

PROJECT MANUAL

for

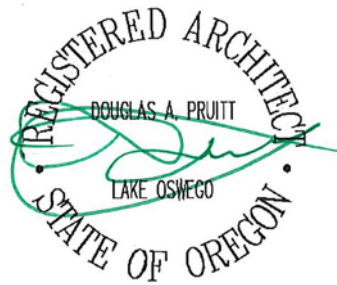
**BEAVERTON SCHOOL DISTRICT  
WEST TUALATIN VIEW ELEMENTARY SSCHOOL  
SEISMIC STRENGTHENING  
MECHANICAL UPGRADE**

JOB NO. 21022.00.L

OWNER BID NO.

Date: DECEMBER 10, 2021

BID SET



**ARCHITECTS**

BBL Architects  
200 North State Street  
Lake Oswego, Oregon 97034  
(503) 635-4425

**STRUCTURAL ENGINEERS**

KPFF Consulting Engineers  
111 S.W. Fifth Avenue  
Suite 2500  
Portland, Oregon 97204-3628  
(503) 227-3251

James G. Pierson, Inc.  
Consulting Structural Engineers  
610 SW Alder, Suite 918  
Portland, OR 97205  
(503) 226-1286

**MECHANICAL-ELECTRICAL ENGINEERS**

M.F.I.A., Inc.  
2007 S.E. Ash  
Portland, Oregon 97214  
(503) 234-0548



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NOTE: Division and Section numbers listed in the Table of Contents and items of work included in each Section conform in general to CSI's MasterFormat, 2010 Upgrade Edition. Section numbers listed are merely for identification and may not be consecutive. Users of this Project Manual shall check the specification with the Table of Contents to be sure each Section is included and shall check each Section to be sure each consecutively numbered pages within each Section is included. The last page of each Section has the statement "END OF SECTION".

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NOTE: Users of this Project Manual shall check the Construction Documents with the List of Drawings to be sure each sheet is included.

**LIST OF DRAWINGS**

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**END OF SECTION**



**SUMMARY OF WORK**

**PART 1 - GENERAL**

**1.1 CONDITIONS AND REQUIREMENTS**

- A. The Bidding Requirements, provided under Division 0, and the Sections contained in Division 1 – GENERAL REQUIREMENTS of these Specifications apply to the Work specified in this Section.

**1.2 SECTION INCLUDES**

- A. Sections contained in Division 0 and Division 1 of the Specifications apply to the Work specified in this Section and in each Section of the Specifications. The Contractor shall instruct each of his Subcontractors to become fully familiar and comply with all requirements of these documents.
- B. The project and the Work of the Contract can be described in summary as follows:
  - 1. Construction of seismic strengthening and HVAC upgrades to the Gymnasium building at West Tualatin View Elementary School.
    - a. Metal stud lateral supporting walls at the interior of the gym,
    - b. Repair of the finishes including gypsum board and paint,
    - c. Replacement of resilient base and wood base,
    - d. Handrails,
    - e. Aluminum ladder,
    - f. Removal and reinstallation of gym equipment including basketball backboards, climbing wall, and pegboards,
    - g. Removal and reinstallation of markerboards and tackboards,
    - h. Removal and reinstallation of devices on the walls including electrical receptacles, data jacks, fire alarm pull stations, phone, clock, light fixtures and exit signs,
    - i. Removal and reconstruction of the sidewalk at the entrance to the building,
    - j. Installation of a new roof top HVAC unit,
    - k. Installation of a new card reader.
- C. General:
  - 1. Do not interrupt electric, gas, water or other services to existing Owner-occupied structures without prior notice to the District and then only at a definite time and for a definite duration approved by the District.
  - 2. Contractor shall schedule demolition and remodel to accommodate Owner's continued use of existing mechanical, plumbing and electrical services as required for Owner's continued occupancy and beneficial use of designated areas.
  - 3. Consult with public and private utility companies for location and extent of all utilities before commencing Work.
  - 4. Provide all services required. Protect and maintain existing utilities, active electrical conductors, sewers, pipes, and other active lines on school property or in street excavations.
  - 5. Arrange for and pay cost of disconnecting, removing, relocating, capping, replacing, or abandoning of public and private utilities in the way of construction operations in accordance with serving utilities, local regulations and governing codes. Utilities, pipes, sewers, electrical conductors and the like to be abandoned shall be capped in accordance with instruction of governing authority or as directed.
- D. Protections:
  - 1. Protect sidewalks, asphalt paving, concrete, shrubs and lawn areas at all times from spillage of materials used in carrying out the Work. Exercise care to preclude materials from clogging catch basins and yard drains. Leave all drainage items clean and in proper working condition.
  - 2. Clean, repair, resurface or restore existing surfaces to their original condition, or completely replace such surface to match existing, where damaged by construction operations.

