irreversible compression connectors.

B. UL and CSA listed

C. Able to accept 6 AWG to 3/0 AWG.

D. Have a traceable feature to ensure proper die size was used to make the crimp.

E. Requires a minimum of two crimps for C Tap and H Tap, 1 crimp for I-Beam and busbar Tap.

F. Crimp according to manufacturer’s recommendation.

PART 3 EXECUTION

3.01 PRIMARY BONDING BUSBAR (PBB)

A. Pre-drilled copper with holes to accommodate lug mounting holes.

B. 1/4-inch H by 4-inches W with varying length.

C. Sized for current applications and future growth.

D. Insulated from its support.

E. Maintain a 2-inch minimum clearance from wall.

F. Installed to maintain clearances required by applicable codes.

G. Location:
1. Accessible
2. Close to the panelboard as practicable, minimum 36-inches.
3. Where a panelboard (electrical power panel) is located in the same room or space as the PBB that panelboard’s alternating current equipment ground (ACEG) bus (when equipped) or the panelboard enclosure bonded to the PBB.

H. Listed by a nationally recognized testing laboratory.

I. Minimum of 36-inches from active electronics or the panelboard.

J. Located in telecommunication entrance facility or the first room/space where the communications cabling and conduits enter the building.

K. Have a mounting height adjusted to accommodate overhead or underfloor cable routing.

L. Minimize the length of bonding conductor for telecommunications.

M. Provide for the shortest and straightest routing of the primary.

N. Be located near backbone cabling and associated terminations.

O. Serve telecommunications equipment that is located within the same room or space.

P. Attachments to PBB:
1. Bonding Conductor: Refer to electrical drawings for tie-in to the building grounding system.
2. Primary Protector
3. Building Steel
4. Outside Plant Cables
5. Backbone cables that incorporates a shield or metallic member.
6. Metallic pathways for telecommunications cabling located within the same room or space as the PBB.
7. Cable Tray
8. Ladder Rack
9. Conduit
10. Telecommunications equipment located in the TEF (e.g., multiplexer or optical fiber termination equipment).
11. TBB
12. TEBC
13. Primary Protector Grounding Conductor: Minimum of 1-foot separation maintained between this insulated conductor and DC power cables, switchboard cable, or high frequency cables, even when placed in rigid metal conduit or EMT.

3.02 SECONDARY BONDING BUSBAR (SBB)

A. Predrilled copper busbar provided with holes for use with standard sized lugs.

B. Have minimum dimensions of 1/4-inch thick by 2-inches wide and variable length to meet the application requirements and with consideration of future growth.

C. Insulated from its support attachment a minimum of 2-inches.

D. Listed by a nationally recognized testing laboratory (NRTL).

E. Maintain 36-inch separation from active electronics.

F. Clean the busbar prior to fastening the conductors to the busbar, and apply an anti-oxidant to the contact area to control corrosion and reduce contact resistance.

G. SBB is the grounding connection point for telecommunications systems and equipment in the area served by that telecommunications room or equipment room.

H. Where a panelboard is located in the same room or space as the SBB that panelboard's ACEG bus (AC electrical ground when equipped) or the panelboard enclosure bonded to the SBB. When a panelboard for telecommunications equipment is not in the same room or space as the SBB, that SBB should be bonded to the panelboard that feeds the distributor.

I. Bond TBBs and other SBBs within the same space to the SBB with a conductor the same size as the TBB.

J. Bond where a backbone bonding conductor (BBC) is required, to the SBB.

3.03 TELECOMMUNICATIONS BONDING BACKBONE (TBB)

A. The intended function of a TBB is to reduce or approved equalize potential differences between telecommunications systems. While the TBB will carry some current under AC power ground fault conditions, it is not intended to provide the only ground fault return path.

B. TBB/BCC conductor size versus length:

TBB/BCC Linear Length	Conductor Size (AWG)
Less than 4-feet	6
4-6-feet	4
6-8-feet	3
8-10-feet	2
10-13-feet	1
13-16-feet	1/0
16-20-feet	2/0
20-26-feet	3/0
26-32-feet	4/0
32-38-feet	250 kcmil
38-46-feet	300 kcmil
46-53-feet	350 kcmil
53-76-feet	500 kcmil
76-91-feet	600 kcmil
Greater than 91-feet	750 kcmil

C. Connect to the PBB and SBB.

D. Size continuous copper conductor no less than 6 AWG to a maximum of 750 kcmil. Size in accordance to the conductor table, refer to Table 1.

E. Be consistent with the design of the telecommunications backbone cabling system.

F. Install and protect from physical and mechanical damage.

G. The TBB conductors should be installed without splices:
   1. Where splices are necessary, the number of splices should be a minimum and accessible and located in telecommunications spaces.
   2. Connect joined segments using exothermic welding, irreversible compression-type connectors, or equivalent.

H. Permit multiple TBBs as dictated by the building size.

I. Do not use metallic cable shield.

J. NOTE: When structural metal is bonded to the building's grounding electrode system it may be used in place of a TBB, a BCC or both. Before utilizing structural metal in place of a TBB or a BCC, building plans (including record drawings as applicable) and specifications reviewed to ensure the structural metal is electrically continuous or can be made so.

3.04 BACKBONE BONDING CONDUCTOR (BBC):

A. Continuous copper conductor that should be sized no less than 6 AWG to a maximum of 750 kcmil. BBC, as a minimum, the same size as the largest TBB to which it is connected.

B. Connect the telecommunications grounding busbar(s) in the same-floor telecommunications rooms on the first, top, and every third floor in a multi-story building.

C. Cable shields do not satisfy requirements.

3.05 TELECOMMUNICATIONS EQUIPMENT BONDING CONDUCTOR (TEBC)

A. Connects the PBB/SBB to equipment racks/cabinets.

B. Continuous copper conductor that should be sized per the length of cable.

C. Separate from ferrous materials by 2-inches or be bonded to the ferrous metal.

D. Route within cable trays or suspended 2-inches under or off the side of the cable tray or ladder rack.

E. Support every 3-wfeet.

F. 8-inch Bend radius with no less than a 90 degree bend.

G. May come in contact with other cable groups at a 90 degree angle only.

H. Cable shields do not satisfy the requirement.

I. There may be more than one TEBC within each telecommunication room.

3.06 RACK BONDING CONDUCTOR (RBC)

A. Use a bonding conductor to connect the rack/cabinet directly to the PBB/SBB.

B. Bond metallic enclosures, including telecommunications cabinets and rack to the SBB, or PBB using a minimum sized conductor of 6 AWG.

C. Do not bond serially cabinets, racks, and other enclosures in computer rooms; each to have their own dedicated bonding conductor to the SBB, or PBB.

3.07 ELECTRICAL DISTRIBUTION PANEL (EDP)

A. When located in the same room as the PBB/SBB, the EDP's equipment grounding bus or the panel board enclosure bonded to the PBB/SBB.

B. Using a bonding conductor for telecommunications (BCT) minimum 6 AWG to a maximum of 3/0 AWG depending on the length of cable required.

C. Use same AWG as TBB.

D. Make connections within an AC electrical panel by a qualified electrician.

E. Outside of the scope of ANSI/TIA-607B.

3.08 CONDUCTIVE FIBER OPTIC CABLES

A. Bond and ground metallic components of a conductive cable are capable of transmitting current.

B. Conductive fiber-optic cables should be bonded and grounded as specified in NEC 770.100.

3.09 LADDER RACK AND/OR CABLE TRAY

A. To achieve the objective of potential equalization in the TR, cable runway sections are bonded together and bonded back to the PBB/SBB.

B. Maintain an 8-inch Bend Radius on the TEBC.

C. Keep a 2-inch separation from other cables, power, and telecommunications.

D. Remove paint, oxidation, etc., from the runway surfaces that are being bonded.

E. Drill two holes as required to accommodate the two-hole compression lug.

F. Apply a thin coat of antioxidant around the holes and on the surface where the lug will be in contact.

G. Attach straps to the runway using stainless steel hardware sized for the lug holes.

H. Tighten the hardware.

I. Wipe off excess antioxidant after installation of the lug.

3.010 LABELING

A. The format for the telecommunications main grounding busbar, TR-PBB, while the format for the SBBs, TR-SBB.
   1. TR identifier is the room number for the space containing the busbar.
   2. PBB is the portion of an identifier designating a telecommunications main grounding busbar.
   3. SBB is the portion of the identifier designating a telecommunications grounding busbar.

B. Assign each telecommunications space or room an identifier unique within the building. Label TS with the TS identifier inside the room so as to be visible to someone working in that room. Use the FS format for the TS identifier.

C. Label should be visible and legible.

3.011 TESTING

A. Earth Ground Resistance Tester:
   1. The earth ground resistance tester generates a specific test current, this current is less susceptible to the influences of stray currents on the grounding system.
   2. This makes the ground resistance tester a more accurate testing devise that a standard Volt-Ohm-multimeter.

B. Two-point ground continuity testing: Maximum value 100 milliohms.

C. Follow manufacturer's instructions on setup and how to perform the test.

D. Care should be taken and safety precautions in place.

END OF SECTION

SECTION 27 05 28
PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Conduit and other Closed Pathway System
2. Pathway Bend Management
3. Wide Base Cable Supports
4. Cable Trays - General
5. Cable Tray – Robust with Side Rails
6. Cable Runways (Ladder Type) Cable Tray
7. Wire Basket Cable Tray
8. Cable Tray Accessories
9. Device Backboxes
10. Enclosures and Pullboxes
11. Floor Boxes
12. Flat Panel Display Wall boxes
13. Fire Rated Pathways
14. Acoustically Separated Pathways
15. Cable Straps

B. Handholes and Boxes for Exterior Underground Cabling

C. Work covered by this Section consists of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified for a complete pathways system for the communications systems.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 27, Communications

C. Section 26 05 33, Raceways and Boxes for Electrical Systems

D. Section 26 05 43, Underground Ducts and Raceways for Electrical Systems

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

F. Provisions of Division 27, Communications Section 27 05 00, Common Work Results for Communications, apply to this Section.