**SUMMARY OF WORK**

3. Whenever it is necessary to cut and remove fences and/or power lines (whether on private or public property), restore such demolished work to condition at least equal to that which existed prior to such demolition.
4. Damage to property adjacent to District's property shall be restored to the satisfaction of respective property owners.

**1.3 ASBESTOS FREE CERTIFICATION**

- A. Absolutely no materials containing asbestos are to be provided or installed as part of this Project. The Contractor shall ensure that no subcontractor or any of Contractor's own forces installs any materials containing asbestos. At final closeout of the Project, the Contractor shall provide to the School District certification that no materials containing asbestos have been installed in the Project and that the Project is asbestos free as required by the State of Oregon.
  1. Upload certification to eBuilder for review to verify it meets the needs of the District.

**1.4 COORDINATION**

- A. The Contractor is responsible for overall coordination of the Project.
- B. The Drawings and Specifications are arranged for convenience only and do not necessarily determine which trades perform the various portions of the Work.
- C. Coordinate sequence of the Work to accommodate Owner occupancy. If mechanical, electrical or plumbing work is to interrupt power or water usage, the District must be notified 72 hours in advance.
- D. Do all necessary Work to receive or join the Work of all trades.
- E. Verify location of existing utilities and protect from damage.
- F. Mechanical and Electrical Drawings: The mechanical and electrical drawings are diagrammatic. Additional offsets and bends may be required and are to be installed as may be required. The Architect may make minor adjustments in fixture, outlets, grille, louver or ventilator locations prior to rough-in work with no additional cost to the project.
- G. Calculate dimensions and measures for layout of work; do not scale the Drawings. Record deviations from Drawing information on existing conditions, and review with the Architect at time of discovery. Record actual conditions on project record drawings.
- H. Installer Inspection:
  1. Require installer of each major unit of work to inspect substrate and conditions for installation, and to report unsatisfactory conditions in writing. Correct unsatisfactory conditions before proceeding with installation.
  2. Inspect each product immediately before installation. Do not install damaged or defective products, materials or equipment.
  3. Start of installation shall be understood as acceptance of substrate conditions by the installer.
- I. Clearances: Review the Design Drawings for possible conflicts prior to rough-in. Contractor is responsible for verification that equipment will fit in the space provided. Resolve conflicts with the Architect prior to rough-in work.
- J. Separate Contracts: The Contractor shall be responsible for the coordination and to coordinate activities with other contractors on site performing Owner provided work under separate contracts occurring during the construction period.



**SUMMARY OF WORK**

**1.5 CUTTING AND PATCHING**

- A. Provide cutting, fitting and patching of the Work as required.
- B. Make its several parts fit properly together.
- C. Uncover Work to provide for installation of ill-timed Work.
- D. Remove and replace defective Work.
- E. Remove and replace Work not conforming to requirements of Contract Documents.
- F. Remove samples of installed Work as specified or where directed for testing.
- G. Install specified Work in existing construction.
- H. Uncover Work to provide for Architect's observation of Work covered prior to inspection or approval.
- I. Provide routine penetrations of non-structural surfaces for installation of piping, ducts, electrical conduit, and other mechanical and electrical items.