1.03 REFERENCES

A. References, Codes and Standards as required by Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.

1.04 QUALITY ASSURANCE

A. Conform to the quality assurance requirements of Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.3

B. Low voltage system cable supports and accessories listed to Underwriter's Laboratories or other national recognized testing laboratory.

C. Low voltage system cable supports and accessories have the manufacturers name and part number stamped on the part for identification.

D. Pre-Installation Meetings:
1. Setup a pre-installation meeting to discuss low voltage cable support layout work and installation guidelines.
2. Organize meeting a minimum of 30 days prior to initiating cable support installation work.

3. Attendees include Contractor, appropriate subcontractors, low voltage system vendors, Architect, and Owner's Representative.

E. Purpose of meeting is to coordinate work between the parties to have a consistent layout for low voltage system cables, minimize interferences, and to make cable system accessibility for future owner modifications and maintenance high priority issue for installers.

1.05 SUBMITTALS

A. Including, but not limited to: Product Data Sheets, Shop Drawings, etc.

B. General:
1. Submit in accordance with Section 27 05 00, Common Work Results for Communications submittal requirements.

C. Closeout Submittals:
1. Submit in accordance with Section 27 05 00, Common Work Results for Communications submittal requirements.

D. Additional requirements specific to this Section:
1. Firestop design basis documentation that includes each type of communication penetration, type of building construction being penetrated including the hourly resistance rating of floor, wall, or other partition of building construction into which firestop design will be installed, and firestop device or system proposed for use.

1.06 COORDINATION

A. Responsible for coordinating the arrangement, mounting and support for communications support equipment.

B. In accordance with the requirements set forth in Section 27 05 00, Common Work Results for Communications, provide the following:
1. Plan view and elevations of raceways (conduits, cable trays, ladder racks, floor ducts, junction boxes, pull boxes, splice boxes, manholes, and associated supports).
   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.

C. Coordinate layout and installation of low voltage cable bundle supports with other construction elements to ensure adequate headroom, working clearance and access. Revise locations and elevations for those indicated as required to suit field conditions and as approved by Owner's Representative.

D. Examine drawings and existing conditions above ceilings and include additional supports in bid price to avoid ducts, pipes, conduits, etc. Installation in existing ceilings can be very difficult. Include extra labor time involved in bid price.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Conduit and Other Closed Pathways Systems:
1. Conduit:
   a. Allied
   b. Prime
   c. Wheatland
   d. Or approved equal.
2. Conduit Supports:
   a. Allied
   b. Prime
   c. Wheatland
   d. Or approved equal.

B. Pathway Bend Management:
1. Panduit Conduit Waterfall

2. Bejed Cable Spillway
3. STI Radius Control Modules
4. Legrand
5. Or approved equal.

C. Wide Base Cable Supports:
1. ERICO Caddy CableCat Series
2. Garvin
3. ICC
4. Or approved equal.

D. Cable Tray, Robust with Side Rails:
1. Cooper B-Line
2. PW Industries
3. Or approved equal.

E. Cable Runways (Ladder-Type) Cable Trays:
1. Chatsworth Products (CPI).
2. B-Line Cooper, Inc.
3. Hoffman.
4. Cablofil/Legrand.
5. Or approved equal.

F. Wire Basket Cable Tray:
1. Cablofil/Legrand
2. Chatsworth Products (CPI)
3. B-Line Cooper, Inc.
4. Hoffman
5. Or approved equal.

G. Cable Tray Accessories:
1. Compatible w/ submitted tray manufacturer.

H. Device Backboxes:
1. Raco
2. Steel City
3. Bowers
4. Or approved equal.

I. Enclosures and Pullboxes:
a. Hoffman
b. Cooper B-Line
c. Or approved equal.

J. Fire Rated Pathways:
1. STI EZ-path
2. Hilti Speed Sleeve
3. 3M
4. Or approved equal.

K. Acoustically Separated Pathways:
1. STI Acoustical Pathway
2. Hilti Acoustic and Smoke Pathway
3. Or approved equal.

L. Cable Straps:
1. Panduit
2. Velcro
3. Or approved equal.

2.02 CONDUIT AND OTHER CLOSED PATHWAY SYSTEMS

A. Conduit Size: In accordance with the NEC, but not less than 1-inch unless otherwise shown in the Contract Drawings.

B. Install in accordance with the construction documents, national codes, and applicable publications designated herein.

C. Conduit:
1. Following construction types:
2. Fiberglass
3. Electrical Metallic Tubing
4. Rigid Galvanized Steel
5. Flexible Non-Metallic Conduit.
6. Install as recommended by the raceway manufacturer and construction documents.
7. Flexible Metallic Conduit is not permitted in this project for interior installation.

D. Conduit Supports:
1. Individual Conduit Hangers: Designed for the purpose, having a preassembled closure bolt and nut, and provisions for receiving a hanger rod.
2. Install conduit supports at a maximum of 5-foot centers.

2.03 PATHWAY BEND MANAGEMENT

A. Device to control the bend radius must comply with National Electrical Code requirements and TIA Standards. In addition, the product must be RoHS compliant to meet environmental requirements, UL 94V-0 approved to reduce the spread of flame, and be approved by UL for use in air handling spaces.

B. UL Listed:

C. Provide at horizontal 4-inch conduits.

D. Provide at cable tray above equipment racks.

2.04 WIDE BASE CABLE SUPPORTS

A. Wide base J-hooks complying with most current revision of the TIA 568 and 569 structured cabling system requirements.

B. Minimum size is 1-5/16-inch diameter loop for 50, 4-pair UTP or 2 strand fiber optic cable or inner duct. Provide larger size or multiple hooks where required.

C. Minimum 1-inch width and flared edges where cables enter and leave support.
1. 1.3-inch diameter loop for maximum 35, 4-pair UTP
2. 2-inch diameter loop for maximum 50, 4-pair UTP

D. Accessories:
1. Provide applicable accessories to independently support J-hooks from structure.
2. Include extender bracket for mounting multiple J-hooks on a single support, fasteners, and clamps for connecting to wall, beams, rods, dedicated support wires and C and Z Purlins as required for specific construction.

E. Cable Retainers: Provide cable retainers at each J-hook.

F. Refer to cable bundling instructions specified herein.

G. Finish:
1. Dry Locations, Above Lay-in Ceiling, Below Raised Floor – galvanized.
2. Wet and Damp Locations: stainless steel.

2.05 CABLE TRAYS – GENERAL

A. Application, unless otherwise noted:
1. Robust with Side Rails: Located overhead within Telecommunications Rooms.
2. Wire-Basket Tray: Located between Telecommunications Rooms and work area outlets.
3. Ladder-Type Cable Runway: Vertical transitions within Telecommunications Rooms.

B. Cable Tray Radius Drops: Provide wherever cable is to drop from one section of cable tray to another lower section of cable tray, or is to drop from cable tray to equipment racks/frames.

C. Cable Tray Grounding Kits: Provide across cable tray splices.

D. Cable Trays and Accessories:
   1. Identified as defined in NFPA 70 and marked for intended location, application, and grounding.
   2. Source Limitations:
      a. Obtain cable trays and components from single manufacturer.

E. Sizes and Configurations: Refer to the Drawings for specific requirements for types, materials, sizes, and configurations.

F. Structural Performance:
   1. Refer to articles for individual cable tray types for specific values for the following parameters:
      a. Uniform Load Distribution:
         1) Capable of supporting a uniformly distributed load on the indicated support span when supported as a simple span and tested according to NEMA VE 1.
      b. Concentrated Load: A load applied at midpoint of span and centerline of tray.
      c. Load and Safety Factors: Applicable to both side rails and rung capacities.
      d. Seismic Performance:
         1) Cable trays and supports able to withstand the effects of earthquake motions determined according to ASCE/SEI 7.
         2) Cable trays will remain in place without separation of parts when subjected to the seismic forces specified.
         3) Component Importance Factor: 1.0.

2.06 CABLE TRAY, ROBUST WITH SIDE RAILS

A. Steel or aluminum construction.

B. Rung Spacing: 9-inches on center.

C. No portion of the rungs protrude below the bottom plane of side rails.

D. Straight Section Lengths: 10-feet except where shorter lengths are required to facilitate tray assembly.

E. Width and Height: As indicated on Drawings.

F. Splicing Assemblies: Bolted type using serrated flange locknuts.

G. Splice Plate Capacity: Splices located within support span not to diminish rated loading capacity of cable tray.

H. Color: Black, U.O.N.

2.07 CABLE RUNWAYS (LADDER-TYPE) CABLE TRAYS

A. Ladder rack manufactured from tubular steel. Stringers (sides) will be made from 3/8-inch wide by 1-1/2-inch high tubular steel with 0.065-inch wall thickness. Cross members (rungs) will be made from 1-inch wide by 1/2-inch high tubular steel with 0.065-inch wall thickness.

B. Rung Spacing: 9-inches on center.

C. No portion of the rungs protrude below the bottom plane of side rails.

D. Straight Section Lengths: 10-feet except where shorter lengths are required to facilitate tray assembly.

E. Width: As indicated on Drawings.

F. Splicing Assemblies: Bolted type using serrated flange locknuts.

G. Splice Plate Capacity: Splices located within support span not to diminish rated loading capacity of cable tray.

H. Color: Black, U.O.N

2.08 WIRE BASKET CABLE TRAY

A. Configuration:
1. Wires are formed into a standard 2-inch by 4-inch wire mesh pattern with intersecting wires welded together.
2. Mesh sections must have at least one bottom longitudinal wire along entire length of section.

B. Materials: High-strength-steel longitudinal wires with no bends.

C. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.

D. Sizes:
1. Furnish straight sections in standard 10-foot lengths.
2. Wire-Basket Depth: As shown in Drawings.

E. Maximum Loads: 50 pounds per foot (74 kg/m).

F. Connector Assemblies:
1. Bolt welded to plate shaped to fit around adjoining tray wires and mating plate.
2. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.

G. Connector Assembly Capacity: Splices located within support span not to diminish rated loading capacity of cable tray.

H. Hardware and Fasteners: Zinc-plated according to ASTM B 633.

2.09 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Barrier Strips: Same materials and finishes as for cable tray.

C. Cable tray supports and connectors, including bonding jumpers, 90 bends, and radius drop-outs as recommended by cable tray manufacturer.

2.010 DEVICE BACKBOXES

A. Flush mounted, sheet steel construction with conduit knockout.

B. UL514A Listed

C. Unless otherwise noted, provide:
1. 4-11/16-inch square, 2-1/8-inch deep backbox standard for Communications and Audio-Video devices.
2. 4-inch square, 2-1/8-inch deep backbox standard for Electronic Security devices.
3. Code minimum rated for the installed application.

D. Gang mud rings sizes as required for the applicable device.

2.011 ENCLOSURES AND PULLBOXES

A. Pull Boxes:
1. Provide enclosure and pull boxes as shown in the construction documents.
2. Measure and provide additional conduit offsets required by Contractor not shown in Drawings with properly sized pull boxes.

3. Pull Box Sizing:

Minimum Trade Size Conduit	Width	Length	Depth	Each Additional Conduit Increase (Width)
3/4-inch	4-inch	12-inch	3-inch	2-inch
1-inch	4-inch	16-inch	3-inch	2-inch
1-1/4-inch	6-inch	20-inch	3-inch	3-inch
1-1/2-inch	8-inch	27-inch	4-inch	4-inch
2-inch	8-inch	36-inch	4-inch	5-inch
2-1/2-inch	10-inch	42-inch	5-inch	6-inch
3-inch	12-inch	48-inch	5-inch	8-inch
3-1/2-inch	12-inch	54-inch	6-inch	6-inch
4-inch	15-inch	60-inch	8-inch	8-inch

2.012 FIRE RATED PATHWAYS

A. Self-closing through wall penetrations for cabling pathway, without the use of sealant, putty, foam pads, or other similar sealing means.

B. Meets hourly rating for the partition penetrated.

C. Accommodates frequent cable moves, adds, and changes.

D. Permits the allowable cable load to range from 0 to 100 percent visual fill.

E. Does not require additional action on the part of the installer to open or close the pathway device, such as, but not limited to:
   1. Opening or closing of doors.
   2. Twisting an inner liner.

F. Minimum STC rating empty or full: 45

2.013 ACOUSTICALLY SEPARATED PATHWAYS

A. Self-closing through wall penetrations for cabling pathway, without the use of sealant, putty, foam pads, or other similar sealing means.

B. Accommodates frequent cable moves, adds, and changes.

C. Permits the allowable cable load to range from 0 to 100 percent visual fill.

D. Does not require additional action on the part of the installer to open or close the pathway device, such as, but not limited to:
   1. Opening or closing of doors.
   2. Twisting an inner liner.

E. Minimum STC rating empty or full: 45

2.014 CABLE STRAPS

A. Use within telecommunications rooms and open cable pathways (cable tray). Provide for strapping groups of cables to raceway and for controlling/managing patch cables.

B. The use of plastic tie wraps for this purpose is not acceptable.
   1. Self-gripping, reusable, constructed of Velcro, and hook-and-loop style.
   2. Plenum rated cable straps to be used in plenum air handling spaces.

C. Quantity:
   1. Provide in sufficient quantity to strap cable bundles at intervals specific to the type of cable bundle. For the purposes of determining the quantity of straps to provide, the number of cables in a cable bundle and the intervals at which straps applied are as follows:
      a. Bundle size (use to determine strap quantity):
         1) For Patch Cables: Maximum of 25 patch cables per cable bundle with straps applied at 1-foot intervals.
         2) For horizontal cabling: Maximum of 25 station cables per cable bundle with straps applied at 3-foot intervals.

3) For Backbone Cables: Maximum of 4 backbone cables per cable bundle with straps applied at 3-foot intervals.

D. Bundling (use to determine strap quantity):
1. Bundle cables by application (patch, horizontal, backbone) and by cable type (Category X, MM Fiber, SM Fiber, etc.).
2. Do not intermix cable applications and types within a bundle.

E. Color: Black

PART 3 EXECUTION

3.01 CONDUIT INSTALLATION

A. Penetrations: Cutting or Holes:
1. Locate holes in advance where they are proposed in the structural sections such as ribs or beams. Obtain the approval of the structural engineer prior to drilling through structural sections.
2. Cut holes through concrete and masonry in new and existing structures with a diamond core drill or concrete saw. Pneumatic hammer, impact electric, hand or manual hammer type drills are not allowed, except where permitted by the Owner's Information Technology as required by limited working space.

B. Fire Stop:
1. Where conduits, wire ways, and other communications raceways pass through fire partitions, fire walls, smoke partitions, or floors, install a fire stop that provides an effective barrier against the spread of fire, smoke, and gases as specified in Division 07, Thermal and Moisture Protection , with rock wool fiber or silicone foam sealant only.
2. Completely fill and seal clearances between raceways and openings with the fire stop material.

C. Waterproofing: At floor, exterior wall, and roof conduit penetrations, completely seal clearances around the conduit and make watertight as specified in Division 07, Thermal and Moisture Protection.

3.02 INSTALLATION, GENERAL

A. Install conduit as follows:
1. In complete runs before pulling in cables or wires.
2. Flattened, dented, or deformed conduit is not permitted. Remove and replace the damaged conduits with new undamaged material.
3. Assure conduit installation does not encroach into the ceiling height headroom, walkways, or doorways.
4. Cut square with a hacksaw, ream, remove burrs, and draw up tight.
5. Mechanically continuous.
6. Independently support conduit at 5-feet on center. No other supports allowed.
7. Support within 1-foot of changes of direction, and within 1-foot of each enclosure to which connected.
8. Close ends of empty conduit with plugs or caps at the rough-in stage to prevent entry of debris, until wires are pulled in.
9. Conduit installations under fume and vent hoods are prohibited.
10. Secure conduits to cabinets, junction boxes, pull boxes, and outlet boxes with bonding type locknuts. Do not use aluminum conduits in wet locations.
11. Unless otherwise indicated on the drawings or specified herein, install conduits concealed within finished walls, floors, and ceilings.

B. Conduit Bends:
1. Make bends only with manufacturer approved tools or fittings.
2. Do not use standard conduit bending machines.
3. Conduit hickey benders may be used for slight offsets, and for straightening stubbed out conduits.

4. Bending of conduits with a pipe tee or vise is prohibited.

C. Layout and Homeruns:
1. Deviations: Make only where necessary to avoid interferences and only after Drawings showing the proposed deviations have been submitted approved by the Owner Information Technology Team.

3.03 CONCEALED WORK INSTALLATION

A. In Concrete:
1. Conduit: Rigid steel, IMC or EMT. Do not install EMT in concrete slabs that are in contact with soil, gravel, or vapor barriers.
2. Align and run conduit in direct lines.
3. Install conduit through concrete beams only when the following occurs:
   a. Where shown on the Structural Drawings.
   b. As approved by the Designer prior to construction, and after submittal of Drawing showing location, size, and position of each penetration.
4. Installation of conduit in concrete that is less than 3-inches thick is prohibited.
   a. Conduit outside diameter larger than 1/4 of the slab thickness is prohibited.
   b. Space between conduits in slabs: Approximately six conduit diameters apart, except one conduit diameter at conduit crossings.
   c. Install conduits approximately in the center of the slab so that there will be a minimum of 3/4-inch of concrete around the conduits.
5. Conduit for conductors 600V and below:
   a. Different type conduits mixed indiscriminately in the same system is prohibited.
6. Align and run conduit parallel or perpendicular to the building lines.
7. Connect recessed lighting fixtures to conduit runs with maximum 6 feet) of flexible metal conduit extending from a junction box to the fixture.
8. Tightening set screws with pliers is prohibited.

3.04 EXPOSED WORK INSTALLATION

A. Unless otherwise indicated on the Drawings, exposed conduit is only permitted in mechanical and electrical rooms.

B. Conduit for Conductors 600V and below: Different type of conduits mixed indiscriminately in the system is prohibited.

C. Align and run conduit parallel or perpendicular to the building lines.

D. Install horizontal runs close to the ceiling or beams and secure with conduit straps.

E. Support horizontal or vertical runs at not over 8-foot) intervals.

F. Surface Metal Raceways:
1. Use only where shown.

G. Painting:
1. Paint exposed conduit as specified in Division 09, Finishes.
2. Paint conduits containing cables rated over 600V safety orange.
3. Refer to Division 09, Finishes for preparation, paint type, and exact color.
4. Paint legends, using 2-inch high black numerals and letters, showing the cable voltage rating.
5. Provide legends where conduits pass through walls and floors and at maximum 20-foot intervals in between.

3.05 EXPANSION JOINTS

A. Conduits 3-inches and larger secured to the building structure on opposite sides of a building expansion joint, require expansion and deflection couplings. Install the couplings in accordance with the manufacturer's recommendations.

B. Provide conduits smaller than 3-inches with junction boxes on both sides of the expansion joint. Connect conduits to junction boxes with sufficient slack of flexible non-metallic conduit to produce 5-inch vertical drop midway between the ends.