**1.6 SUBMITTALS-All BSD contracts require use of e-Builder.**

- A. Contractor shall use e-Builder to conduct the following work processes:
  - 1. Submission of shop drawings and other submittals and receiving the processed submittals.
  - 2. Submission of Requests for Information (RFI) and receiving RFI responses from the Owner and A/E.
  - 3. Submission of Invoices and approval or rejection of same.
  - 4. Distribution of Meeting Minutes.
  - 5. Submission of As-Built Record Drawing.
  - 6. Submission of Test Results and Operation and Maintenance (O&M) manuals (electronic format).
  - 7. Submission of Change Orders (COs) and Contract Amendment and approval or rejection of same.
  - 8. Transmission of formal letters and notices between the District and the Contractor.
  - 9. In the event of occasional operational problems with e-Builder, transmission of the above documents may be done for a temporary period of time by hand carrying, email, normal mail or express mail. Prior approval must be obtained from the District before utilizing this backup communication system and a resumption of e-Builder use is to initiate as soon as the operational problems are corrected.
- B. Submit schedule of all shop drawings, product data and samples specified in each individual section of the project manual. Coordinate construction schedule and installation dates of each product and assembly and allow ample time for Architect's review. Allow time for possible disapproval and resubmission.
- C. Deliver submittals (that need to be reviewed in person) to BBL Architects, 200 North State Street, Lake Oswego, Oregon 97034.

**SUMMARY OF WORK**

- D. Transmit each item under Architect-accepted form. Identify Project, Contractor, Subcontractor, and major supplier; identify pertinent Drawing sheet and detail number, and Specification Section number, as appropriate. Identify deviations from Contract Documents. Provide space for Contractor and Architect review stamps.
- E. Apply Contractor's stamp, signed or initialed certifying that review, 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.
- F. Coordinate submittal of related items with construction schedule for timely submittal to the Architect.
- G. After Architect's review of submittal, revise and resubmit as required, identifying changes made since previous submittal.
- H. Do not fabricate products or begin work that requires submittals until return of submittal with Architect acceptance.
- I. Timing of Submittals:
  - 1. Submittals – Within 10 days of Notice of Award of Contract:
    - a. A designation of the Work to be performed by the Contractor by his own forces.
    - b. List of Subcontractors and major materials suppliers for principal portions of the Work.
  - 2. Submittals – Prior to Notice to Proceed:
    - a. Executed Agreement.
    - b. Performance and Labor & Material Payment bonds per Oregon Law (ORS 279.029, 279.542, 701.430) with certified copy of Power of Attorney from Attorney-in-Fact executing bonds.
    - c. Certified copies of Contractor's Liability Insurance Policies (AIA Doc.G705)
  - 3. Submittals – Within 15 days After Notice to Proceed and Prior to first Payment Application, upload the following to the Submittal Process on Ebuilder:
    - a. Schedule of values.
    - b. Schedule of submittals. Upload to Submittal Register on Ebuilder.
    - c. Copies of acquired building permit licenses etc. to complete the work of this contract.
    - d. Construction schedule.
  - 4. Submittals – Prior to each Month's Payment:
    - a. Application and Certificate for Payment (AIA Document G702 and G703).
      - 1) Submit with back-up using Invoice Approval Process in Ebuilder.
    - b. Notarized affidavit of payments to all subcontractors and major material suppliers.
    - c. Updated construction schedule.
    - d. Public Works Contractor Wage Certification per Oregon Law. Upload BOLI Payroll submittals to Ebuilder.
  - 5. Submittals – Prior to Substantial Completion: Notification to Architect that work of the Project is substantially complete, including a listing of items of work to be completed or corrected, together with certificate of occupancy or occupancy permit issued by the Local Building Department for the entire Project.
    - a. Attach Commissioning Reports for critical life safety systems to Substantial Completion notification on Ebuilder.
- J. Schedule of Values:
  - 1. Submit typed schedule on AIA Form G703. Contractor's standard form or media-driven printout will be considered on request.
  - 2. Provide breakdown per each specification section listed in the project manual.
    - a. Include line item for project closeout.
  - 3. Upload draft of Schedule of Values to the Submittal Process on Ebuilder.

**SUMMARY OF WORK**

K. See Section 01 33 00 SUBMITTAL PROCEDURES.

**1.7 COMMUNICATIONS**

A. Communication and the flow of transmitted documents shall flow from the Trade Contractor to the CM/GC (Prime Contractor) and then in parallel to the A/E and the District. Communication and document transmission from the A/E and the District to the Trade Contractor is to occur in the same manner, except that the flow will be the reverse of that noted above.

**PART 2 – PRODUCTS**

**2.1 MATERIAL**

A. The Contractor warrants to the Owner that the materials and equipment furnished under the Contract will be of good quality and new unless otherwise required or permitted by the Contract Documents, that the Work will be free from defects not inherent in the quality required or permitted, and that the Work will conform to the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. If required by the Architect, the Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment.

**PART 3 – EXECUTION (Not Used)**

**END OF SECTION**



**WORK RESTRICTIONS****PART 1 - GENERAL****1.1 WORK RESTRICTIONS****A. Work Sequence:**

1. Complex schedules, phased construction and/or compressed schedules are common.
2. Coordinate work sequence and phased construction requirements with BSD Representative.

**1.2 CONTRACTOR USE OF PREMISES – GENERAL****A. General:** Owner will occupy portions of the building during the construction period. Do not interfere with the Owner's operations. Coordinate use of premises under the direction of the Owner.**B. Use of Site:**

1. Assume full responsibility for the protection and safekeeping of Products under this Contract, stored on the Site.
2. Confine operations at the site to the areas permitted. Portions of the site beyond areas on which work is indicated are not to be disturbed.
3. Move any stored Products, under Contractor's control, which interfere with operations of Owner or separate contractors.
4. Keep existing driveways and entrances serving the premises clear and available at all times. Do not use for parking or storage of materials.
5. Maintain continuity of utility services to existing building.
6. Lock automotive type vehicles and other mechanized or motorized construction equipment, when parked and unattended. Do not leave vehicles or equipment unattended with the motor running. Keys are not to be left in the vehicle.
7. Do not encumber the site with materials or equipment. Confine stockpiling of materials and location of storage sheds to the areas indicated.
8. Limit access to prohibited locations and arrange schedules with BSD personnel.
9. Define contractor areas for work, access, staging, storage, etc.
10. Provide staging & logistics plan. Delineate on site plan. Submit Staging & Logistics Plan with submission of Bid and again with submission of Construction Schedule.

**1.3 CONTRACTOR USE OF PREMISE – EXISTING BUILDINGS****A. Use of Site:**

1. Maintain the existing building in a safe and weathertight condition throughout the construction period. Repair damage caused by construction operations. Take all precautions necessary to protect the building and its occupants during the construction period.
2. Keep public areas such as hallways, stairs, and toilet rooms free from accumulation of waste material, rubbish, or construction debris.
3. Smoking or open fires will not be permitted within the building enclosure or on the premises.
4. Contractor personnel prohibited from undesignated areas.
5. Toilet facilities are the Contractor's responsibility to provide.
6. Limit/contain smoke, dust, dirt, noise – including radios to immediate work area.
7. Broom-clean work area daily.
8. Restore existing surfaces where damaged or modified by construction operations to their original condition.
9. Room may be designated for use as a field office if coordinated through the BSD representative. Room must be vacated by stipulated completion date, regardless of authorized adjustments to construction schedule.

**WORK RESTRICTIONS**

**1.4 OCCUPANCY REQUIREMENTS – EXISTING BUILDINGS**

- A. Partial Owner Occupancy:
  - 1. The Owner reserves the right to place and install equipment in completed areas of the building and to occupy completed areas prior to substantial completion, provided that occupancy does not interfere with completion of the Work.
  - 2. Placing of equipment and partial occupancy shall not constitute acceptance of the Work or any part of the Work.
- B. Scheduling Requirements:
  - 1. Contractor shall organize and coordinate work in a manner that does not interfere with the normal operations of areas of the facility being occupied and used by the Owner.
  - 2. Contractor shall maintain safe and convenient public access to the toilet rooms at all times that the facility is normally open to the public.
  - 3. Contractor shall continuously maintain public entry to the portions of the building being used by the Owner. The Contractor shall also continuously maintain safe, direct and legal exiting routes from all areas of the building to the outside.
  - 4. Normal operating hours of the building are: 6:30 am – 4:30 pm M-F
  - 5. Owner's Project Manager contact information:
    - a. Kurt Meeuwsen, Project Manager:
      - 1) Cell Phone: 503-964-2091.
      - 2) Office Phone: 503-356-4552.
      - 3) Email: [kurt\\_meeuwsen@beaverton.k12.or.us](mailto:kurt_meeuwsen@beaverton.k12.or.us)
- C. Provide for continued occupancy, access, and egress. Existing utilities shall be maintained to the building. Provide minimum 24 hour notice for any disruption.
- D. Provide safety protection for occupants.
- E. Owner items will be stored in a separate storage space not accessible to Contractor.