C. Install expansion and deflection couplings where shown.

3.06 CONDUIT SUPPORTS, INSTALLATION

A. Safe working load not to exceed 1/4 of proof test load of fastening devices.

B. Use pipe straps or individual conduit hangers for supporting individual conduits. Maximum distance between supports is 8-foot on center.

C. Support multiple conduit runs with trapeze hangers. Use trapeze hangers that are designed to support a load equal to or greater than the sum of the weights of the conduits, wires, hanger itself, and 200 pounds. Attach each conduit with U-bolts or other approved fasteners.

D. Support conduit independently of junction boxes, pull boxes, fixtures, suspended ceiling T-bars, angle supports, and similar items.

E. Fasteners and Supports in Solid Masonry and Concrete:
   1. New Construction: Use steel or malleable iron concrete inserts set in place prior to placing the concrete.
   2. Existing Construction:
      a. Steel expansion anchors not less than 1/4-inch bolt size and not less than 1-1/8-inch embedment.
      b. Power set fasteners not less than 1/4-inch diameter with depth of penetration not less than 3-inches.
      c. Use vibration and shock resistant anchors and fasteners for attaching to concrete ceilings.

F. Hollow Masonry:
   1. Toggle bolts are permitted.

G. Bolts supported only by plaster or gypsum wallboard are not acceptable.

H. Metal Structures: Use machine screw fasteners or other devices specifically designed and approved for the application.

I. Attachment by wood plugs, raw plug, plastic, lead or soft metal anchors, or wood blocking and bolts supported only by plaster is prohibited.

J. Do not use chain, wire, or perforated strap to support or fasten conduit.

K. Spring steel type supports or fasteners are prohibited for uses except: horizontal and vertical supports/fasteners within walls.

L. Vertical Supports:
   1. Vertical Conduit:
      a. Riser clamps and supports in accordance with the NEC and as shown.
   2. Provide supports for cable and wire with fittings that include internal wedges and retaining collars.

3.07 BOX INSTALLATION

A. Boxes for Concealed Conduits:
   1. Flush mounted.
   2. Provide raised covers for boxes to suit the wall or ceiling, construction, and finish.

B. Install additional boxes where needed to prevent damage to cables and wires during pulling in operations.

C. Remove only knockouts as required and plug unused openings. Use threaded plugs for cast metal boxes and snap-in metal covers for sheet metal boxes.

3.08 COMMUNICATION SYSTEM CONDUIT

A. Minimum conduit size of 1-inch, but not less than the size shown on the Drawings.

B. Equip conduit ends with insulated bushings.

C. 4-inch conduits within buildings include pull boxes after every two 90 degree bends. Size boxes per the NEC.

D. Vertical conduits/sleeves through closets floors terminate not less than 3-inches below the floor and not less than 12-inches) below the ceiling of the floor below.

E. Terminate conduit runs to/from a backboard in a closet or interstitial space at the top or bottom of the backboard. Conduits enter communication closets next to the wall and be flush with the backboard.

F. Where drilling is necessary for vertical conduits, locate holes so as not to affect structural sections such as ribs or beams.

G. Seal empty conduits located in communication closets or on backboards with a standard non-hardening duct seal compound to prevent the entrance of moisture and gases and to meet fire resistance requirements.

1. Conduit runs contain no more than 2 quarter turns (90 degree bends) between pull boxes/backboards. Minimum radius of communication conduit bends as follows (special long radius):

Sizes of Conduit Trade Size	Radius of Conduit Bends
3/4	6-inches
1	6-inch
1-1/4	7-1/5-inch
1-1/2	9-inch
2	12-inch
2-1/2	25-inch
3	30-inch
3-1/2	36-inch
4	40-inch

3.09 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA VE 2-2000 and manufacturer recommendations.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Install cable trays so that the tray is accessible from an 8-foot ladder for cable installation and splices are accessible for inspection and adjustment.

D. Remove burrs and sharp edges from cable trays. Provide nylon bushings at exposed cut edges.

E. Fasten cable tray supports to building structure and install seismic restraints.

F. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 pounds. Comply with requirements in Division 26, Electrical.

G. Construct supports from channel members, threaded rods, and other appurtenances furnished by cable tray manufacturer. Arrange supports in trapeze or wall-bracket form as required by application.

H. Support bus assembly to prevent twisting from eccentric loading.

I. Install center-hung supports for single-rail trays designed for 60 vs. 40 percent eccentric loading condition, with a safety factor of 3.

J. Locate and install supports according to NEMA VE 2. Do not install more than one cable tray splice between supports.

K. Make changes in direction and elevation using manufacturer's recommended fittings.

L. Make cable tray connections using manufacturer's recommended fittings.

M. Seal penetrations through fire and smoke barriers. Comply with requirements in Division 07, Thermal and Moisture Protection.

N. Install cable trays with enough workspace to permit access for installing cables. Install tray so it is accessible from an 8-foot ladder.

O. Install warning signs in visible locations on or near cable trays after cable tray installation.

P. Provide Radius Tray drop-out at drop locations that exceed a 6-inch drop.

Q. Provide Cable Tray Sleeves where the cable tray penetrates a wall.

3.010 CABLE TRAY GROUNDING

A. Ground cable trays per Section 27 05 26, Grounding and Bonding for Communications Systems.

B. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Division 26, Electrical.

C. Bond cable trays with communications cable together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. Bond cable trays with control conductors together with splice plates listed for grounding purposes or with listed bonding jumpers.

E. Ground cable trays following the NFPA 70 table 392.7(B) for conductor sizes. Field modified cable trays conform to the minimum Metal Area Requirements as specified in Table 392.7(B) of NFPA 70.

F. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, Size of Equipment Grounding Conductors.

3.011 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on vertical runs to cable trays every 18 inches, using specified Velcro cable straps. Plastic wire-ties are not permitted for communications use.

C. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure no more than 72-inches.

D. Pathway cabling fill to not exceed a maximum of 40 percent, or per manufacturer's recommendations. Provide multiple support and pathway systems where required cable count exceeds 40 percent fill.

E. Unless otherwise noted, group cabling in separate supports and pathways by the following systems:
   1. Voice and Data, Intercom and IP Video Surveillance Systems
   2. Analog Video Surveillance and SMATV/CATV Systems
   3. Access Control and Intrusion Systems
   4. Audio-Visual Systems
   5. Distributed Antenna Systems
   6. Building Automation Systems
   7. Lighting Control Systems
   8. Motorized Shade Systems
   9. Fire Alarm Systems

3.012 CONNECTIONS

A. Connect pathways to cable trays according to requirements in NEMA VE 2-2000 and NEMA FG 1-1993 where applicable.

3.013 FIELD QUALITY CONTROL

A. Perform the following tests and inspections, with the assistance of a factory-authorized service representative if necessary:
   1. After installing cable trays and after cabling has been energized, survey for compliance with requirements.
   2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.
   3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by physical barriers or are installed in separate cable trays. Barriers are required between different voltage types.
   4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
   5. Remove dust deposits, industrial process materials, trash of description, and blockage of tray ventilation.
   6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and re-torque in suspect areas.
   7. Check for improperly sized or installed bonding jumpers.
   8. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
   9. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 Ohm.

B. Provide test and inspection reports.

3.014 PROTECTION

A. Protect installed cable trays and cables.
   1. Install temporary protection for cables in open trays to safeguard exposed cables against falling objects or debris during construction.
   2. Repair damage to galvanized finishes with zinc-rich paint recommended by cable tray manufacturer.
   3. Repair damage to paint finishes with matching touchup coating recommended by cable tray manufacturer.

END OF SECTION

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SECTION 27 15 00
COMMUNICATIONS HORIZONTAL CABLING

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
   1. Horizontal Cable
   2. Coaxial Cabling
   3. Work Area Outlet Jacks
   4. Faceplates
   5. Wall Phone Wall Jack Assembly
   6. Equipment/Patch Cables

B. Horizontal cabling is the portion of the cabling system that extends from the work area to the Telecommunications Room Cross-connect.

C. Configure horizontal cabling in a star topology. The horizontal cabling includes the horizontal cables, mechanically connected jacks, outlets, and faceplates.

D. Minimum requirements for the following:
   1. Category **[6][6A] (confirm with CCC)** Cable, Jacks and Patch Cables.
   2. Installation and Termination Methods

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 27, Communications

C. Section 27 05 00, Common Work Results for Communications

D. Section 27 05 28, Pathways for Communications Systems

E. Section 27 13 00, Communications Backbone Cabling

1.03 REFERENCES

A. References, Codes and Standards as required by Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.

1.04 QUALITY ASSURANCE

A. Conform to the quality assurance requirements of Section 27 05 00, Common Work Results for Communications and Division 01, General Requirements.

B. Install cabling and connectivity components in a neat and workmanlike manner. Methods of construction that are not specifically described or indicated in the Contract Documents and subject to the control and approval of the owner's Information technology Department.

C. Equipment and materials quality and manufacture indicated. Equipment specified is based upon the manufacturers listed.

D. Equipment new and free of defects.

E. Strictly adhere to Telecommunications Industry Alliance standard installation practices when installing UTP data cabling.

F. Materials and work specified herein comply with the most current version of the publications listed in the References section of this document.

1.05 SUBMITTALS

A. Including, but not limited to: Product Data Sheets, Shop Drawings, etc.

B. General:
   1. Submit in accordance with Section 27 05 00, Common Work Results for Communications submittal requirements.

C. Closeout Submittals:
1. Submit in accordance with Section 27 05 00, Common Work Results for Communications submittal requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Horizontal Cable:
1. Nexans (Berk-Tek)
2. Superior Essex
3. General
4. Or approved equal.