**1.5 WORK SEQUENCE**

- A. Coordinate the construction schedule and operations with the Owner's Designated Representative.
- B. The Contractor is responsible for employing an approved abatement contractor for the removal of hazardous materials at the school as necessary.
- C. It is anticipated that Contractor may begin Work on the Site on **June 23, 2022**.

**END OF SECTION**

**SUBSTITUTION PROCEDURES****PART 1 – GENERAL****1.1 SUBSTITUTIONS**

- A. Submit two copies of CSI substitution form attached at the end of this document to the Architect via Ebuilder. Architect to forward any substitution to BSD representative for approval via Ebuilder prior to acceptance by the Architect.
- B. Include in Request:
1. Complete data substantiating compliance of proposed substitution with Contract Documents.
  2. For Products:
    - a. Product identification, including manufacturer's name and address.
    - b. Manufacturers literature.
    - c. Product description.
    - d. Performance and test data
    - e. Reference standards.
    - f. Samples, where appropriate.
    - g. Name and address of similar projects on which product was used and date of installation.
    - h. If item deviates from District standards.
      - 1) District Standards can be viewed at the District's website at [www.beaverton.k12.or.us/depts/facilities](http://www.beaverton.k12.or.us/depts/facilities). At Home Page, click on Facilities Development" for list of documents.
    - i. Maintenance requirements
    - j. Unit Cost
  3. For Construction Methods:
    - a. Detailed description of proposed method and Drawings illustrating methods.
    - b. Itemized comparison of proposed substitutions with product or method specified.
    - c. Data relating to changes in construction schedule.
    - d. Accurate cost data on proposed substitution in comparison with product or method specified.
    - e. If method deviates from District standards.
      - 1) District Standards can be viewed at the District's website at [www.beaverton.k12.or.us/depts/facilities](http://www.beaverton.k12.or.us/depts/facilities). At Home Page, click on "Facilities Development" for list of documents.
- C. Substitution after Award of Contract
1. Substitution of products will not normally be approved after Contract is executed. However, substitutions may be considered for one or more of the following conditions.
    - a. Unavailability beyond control of Contractor, such as strikes, lockouts, discontinuance by the manufacturer or his authorized supplier.
    - b. Requirements for compliance with final interpretation of code requirements or insurance regulations.
    - c. BSD or Architect requested substitution.
    - d. If it can be shown that specified product or system is not well suited for proposed application or that another is superior and/or less costly and has attached detailed documentation including cost savings/increase.
    - e. Subsequent information or data discloses inability of specified product to perform properly in the design for which it was intended.
    - f. Manufacturer or fabricator refusal to certify or guarantee performance of specified product as required.
    - g. Subsequent information that a long delivery rate will not be compatible with Contract construction period.

**SUBSTITUTION PROCEDURES**

- h. Proof for any of the above set forth conditions shall be submitted to the Consultant in writing with all pertinent data in the form of a Change Order Request for Consultant's and less costly substitution shall be credited to BSD's account.

**END OF SECTION**



## SUBSTITUTION REQUEST

TO:

PROJECT:

SPECIFIED ITEM:

Section	Page	Paragraph	Description
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### PROPOSED SUBSTITUTION:

Attached data includes product description, specifications, drawings, photographs, performance and test data adequate for evaluation of request including identification of applicable data portions.

Attached data also includes description of changes to Contract Documents and proposed substitution requires for proper installation.

### Undersigned certifies following items, unless modified by attachments, are correct:

1. Proposed substitution does not affect dimensions shown on drawings.
2. Undersigned pays for changes to building design, including engineering design, detailing, and construction costs caused by proposed substitution.
3. Proposed substitution has no adverse effect on other trades, construction schedule, or specified warranty requirements.
4. Maintenance and service parts available locally or readily obtainable for proposed substitution.

Undersigned further certifies function, appearance, and quality of proposed substitution are equivalent or superior to specified item.

Undersigned agrees, if this page is reproduced, terms and conditions for substitutions found in Bidding Documents apply to this proposed substitution.

Submitted by:

Name (Printed or typed)	
Signature	
Firm Name	
Address	
City, State, Zip	
Date	
Tel:	Fax:

General Contractor (if after award of Contract)

For use by A/E	
<input type="checkbox"/> Approved	<input type="checkbox"/> Approved as noted
<input type="checkbox"/> Not Approved	<input type="checkbox"/> Received too late
By	
Date	
Remarks	

The Construction Specifications Institute  
Northwest Region

September 1997





**CONTRACT MODIFICATION PROCEDURES****PART 1 – GENERAL****1.1 CONTRACT MODIFICATION PROCEDURES****A. Proposal Requests:****1. BSD-Initiated Proposal Requests:**

- a. Architect will issue a detailed description of proposed changes in the work that may require adjustment to the Contract Sum or Contract Time via Ebuilder.
- b. Request shall be presented on AIA Document G709 or similar form approved by BSD Representative.
- c. Proposal requests issued by Architect are for information only, and shall not be considered instructions to stop work or to execute the proposed change.
- d. Within 10 working days after receipt of proposal request, Contractor shall submit a quotation of cost adjustments to the Contract Sum and Contract Time necessary to execute the change via Ebuilder.
- e. Contractor shall include an itemized breakdown of cost including quantities of materials, labor costs with breakdown by trade, costs of rental equipments, transportation, storage, etc.
- f. Contractor shall include an updated Construction Schedule via Ebuilder that indicates the effect of the change including, but not limited to, changes in activity duration, start and finish dates, and activity relationships. Contractor shall utilize available total float before requesting an extension of Contract Time.

**2. Contractor-initiated Proposal Requests:**

- a. Contractor shall provide a complete description of the proposed change, indicating the effect of the proposed change on the Contract Sum and on the Contract Time.
- b. Contractor shall include an itemized breakdown of cost including quantities of materials, labor costs with breakdown by trade, costs of rental equipment, transportation, storage, etc.
- c. Contractor shall include an updated Construction Schedule that indicates the effect of the change including, but not limited to, changes in activity duration, start and finish dates, and activity relationships.
- d. Contractor shall utilize available total float before requesting an extension of Contract Time.

**3. Proposal Request Log:** Contractor shall maintain a current log of all proposal requests and submit same at each project meeting and with each application for payment via Ebuilder. Each proposal request shall have a unique number for tracking purpose. The log shall, at minimum, show the proposal request number, date initiated, brief description, reference (i.e. RFI or supplemental instruction), estimated cost, estimated time, status, and reason for the proposal request (i.e. Unforeseen Condition / Regulatory Requirement / BSD Request / E&O).**B. Change Orders:**

1. District and Consultant shall review the Proposal Requests submitted by the Contractor for revisions in the contract cost and the contract time, and may request the Contractor modify its proposal.
2. Upon acceptance of the Proposal Requests by the BSD Representative, Contractor, and Architect, the Architect will prepare the Change Order via Ebuilder on the District's form attached for signatures by all parties.

**CONTRACT MODIFICATION PROCEDURES**

- C. Construction Change Directives:
  - 1. Construction Change Directive shall contain a complete description of the change in the work, and shall designate the method to be followed to determine changes in the Contract Sum or Contract Time.
  - 2. Documentation: Contractor shall maintain detailed records on a time and material basis of work required.
  - 3. Upon completion of the change in the work, the Contractor shall submit an itemized account and supporting data necessary to substantiate cost and time adjustments to the Contract for preparation of a Change Order by the Consultant.
  - 4. Payments to the Contractor shall not be made on a basis of a Construction Change Directive until it is made into a Change Order approved by BSD Representative, Contractor, and Consultant- portions of a Construction Change Directive shall not be eligible to be made into a Change Order for partial Payment.
  
- D. Minor Changes In The Work:
  - 1. Architect may issue supplemental instructions authorizing minor changes in the work that do not involve adjustment to the contract sum nor the contract Time. Minor changes in the work shall use AIA Document G710, "Architect's Supplemental Instructions" or a similar form as approved by the BSD Representative and be submitted via Ebuilder.