B. Coaxial Cabling:
a. Belden
b. General
c. Superior Essex
d. Or approved equal.

C. Work Area Outlet Jacks:
1. Leviton
2. Legrand (Ortronics)
3. Panduit
4. Or approved equal.

D. Faceplates:
1. Leviton
2. Legrand (Ortronics)
3. Panduit
4. Or approved equal.

E. Wall Phone Wall Jack Assembly:
1. Leviton
2. Legrand (Ortronics)
3. Panduit
4. Or approved equal.

F. Equipment/Patch Cables:
1. Nexans (Berk-Tek)
2. Superior Essex
3. General
4. Or approved equal.

2.02 HORIZONTAL CABLE

A. Performance: Transmission Characteristics: ANSI/TIA/EIA-568-B.2-10 standard for **Category [6][6A] CONFIRM WITH CCC UTP** cable.

B. Meet applicable requirements of ANSI/ICEA S-80-576.

C. Four 24 AWG Twisted pairs.

D. The overall diameter of the cable less than 0.28 inches.

E. The ultimate breaking strength measured in accordance with ASTM D 4565 400 N minimum.

F. Lead free cable jackets and rated for its installed environment.

G. Withstand a bend radius of 1-inch at -20 degrees C without jacket or insulation cracking.

H. Cable jacket color blue, unless otherwise noted.

I. The cabling used in this project manufacturer compatible with other parts of the component system for a full 20-year warranty. In order to qualify for the warranty, the structured cabling system must be installed per the following:

1. Meet TIA/EIA commercial building wiring standards.
2. Use products purchased from authorized distributors.
3. Install installed in accordance with the manufacturer's warranty guidelines.

2.03 COAXIAL CABLING

A. Provide coaxial cabling as specified on the contract drawings, from the Telecommunications Room/Telecommunications Enclosure to the designated Work Area Outlet.

B. RG-6QS (Radio Grade – Series 6 Quad shield).

C. Color: Black

D. Sweep tested for up to 3GHz operation.

2.04 WORK AREA OUTLET JACKS

A. Performance:
1. Physical Characteristics:
   a. Keystone style.
   b. Functional from -10 degrees F to 140 degrees F.
   c. Test in accordance with ANSI/EIA/TIA-568-B.2-1 for Category [6][6A] **CONFIRM WITH CCC**
   d. Modular RJ45 jacks that snap into user configurable faceplates meeting durability requirements specified in IEC 603-7.
   e. 110 IDC, RJ45 type suitable for eight 22-26 AWG wires and be certified Category 6 compliant.
   f. Construct jacks of high-impact plastic.
   g. Separate and align conductors internally by separate compartments within the jack.
   h. Wired in accordance with EIA/TIA T568B polarization sequence.
   i. CONFIRM WITH CCC - Provide jacks in the following colors:
      1) Data Blue
      2) Analog Voice Yellow
      3) Wireless Applications White

2.05 FACEPLATES

A. Provide high-impact plastic faceplates with labels, label faceplates according to campus standard.

B. Single gang faceplates, 2-3/4-inch by 4-1/2-inch

C. Double-gang faceplates, 4-1/2-inch by 4-1/2-inch

D. Keystone style.

E. 4 port standard.

F. Provide blank inserts for unfilled outlet locations.

G. Finish: To match outlets per Section 26 27 26, Wiring Devices

H. UL Listed

2.06 WALL PHONE WALL JACK ASSEMBLY

A. Stainless steel construction

B. Mounting lugs designed to mate with corresponding telephone base plate or adapter.

C. Mount to single gang outlet box.

2.07 EQUIPMENT / PATCH CABLES

A. Equipment and Patch cables are part of the horizontal channel and tested as specified in Section 27 08 00, Commissioning for Communications Systems.

B. Provide 20-foot equipment cables for WAP locations shown on contract drawings.

C. Physical Characteristics:
1. Verify lengths with authorized representative prior to procurement.

2. Stranded conductors and meet Category [6] [6A] **CONFIRM WITH CCC** performance criteria as defined by TIA 568-B.2-1.
3. Lengths required will range from 3 to 15 feet as required by Owner's authorized representative.
   a. 15-foot workstation cords for 80 percent of the installed faceplates.
   b. 4-foot patch cords for 40 percent of the installed faceplates.
   c. 6-foot patch cords for 40 percent of the installed faceplates.
   d. 4-foot patch cords for 20 percent of the installed faceplates.
   e. 6-foot patch cords for 20 percent of the installed faceplates.
4. Provide the following colors **CONFIRM WITH CCC**:
   a. Voice Yellow
   b. Wireless Black
   c. Workstation White

PART 3 EXECUTION

3.01 INSTALLATION

A. UTP Cable:
1. Conceal wiring in walls or soffits. Install in metal conduits.
2. Install exposed wiring in surface raceway.
3. Install wiring above ceilings in cable tray or open top cable hangers.
4. Support cable above accessible ceilings 3-foot on center from cable support attached to building structure.
5. Do not untwist cable pairs more than 1/2-inch when terminating.
6. Maximum length, 90 meters.
7. No physical defects such as cuts, tears, or bulges in the outer jacket. Replace defective cables.
8. Install cable in neat and workmanlike manner. Neatly bundle and tie cable in closets. Leave sufficient cable for 90 degree sweeps at vertical drops.
9. Maintain the following clearances from EMI sources.
   a. Power Cable: 6-inches
   b. Fluorescent Lights: 12-inches
   c. Transformers: 48-inches
10. Do not install horizontal network cable with more than 25 pounds pull force, as specified in EIA/TIA and BICSI installation practices. Utilize appropriate cable lubricant in sufficient quantity to reduce pulling friction to acceptable levels on:
    a. Long pulls inside conduit, pulls of multiple cables into a single small bore conduit, on conduit runs greater than 100 lineal feet with bends of opposing directions, and in conduit runs that exceed 180 degrees of accumulated bends.
    b. Use of tensile rated cords (i.e., fishing line) should be used for difficult or questionable pulls – to judge to go/no-go condition of the conduit and pulling setup. Utilize thin-coat lubricants when feasible.
11. Replace cables jackets that are chaffed or burned exposing internal conductor insulation or have bare copper, shiners.
12. Firestop openings where cable is installed through a fire rated wall or enclosure.

B. Inserts and Faceplates:
1. Terminate cables with high density modular jacks that snap into a faceplate mounted on a wall outlet box, surface raceways, or power pole.
2. Secure outlet boxes to building with mechanical fasteners. Adhesive fasteners are not allowed.
3. Fill extra openings with blank inserts.
4. Terminate cable per EIA/TIA T568B standard pin assignments.
5. Locate so that combined length of cables and cords from panel to phone or computer does not exceed 3m.

END OF SECTION

SECTION 28 05 00

COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 GENERAL

1.01 SUMMARY

A. The Work to be done under this section of the specifications includes the furnishing of labor, material, equipment, and tools required for the complete installation of the work indicated on the drawings or as specified herein.

B. Materials, as part of the electronic security infrastructure and necessary to its proper operation, but not specifically mentioned or shown on the drawings, furnished and installed without additional charge.

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 28, Electronic Safety and Security

1.03 QUALITY ASSURANCE

A. Specifications, Standards, and Codes: Complete work in accordance with the following:

1. NFPA National Electrical Code, NFPA 70, 2014 Edition
2. ANSI American National Standards Institute
3. NEMA National Electrical Manufacturers Association
4. TIA Telecommunications Industries Association
5. EIA Electronic Industries Association
6. IEEE Institute of Electrical and Electronics Engineers
7. UL Underwriters Laboratories
8. ASA American Standards Association
9. FCC Federal Communications Commission
10. OSHA Occupational Safety and Health Administration
11. ASTM American Society of Testing Material
12. ADA Americans with Disabilities Act
13. Local city and county ordinances governing electrical work.
14. In the event of conflicts, the more stringent provisions apply.

1.04 WORK INCLUDED

A. The Electronic Security Systems installed and work performed under this division of the Specifications include but not necessarily be limited to the following:

1. Access Control
2. Video Surveillance
3. Conduits, raceways, racks, cabinets and equipment mounting boards as indicated on the Drawings
4. Grounding and Bonding

1.05 DEFINITIONS

A. Terms The following definitions of terms supplement those of the General Requirements and are applicable to Division 28, Electronic Safety and Security.

B. Provide Furnish, install, and test (if applicable) complete.

C. Infrastructure Completely install cable, conduit, raceway with required boxes, fittings, connectors, and accessories; completely installed.

D. Work: Materials completely installed, including the labor involved.

1.06 DRAWINGS

A. Drawings are generally diagrammatic and show the arrangement and location of pathways, outlets, support structures, and equipment. Carefully investigate the structural and finish conditions affecting its work and arrange its work accordingly. Should conditions on the job make it necessary to make adjustments to pathways or materials, advise the Owner and secure approval before proceeding with such Work.

B. Where exact locations are required by equipment for stubbing-up and terminating conduit concealed in floor slabs, request drawings, equipment location drawings, foundation drawings, and other data required by it to locate the concealed conduit before the floor slab is poured.

C. Materials, equipment, or labor not indicated, but which can be reasonably inferred to be necessary for a complete installation. Drawings and Specifications do not undertake to indicate every item of material, equipment, or labor required to produce a complete and properly operating installation.

D. The right is reserved to make reasonable changes in locations of equipment indicated on Drawings prior to rough-in without increase in contract cost.

E. Do not reduce the size or number of conduit runs indicated on the Drawings without the written approval of the Owner.

F. Work installed contrary to Contract Drawings is subject to change as directed by the Owner and no extra compensation will be allowed for making those changes.

G. Location of equipment, support structures, outlets, and similar devices shown on the Drawings are approximate only. Do not scale Drawings. Obtain layout dimensions for equipment from Architectural plans unless indicated on Electronic Security plans.

H. Schematic diagrams shown on the Drawings indicate the required functions only. Technology of a particular manufacturer may be used to accomplish the functions indicated without exact adherence to the schematic Drawings shown. Furnish additional labor and materials required for such deviations at the Contractor's expense.

I. Verify the ceiling type, ceiling suspension systems, and clearance above hung ceilings prior to ordering cabling and associated hardware. Notify the Engineer of discrepancies.

1.07 SUBMITTALS

A. Submit for approval the details of materials, equipment, and systems to be furnished. Do not proceed Work without the Owner and/or the Project Manager's approval of the submitted items. Submit three copies of the following:

1. Submittals for individual systems and equipment assemblies that consist of more than one item or component made for the system or assembly as a whole. Partial submittals will not be considered, reviewed, or stored, and such submittals will not be returned except at the request and expense of the Contractor.
2. Generate shop drawings. Modify reviewed and accepted shop drawings to include revisions based upon completion of work. Submit shop drawings with record drawings on hard copy.
3. Shop drawings include equipment racks, patch panels, termination blocks, connection details, rack mounting details, and other details not included in the construction drawings.
4. Materials and equipment listed that are not in accordance with Specification requirements may be rejected.
5. The approval of material, equipment, systems, and shop drawings is a general approval subject to the Drawings, Specifications, and verification of measurements at the job. Approval does not relieve the Contractor from the responsibility of shop drawing errors. Carefully check and correct shop drawings prior to submission for approval.

1.08 QUALITY ASSURANCE

A. Equipment and materials required for installation under these Specifications current model and be new, unused, and without blemish or defect.

B. Equipment bear labels attesting to Underwriters Laboratories or certification by other recognized laboratory, where subject to label service. Manufacturers of equipment and materials pertinent to these items have been engaged in the manufacture of said equipment a minimum of three years and, if so directed by the Owner, be able to furnish proof of their ability by submitting affidavits and descriptive data about their product including size and magnitude comparable to requirements specified herein.

1.09 CONTRACTOR QUALIFICATIONS

A. Total responsibility for the coordination and installation of the work shown and described in the Drawings and Specifications. Company specializing in the design, fabrication, and installation of integrated Electronic Security Systems.

B. Electronic Security Systems specified installed under the direction of a qualified contractor. Qualification requirements include submittal by the Contractor to the Architect of the following:
   1. Have experience with three or more installations of systems comparable in size, complexity, type, and design as specified herein.
   2. Perform each of these installations satisfactorily for at least one year after final acceptance by the user. Include the names, locations, and point of contact for these installations as a part of the initial submittal documentation.
   3. List of previous projects of this scope, size, and nature, including names and sizes of projects, description of work, time of completion, and names of contact persons for reference.

C. Certify that they are manufacturer-authorized for work to be performed.

1.010 COORDINATION WITH OTHER TRADES

A. Coordinate electronic security work with that of other sections as required ensuring that the entire electronic security work will be carried out in an orderly, complete, and coordinated fashion.

1.011 SITE INVESTIGATION

A. Prior to submitting bids of the project, visit the site of the work to become aware of existing conditions that may affect the cost of the project. Where work under this project requires extension, relocation, reconnections, or modifications to existing equipment or systems, the existing equipment or systems restored to their original condition before the completion of this project.

1.012 PERMITS

A. Obtain permits and inspections for the installation of this work and pay charges incident thereto. Deliver to the Owner certificates of said inspection issued by authorities having jurisdiction.

PART 2 PRODUCTS

2.01 SUBSTITUTIONS

A. Where equipment is identified by manufacturer and catalog number, no substitutions permitted.

B. Where manufacturers of equipment are identified by name, submit for approval products from those manufacturers which meet project requirements. Products from other manufacturers not acceptable.

C. The Owner’s final decision as to whether the submitted equipment is final and binding.

2.02 MATERIALS

A. Materials used in this work are new and bear the inspection label of Underwriters Laboratories Inc. (UL) or certification by other recognized laboratory.

B. The published standards and requirements of the Telecommunications Industries Association (TIA), National Electrical Manufacturers Association (NEMA), the American National Standard Institute (ANSI), the Institute of Electrical and Electronic Engineers (IEEE), and the American Society of Testing Materials (ASTM) are made a part of these Specifications and apply wherever applicable.

C. Materials and equipment furnished of current production by manufacturers regularly engaged in the manufacture of such items, for which replacement parts are available.

D. When more than one unit of the same class of equipment or material is required, products of a single manufacturer or partner manufacturers that offer a certified solution.

E. Components of an assembled unit need not be products of the same manufacturer, but must offer a certified end-to-end solution.

F. Manufacturers of equipment assemblies, which include components made by others, assume complete responsibility for the final assembled unit.

G. Components compatible with each other and with the total assembly for the intended service.

PART 3 EXECUTION

3.01 EXAMINATION OF CONDITIONS

A. Prior to the start of work, carefully inspect the installed work of other trades and verify that such work is complete to the point where installation may properly commence. Start of work indicates acceptance of conditions.

B. Install equipment in accordance with applicable codes and regulations, the original design, and the referenced standards.

C. In the event of a discrepancy, immediately notify the Project Manager.

D. Do not proceed with installation until unsatisfactory conditions and discrepancies have been fully resolved.

3.02 PROTECTION OF SYSTEMS AND EQUIPMENT

A. Protect materials and equipment from damage during storage at the site and throughout the construction period. Equipment and materials protected during shipment and storage against physical damage, dirt, theft, moisture, extreme temperature, and rain.

B. Damage from rain, dirt, sun, and ground water prevented by storing the equipment on elevated supports and covering the sides with securely fastened protective rigid or flexible waterproof coverings.

C. During installation, equipment protected against entry of foreign matter on the inside and be vacuum-cleaned both inside and outside before testing, operating, or painting.

D. As determined by the Project Manager, damaged equipment fully repaired or removed and replaced with new equipment to fully comply with requirements of the Contract Documents. Decision of the Project Manager final.

E. Damaged paint on equipment and materials repainted with painting equipment and finished with the same quality of paint and workmanship as used by the manufacturer.

3.03 ACCESS TO EQUIPMENT

A. Install equipment in location and manner that will allow convenient access for maintenance and inspection.

B. Working spaces not less than specified in the National Electrical Code (NEC) for voltages specified.

C. Where the Project Manager determines that the Contractor has installed equipment not conveniently accessible for operation and maintenance, equipment removed and reinstalled, one time only, as directed by the Project Manager, at no additional cost to the Owner. Conveniently accessible is defined as being capable of being reached without the use of ladders or without climbing or crawling under or over obstacles such as motors, pumps, belt guards, transformers, piping, and ductwork.

3.04 CLEANING

A. During construction, and prior to Owner acceptance of the building, remove from the premises and dispose of packing material and debris caused by electronic security work.

B. Remove dust and debris from interiors and exteriors of electrical equipment. Clean accessible current-carrying elements prior to being energized.

3.05 COMPLETION

A. General: Upon completion of the work, remove excess debris, materials, equipment, apparatus, tools, and similar items. Leave the premises clean, neat, and orderly.

B. Results Expected: Complete and operational systems. Set and calibrate controls. Complete testing, start-up, and cleaning work.

C. Maintenance Materials: Deliver to Owner special tools for proper operation and maintenance of the equipment provided under this Specification.

3.06 TESTING AND VERIFICATION

A. Refer to Division 28, Electronic Safety and Security for testing parameters of sub-systems.

B. Test reports: Submit minimum of two weeks prior to final punch walkthrough. Maintain test equipment on-site during punch for sample proof-of-performance tests.

C. Verify that requirements of this Specification are met. Verification through a combination of analyses, inspections, demonstrations, and tests, as described below.

D. Verification by inspection includes examination of items and comparison of pertinent characteristics against the qualitative or quantitative standard set forth in the Specifications. Inspection may require moving or partially disassembling the item to accomplish the verification, included as part of the work at no additional cost to the Owner.

E. Verify by formal demonstrations or tests that the requirements of this Specification have been met. Demonstrate that the electronic security systems, components, and subsystems meet specification requirements in the as-installed operating environment.

F. Carefully plan and coordinate the final acceptance tests so that tests can be satisfactorily completed. Provide necessary instruments, labor, and materials required for tests, and including the equipment manufacturer's technical representative and qualified technicians in sufficient numbers to perform the tests within a reasonable time period.

G. Satisfy items detailed in the final acceptance check-off list (punch list). Complete representation of specified installation requirements. At the time of final acceptance, punch list items corrected until the system is found to be acceptable to the Owner and the Project Manager.

H. After the Contractor systems have been installed and tested, have the completed test plan signed by the Electronic Security Contractor Project Manager and submitted for approval.

END OF SECTION

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SECTION 28 30 00

FIRE DETECTION AND ALARM

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes:
1. Control Panel
2. Central Station Reporting
3. Strobe Synchronization
4. Software
5. Remote Equipment
6. Detection Devices
7. Manual Pull Stations
8. Annunciation Devices
9. Electromagnetic Door Holders
10. Addressable Accessories
11. Controlled Devices
12. Cable

1.02 RELATED SECTIONS

A. Division 01, General Requirements

B. Division 28, Electronic Safety and Security

C. Section 26 05 19, Low Voltage Electrical Power Conductors and Cables

D. Section 26 05 33, Raceways and Boxes for Electrical Systems

E. Section 26 05 53, Identification for Electrical Systems

1.03 SUBMITTALS

A. Shop drawings produced in AutoCAD with Fire Marshal's stamp of approval.

B. Product data with wiring schematics.

C. AutoCAD wiring diagrams of each type of device.

D. AutoCAD riser diagram of the complete systems/

E. Battery and voltage drop calculations based on intended routing and wiring.

F. Prepare shop drawings of the system by the manufacturer in AutoCAD and submitted to the Fire Marshal for approval. The approved shop drawings will be utilized as the installation drawings. The shop drawings show actual conduit routing and conductors as to be installed. Update drawings to include revisions and changes to the system during construction and installation.