**END OF SECTION**

**PAYMENT PROCEDURES****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Forms and procedures for progress payments.

**1.2 APPLICATION FORMS**

- A. For applications for payment, AIA Document G702, supported by AIA Document G703, Continuation Sheet.
- B. Prepare the schedule of values in such a manner that each major item of Work and each subcontracted item of Work is shown as a line item broken down in terms of material and labor costs on AIA Document G703, Application and Certificate for Payment Continuation Sheet in similar format.
- C. The schedule of values shall be submitted for review by the Owner and Architect prior to the first application for payment via Ebuilder; and may be used when, and only when, accepted in writing by the Owner and Architect.
- D. Payment request is to include the Contractor's Federal Tax Identification number and return address.
- E. Each Application for Payment shall be based upon the Schedule of Values submitted by the Contractor to the BSD Representative and the Architect within 10 days of the award of Contract. The Schedule of Values shall allocate the entire Contract Sum among the various portions of the Work and be prepared in such form and supported by such data to substantiate its accuracy as the BSD Representative and the Consultant may require: Format AIA G702 with G703 Schedule of Values.
  - 1. Include line item for project closeout.

**1.3 PAYMENTS**

- A. Owner will make progress payments on account of the Contract once monthly for the scheduled duration of the project based on the value of Work accomplished or materials in the job site, as stated in the schedule of values on the Application and Certificate for Payment. Complete and forward on or about the 20<sup>th</sup> day of each month.
- B. Submit via Ebuilder forms requesting payment to Architect.
- C. Payments will be made on protected materials on hand at the job site properly stored, protected, and insured. Materials held offsite in a bonded and insured warehouse will be considered for payment if the application for payment contains an insurance certificate and bill of sale for materials stored offsite. Estimated quantities shall be subject to Architect's review and judgment.

**1.4 EARLY PURCHASE AND PAYMENT OF MATERIALS AND EQUIPMENT**

- A. Order materials and equipment requiring a long lead or waiting time early so as not to delay progress of the Work.
- B. The Contractor will be reimbursed for early order materials or items upon receipt and verification of quality and quantity against submittals and shipping documents by Owner's Representative. Receipt shall be to the job site or stored at Owner's other premises in an orderly and safe manner, secured from normal weather damage. Security remains the responsibility of the Contractor.
- C. When such items are procured by BSD, the items will be assigned to the General Contractor for receiving and installation.

**PAYMENT PROCEDURES**

- D. As part of the procurement of the items, the specifications will require the start of the product warranty/guarantee extended to coincide with the Project Substantial Completion date and be fully assignable to the General Contractor or its designee.

**END OF SECTION**

**PROJECT MANAGEMENT AND COORDINATION****PART 1- GENERAL****1.1 COORDINATION**

- A. The contractor shall coordinate scheduling, submittals, sequencing of the installation of interdependent elements, utility coordination, and space requirements for installation and maintenance of finished work and storage or staging areas for all trades. The mechanical, electrical, and electrical drawings are diagrammatic and may require special coordination between trades. The Contractor shall provide multidisciplinary coordination of drawings as necessary to insure proper space and layout of various portions of the work.
- B. Notes on various drawings are not meant to determine trade or work jurisdictions. As an example, there may be “architectural” items shown or indicated on mechanical, plumbing, and electrical drawings. Further, there may also be “mechanical”, “plumbing” or “electrical” items shown on architectural drawings. The Contractor is responsible to include all items in the bid cost regardless of which drawing they are indicated on.
- C. The Contractor shall coordinate all work with the Owner’s representative to minimize conflict and insure the least inconvenience to the general public and adjoining properties. Claims for additional time or money resulting from a lack of coordination will not be considered.
  - 1. Directions shall originate only from the Owner’s designated representative and/or the Architect. Communications with other BSD stakeholders are to be considered supplementary and not binding. Instructions, information, and/or direction from other BSD stakeholders are not official direction, and must be confirmed with the Owner’s designated representative and/or the Architect.

**1.2 SUPERVISION**

- A. The Contractor shall provide a competent superintendent who is present on-site during all phases of construction and while work is in progress.