1.04 QUALITY ASSURANCE

A. Approve and install equipment in accordance with NFPA, ADA and IBC requirements and UL listed both in individual components and as a system. ISO-9000 certified; UL and FM listed and meet NFPA 72.

B. Furnish evidence that there is an experienced and efficient service organization which carries a stock of repair parts for the system to be furnished and that the organization is capable of providing repair service within 24 hours of a trouble call.

C. Install system by an electrical contractor experienced in the installation of addressable fire alarm systems and certified by the national institute for certification in engineering technologies (NICET) for fire alarm systems. Control equipment factory representative services be obtained to provide engineered system floor plans and point-to-point drawings on AutoCAD. Representative to supervise the installation, system start-up, programming, make final adjustments and provide testing of the completed system. The factory representative provides a letter of system certification to the Architect.

1.05 CONTRACTOR DESIGN

A. Equipment shown on the contract drawings indicate the general nature of the fire alarm system, but does not necessarily show components required. Provide a complete fire alarm and communications system as needed to meet applicable codes and requirements under this section.

B. Review various sets of drawings for initiating and notification devices, and add devices if needed to comply with the requirements of NFPA 72.

C. Raceway, routing, and wiring for field devices are not shown on the drawings except for a few specific design requirements.

1.06 SYSTEM DESCRIPTION

A. Operate automatic fire detection systems in a local, supervised non-coded fashion. The system low voltage operating at 24V DC. Fully addressable with analog technology for sensors. Signal circuits either class A or B without changing modules. Design system Class B. Load circuits to 75 percent capacity maximum.

B. Signal, visual and audible alarms, flow and tamper module circuits supervised for opens, shorts and grounds. Open, short or ground causes a trouble on the system, sound the audible trouble sounder and annunciate at the control and remote annunciator: the device, location, and nature of the trouble condition.

1.07 SYSTEM OPERATION

A. Operation of manual or automatic initiating device cause an audible and visual alarm to sound, activate the control-by-event program and perform auxiliary functions.

B. Annunciate fault in the circuits at the control panel and the remote annunciators.

C. Utilize a single pair of wires to power, transmit, and receive data from the addressable analog initiating devices and to transmit commands to the remote control points. Size wire for the length of communications loop but in no event less than number 18-2 wire size.

1.08 SEQUENCE OF OPERATION

A. The system alarm operation subsequent to the alarm activation of manual station, automatic initiating device, or sprinkler flow/pressure switch is to be as follows:
   1. Audible alarm indicating appliances sound a digitized tone until silenced by the alarm silence switch at the control panel.
   2. Visual alarm indicating appliances (xenon strobes) display a continuous pattern until extinguished by the alarm silence switch.
   3. Doors normally held open by door control devices release. Signal door lock systems to unlock.
   4. A supervised signal to notifies an approved central station to activate.
   5. Combination fire/smoke dampers de-energizes to normally closed position.

B. Alarm activation of elevator lobby, hoistway, or machine room smoke or heat detector in addition to the operations listed above, cause the elevator cab to be recalled according to the following sequence:
   1. If the alarmed detector is on another floor other than the preferred level of egress, recall elevator cab to the preferred level of egress.
   2. If the alarmed detector is on the main egress level, the elevator cabs recalled to the predetermined alternate recall level as determined by the local authority having jurisdiction.
   3. The activation of heat detector in an elevator hoistway or machine room automatically disconnect power to the elevator motor via base-mounted contacts activating the elevator feeder shunt-trip circuit breaker. Refer to drawings.

C. Control panel has a dedicated supervisory service indicator and a dedicated supervisory service acknowledge switch.

D. The activation of standpipe or sprinkler valve tamper switch activates the system supervisory service audible signal and illuminate the indicator at the control panel.
   1. Activating the supervisory service acknowledge switch will silence the supervisory audible signal while maintaining the supervisory serviced LED on indicating the tamper contact is still in the off-normal state.
   2. Restoring the valve to the normal position cause the supervisory service indicator to extinguish thus indicating restoration to normal position.

E. The activation of sprinkler pre-action system pressure or low air switch activate the system supervisory service audible signal and illuminate the indicator at the control panel.
   1. Activating the supervisory service acknowledge switch will silence the supervisory audible signal while maintaining the supervisory service indicator on indicating the pressure/air contact is still in the off-normal state.
   2. Restoring the air pressure to the normal causes the supervisory service indicator to extinguish thus indicating restoration to normal position.

F. Immediately display alarm and trouble conditions on the control panel front alphanumeric display and of remote annunciators. If more alarms or troubles are in the system the operator may scroll to display new alarms.

G. Alarm list key that will allow the operator to display alarms, troubles, and supervisory service conditions with the time of occurrence.

H. In normal operation, fire alarm system close combination fire/smoke dampers when corresponding fan system is OFF. Fire alarm system open combination fire/smoke dampers when corresponding fan system is ON.

1.09 CONNECTION TO EXISTING NETWORK

A. General: Communication between peer-to-peer fire alarm control panels via TCP/IP over existing Ethernet, RS-485, RS-232 or other previously established panel system communication protocol.

B. Provide hardware, software and system integration to seamlessly integrate to the existing server for common system graphics, alarming, paging out of alarms via existing system.

C. Provide upgrade to existing control monitoring to accept new alarm points.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Match existing building manufacturer

2.02 GENERAL

A. Furnish labor, materials, and equipment required for a complete and operating system of manual and automatic initiating devices, control panels, auxiliary relays, power supplies with batteries and accessories necessary to accomplish the desired sequence of events.

B. Fully electronic and addressable systems as described below with monitoring and annunciation of system alarms and troubles.

2.03 CONTROL PANEL (WHERE REQUIRED)

A. Provide processor, switches, relays, solid state indicator lamps and displays, wiring, terminals, etc., as required for operation, supervision and control of complete system.

B. General:
   1. Microprocessor based, point identified system utilizing twisted pair 18 to 12 AWG, depending on distance, class B communication loop. Equip for a minimum of four loops.

C. Cabinet:
   1. 16-gauge enameled steel designed for two level access.
   2. Level 1 gives access to the interface control panel.
   3. Level 2 gives access to the electronics.

D. Outputs:
   1. Two general alarm signal circuits, programmable signal circuits, alarm contacts, trouble contacts, and RS485 annunciator line circuit.

E. Controls and Displays:
   1. Alarm silence, trouble silence, alarm/trouble acknowledge, and reset switches, 80-character LCD display, touch keypad, and power indicator.

F. Power Supply:
   1. Minimum 1.8A of regulated, filtered power at 24 VDC plus 3A unregulated.

G. Failsafe Auxiliary Degrade Alarm Circuit:
   1. System will perform basic detection and alarm function and send a signal to the fire department with the CPU failed.

H. Two-Way Loop:
   1. System capable of addressing and operating smoke detectors, manual pull stations, open contact devices and addressable auxiliary control relays on the same two-wire communication loop.

I. Battery Back-up:
   1. Self-charging sealed lead battery backup for system auxiliary power supplies and remote annunciators in accordance with code requirements (operate 24 hours, then alarm for 5 minutes, minimum).
   2. Monitor batteries and initiate a trouble signal if disconnected or discharged more than 15 percent.

2.04 STROBE SYNCHRONIZATION

A. Synchronize strobes to 1Hz flash to comply with the Americans with Disabilities Act (ADA).

2.05 SOFTWARE

A. Field Configuration Program:
   1. Provide programmable operating instructions for the system resident program stored on a non-volatile EEPROM.

B. Programming:
   1. Perform at the location of the fire alarm control using a laptop computer system; hard copy of the system configuration is to be updated and maintained at the site.

C. Control-By-Event:
   1. Program each address for selective alarm output, zone verification operation, control point activation on alarm or trouble and transmit alarm to the fire department.
   2. Programmed control point activation to provide selective control.

2.06 REMOTE EQUIPMENT

A. Annunciator Control Panels: Alphanumeric display module:
   1. 80 character LED/LCD display, back lighted.
   2. System acknowledge, signal silence, and system reset touchpad control switches.
   3. Time/date display.
   4. Integral sounder with subsequent alarm/trouble resound.
   5. Flush mounting.

B. Transponders:
   1. Up to 26 field configurable circuits of any mix.
   2. Full LED/LCD display of alarm and trouble per point.
   3. Status displays and controls including power, on-line, local alarm and local trouble LED/LCD’s plus reset and lamp test switches.
   4. Power supply, charger and battery as required for control panel.

C. Lamp Driver Modules:
   1. Field selectable alarm and trouble or alarm only.

2. Integral system trouble lamp on-line/power LED/LCD, alarm and trouble resound with flash function of new events, serial RS-485 interface to control panel, capable of being powered remotely or locally with supervision.
3. Integral lamp test function.

D. Power supplies, with integral chargers and batteries current limited low energy as recommended by the manufacturer but sized for 25 percent spare capacity.

2.07 DETECTION DEVICES

A. Analog photoelectric smoke detectors provide for individual addressing of each detector. Sensor is constantly monitored to measure change in its sensitivity due to the environment caused by dirt, aging, temperature, humidity, etc.

B. Give an advanced indication to the control panel of the need for maintenance and can be specific as to where the maintenance is needed . It is to be mounted on a two wire standard device base. Photoelectric detectors located within the elevator shaft rated for installation within a pressurized shaft.

C. Duct smoke detector housing assemblies accommodate the mounting of an analog/addressable detector along with a standard, relay or isolator detector mounting base. Housing protects the measuring chamber from damage and insects. Utilize an air exhaust tube and an air sampling inlet tube that extends into the duct air stream up to twelve feet. Provide drilling templates and gaskets to facilitate locating and mounting the housing.
1. Provide sampling tube length as required to accommodate air duct width.
2. Provide remote status/alarm LED indicator and keyswitch test station for each duct smoke detector.
3. Duct smoke detector air velocity range includes design air velocity of the ductwork in which the duct smoke detector is to be installed.

D. Analog thermal detectors consist of a dual thermistor sensing circuit for fast response. Sensor is continually monitored to measure changes in their sensitivity due to temperature. Advanced indication to the control panel of the need for maintenance and can be specific as to where the maintenance is needed. Mount on a two wire standard device base. Equip thermal detectors in elevator shafts and machine rooms with a set of auxiliary contacts for elevator equipment use. Rate thermal detectors located within elevator shaft for installation within a pressurized shaft.

E. Projected Beam Type Smoke Detectors:
1. 4-wire 24 VDC and powered from the control panel four-wire smoke power source.
2. Consists of a separate transmitter and receiver capable of being powered separately or together.
3. Operate in either a short range of 30-feet to 100-feet or a long range of 100-feet to 300-feet.
4. Feature a bank of four alignment LEDs on both the receiver and transmitter that are used to ensure proper alignment without the use of special tools.
5. The beam detector features automatic gain control that compensate for gradual signal deterioration from dirt accumulation on lenses. Ceiling or wall mount as shown on the drawings. Carry out testing out using calibrated test filters. Provide a key activated remote test station.
6. Provide monitor modules for alarm and trouble and control relay module for reset.

F. Provide addressable monitor modules an address for a single, normally open initiating device such as a waterflow switch, manual station, etc. UL approved to extend the sensor loop to lengths up to 2,500-feet.

2.08 ANNUNCIATION DEVICES

A. Horn and Combination Horn/Strobe:
1. Mount to a recessed box with an extension ring.
2. Front of the unit allows for candela light levels as required by ADA for the spacing as installed.

3. Horns provide a 100 dba peak sound output with field adjustable output level.
4. Finish: Match existing red/white device type as others in the building.

B. Strobe Lights:
1. Triangular with FIRE on white plastic lens, polarized 24 VDC, mounting single gang on four square box.
2. Front of the unit allows for candela light levels as required by ADA for the spacing as installed.
3. Strobe candela level adjustable field from 15-110 CD.
4. Mount at 80-inches or as shown on drawings.
5. Finish: Match existing red/white device type as others in the building.

C. The candela rating of each strobe installed apparent to the Fire Marshal and to qualified service personnel either as installed or with the removal of the faceplate. If faceplates are interchangeable between strobes of different ratings the indication of candela rating not on the faceplate.

2.09 ELECTROMAGNETIC DOOR HOLDERS

A. Equipment consists of an armature contact plate with adjustable pivot mount, install on door. Mount behind the door on the wall or floor a heavy-duty electromagnet, in a durable enclosure.

B. Fail-Safe operation, loss of power releases the door holder for the door to close.

C. Unit accepts 12VDC, 24VAC/VDC or 120VAC. Coordinate voltage by the fire alarm system installer/supplier. Circuitry required for the systems operation provided by the system installer.

D. Door holder equipment of the same manufacturer as the fire alarm system to ensure system compatibility and proper UL compatibility listings.

2.010 ADDRESSABLE ACCESSORIES

A. Control Modules:
1. Connects to the same loop as the initiating devices and provides a form C relay contact.
2. Program module to transfer from either a trouble or alarm input from any or combination of any addressable device.

2.011 CONTROLLED DEVICES

A. Mechanical control system for control of air handlers and smoke/fire rated dampers.

B. Fire protection tamper, flow, dry system and preaction system.

2.012 CABLE

A. Plenum rated as recommended by System Manufacturer and the building construction methods.

PART 3 EXECUTION

3.01 INSTALLATION

A. General:
1. Install in accordance with code, UFC, UBC, NFPA 72, 101 and the manufacturer's instructions.
2. Review proper installation of each type of device with manufacturer's agent.
3. Install wiring, raceway and outlet boxes required for a complete system as indicated in the Contract Documents.
4. Comply with applicable requirements of Section 26 05 33, Raceways and Boxes for Electrical Systems, for boxes and surface mounted raceways.

B. Typical Wiring:
1. Install manufacturer's recommended listed cable to connect devices as recommended by the manufacturer.
2. Run cable in conduit where exposed to physical damage.

C. Detectors:
   1. Locate 48-inches clear of supply air vents and 12-inches clear of lights and sprinkler heads.
   2. Install detector heads not more than two weeks prior to substantial completion. Verify the design locations shown conform to the actual construction.
   3. Do not locate detectors in close proximity to air supply vents.
   4. Bring cases of uncertain applicability to the attention of the Architect for resolution prior to roughing in.

D. Duct Smoke Detectors
   1. Provide/maintain working access to duct smoke detectors.
   2. Locate duct smoke detectors in accordance with code requirements. Locations must ensure adequate airflow within the duct housing.
   3. Locate remote status/alarm LED indicator and keyswitch test station at readily accessible location out of general viewdirectly below duct smoke detector location. Identify locations on fire alarm shop drawings prior to installation.

E. Install remote annunciator as indicated on plans and where required by Fire Marshal. Coordinate prior to rough-in.

F. Provide auxiliary power supplies as required and extend the 120V power to the power supply as required and per NEC.

G. Provide visual devices and alarm devices as required. Device locations are diagrammatic showing intent of area coverage. The exact placement, sound or light level is to be per the requirements and the listing of the manufacturer's equipment.

3.02 LABELING

A. Label alarm initiating devices with 1/2-inch by 1-inch lamicoid nameplates, indicating control panel point designation. Locate nameplates in the vicinity of the device as approved by the Owner.

B. Provide Brady type wire markers to identify conductors at each junction or terminal. Use numbers indicated on the wiring diagrams.

3.03 TESTS

A. Provide the service of a competent, factory-trained technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during the programming, final connections, adjustments and tests for the system.

B. When the system is complete and prior to the substantial completion, furnish testing equipment and perform the following tests:

C. Before energizing system, check for correct wiring connections and test for short circuits, ground faults, continuity, and insulation.

D. Test the insulation on installed wiring by standard methods as recommended by the equipment manufacturer.

E. Open supervised circuits to see if the trouble signal activates.

F. Ground supervised circuits and verify response of trouble signals.

G. Check installation, supervision, operation, and sensitivity of smoke detectors as recommended by the manufacturer to ascertain that they will avoid false alarm signals yet provide the required automatic detection.

H. Test each device for proper operation and auxiliary function.

I. Submit a print out of the entire test procedure to the engineer with the letter of certification for the completed fire alarm system.

J. When defects in the work are detected, make repairs and repeat the tests as required.

K. Test system for NFPA standby and alarm runtime for the actual load on the system batteries and recharge time of system batteries.

L. Perform required and necessary verification of the system operating functions with the Architect and Owner's facility staff prior to turnover of the complete system for final test observed by the Fire Department. Perform tests in the presence of the Owner or the Owner's Representative. A System Certification verifying the proper system operation is required prior to acceptance. Instruct Owner's personnel in system operation, maintenance and programming for a minimum of 20 hours. The cost of retesting as a result of the failure of the system to operate in accordance with these specifications, drawings, or applicable codes paid for by the contractor to the Owner.

3.04 WARRANTY SERVICE AND INSTRUCTION

A. The fire alarm system will be checked on a monthly basis by the fire alarm system service organization for a period of one year after beneficial occupancy. The monthly checks will consist of reviewing the operation of the system with the Owner's operating and maintenance personnel, providing additional hands on instruction, and assisting in execution of programming revisions. Each monthly visit will consist of not less than two hours of on-site time and no more than four hours. The monthly visits will be scheduled with the Owner not less than one week in advance.

3.05 EXTRA STOCK/SPARE PARTS

A. Provide the following equipment to be turned over to the owner with the operation and maintenance manuals.
   1. Two photoelectric smoke detector heads
   2. Two thermal heat detector heads
   3. One addressable dry contact modules
   4. Two horns
   5. Two horns/strobes
   6. One manual pull stations
   7. One complete set of fuses to match panel counts

3.06 TRAINING

A. Provide operation and maintenance training for Owner's personnel.

B. Conduct a minimum of two maintenance training sessions upon completion of the work. Maintenance training sessions include a walk-thru of the completed facilities identifying the location, address, and means of access to every device monitored by the fire alarm system.

C. Conduct training sessions for two operator levels.

D. Operator training. Provide a minimum of three refresher and system update training sessions of on-the-job training.

E. Supervisor training. Provide a system update training session for supervisory functions.

F. Training sessions with fully qualified, trained representative, of the equipment manufacturer who is thoroughly knowledgeable of the specific installation.

END OF SECTION

DIVISION 32 - EXTERIOR IMPROVEMENTS

SECTION 32 17 23.13 - PAINTED PAVEMENT MARKINGS

MATERIALS

Line and Zone Marking Paint: MPI (APL) No. 97 Latex Traffic Marking Paint; color(s) as indicated.

Paint For Obliterating Existing Markings: FS TT-P-1952; black for bituminous pavements, gray for portland cement pavements.

Reflective Glass Beads: FS TT-B-1325, Type I (low index of refraction), Gradation A (coarse, drop-on); with silicone or other suitable waterproofing coating to ensure free flow.

Temporary Marking Tape: Preformed, reflective, pressure sensitive adhesive tape in color(s) required; Contractor is responsible for selection of material of sufficient durability as to perform satisfactorily during period for which its use is required.

SECTION 32 31 13 - CHAIN LINK FENCES AND GATES

MATERIALS

Posts, Rails, and Frames: _____:

Wire Fabric: _____:

SECTION 32 33 00 - SITE FURNISHINGS

BOLLARDS

Steel Pipe Bollards: Concrete filled steel pipe with plain shaft.

Materials:

Steel Pipe: ASTM A53/A53M, standard weight.

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