**1.3 PRE-CONSTRUCTION CONFERENCE**

- A. Purpose:
  - 1. To discuss items of interest in such detail that the Contractor shall have a clear understanding of the Owner's requirements, Contract Documents, and conditions affecting the Work. Items to be discussed include, but are not limited to:
    - a. Roles of Architect, Owner, Contractor, and Inspectors.
    - b. Procedures for handling change orders, requests for payment, and other administrative details.
    - c. Procedures for handling shop drawing, substitutions, inspections, etc.
    - d. Scheduling of the work.
    - e. Contractor's comments on any inaccuracies or ambiguities found in the Contract Documents.
    - f. To discuss any and all questions by the Contractor to make sure that the Contractor is aware of all conditions affecting the work prior to the awarding of the Contract.
  - 2. For the General Contractor to discuss with the Owner, Architect, subcontractors, and other interested parties the design, methods, organization, schedule of the work, contract requirements, mutual understandings relative to the Contract Documents, and procedures of the Administration of the Contract. Items to be discussed include, but are not limited to:
    - a. Construction Schedule.
    - b. Project Coordination: Designation of responsible personnel.
    - c. Procedures and processing of submittals, pay requests, change orders.
    - d. Record Document maintenance.

**PROJECT MANAGEMENT AND COORDINATION**

- e. Hazardous materials.
- f. Review of existing building conditions.
- B. Date of Conference: Before actual construction begins, when scheduled by the Architect.
- C. Attendance: The Owner, Architect, Contractor, and his superintendent shall attend as well as subcontractors and suppliers designated by the Owner, Architect, or Contractor.
- D. Place: To be designated by the Owner.

**1.4 PROJECT COORDINATION SUBMITTALS**

- A. Schedule of Values: Submit within 15 days from Award of Contract. Provide in format approved by the Owner's Representative.
  - 1. Format: Identify each line item with number and title of the corresponding SPECIFICATION SECTIONS. Indexing by general division is not acceptable.
  - 2. Keep Schedule of Values current with progress of work, and provide as integral part of Application for Payment. Revise schedule to list Change Orders for each Application for Payment.
  - 3. Breakdown per phasing (if included in project). Submit via Ebuilder.
- B. Construction Schedule:
  - 1. Submit Construction Schedule in line with published schedule contained in these bid documents within 20 days of Award of Contract and provide update at every week subcontractor coordination meeting. Schedule shall consist of a horizontal bar chart with separate designation for each major trade or operation, identifying first workday of each week. Clearly designate Critical Path of construction.
  - 2. Show complete sequence of construction by activity, identifying work of separate stages and other logically grouped activities. Show projected percentage of completion for each item of work as of the first of each month. Submit via Ebuilder.

**1.5 SUBMITTAL PROCEDURES**

- A. Submit information as required by each Section of the Specification. Coordinate with construction schedule and allow sufficient time for Architect and consultant review. Allow time for potential disapproval and re-submittal.
  - 1. The Contractor should expect a minimum review/processing time of seven (7) days for the Architect review and a minimum of fourteen (14) days for Architect's consultant and Owner's review.

**1.6 SHOP DRAWINGS**

- A. Submit drawings via Ebuilder.

**1.7 SAMPLES**

- A. Submit full range of manufacturer's standard colors or custom colors where specified, textures and patterns for Architects final selection. Submit via Ebuilder unless sample cannot be adequately reviewed without seeing the physical sample.
- B. Submit samples to illustrate functional characteristics of the product, with integral parts and attachment devices. Coordinate submittal of different categories for interfacing work.
- C. Include identification on each sample, giving full information.



**PROJECT MANAGEMENT AND COORDINATION**

- D. The Contractor shall clearly mark and identify applicable products, models, options and other data on manufacturer's standard data or catalog cuts. The Contractor shall provide supplemental data or information unique to this project. Where specified in other sections of the specification, assembly, installation, start-up, adjusting and finishing. The Contractor shall submit supporting reference data, affidavits and certifications that products meet or exceed the specified requirements.

**1.8 PRODUCT DATA**

- A. Mark each copy to identify applicable products, models, options, and other data; supplement manufacturer's standard data to provide information unique to the work.
- B. Submit via Ebuilder.

**1.9 WARRANTIES**

- A. Prior to final payment, furnish one (1) original and two (2) copies of all warranties required for each item of materials where stipulated in the Contract Documents. Submit as part of the O&M deliverables.

**1.10 LAYOUT OF THE WORK**

- A. The Contractor shall survey and verify the conditions of the existing project site. The purpose of the survey is to record existing conditions prior to the construction for comparison with the Contract Documents.
- B. The Contractor shall report any conflicts to the Architect prior to the start of the Work. The Architect will provide revisions to the Contract Documents or issue instructions to deal with conflicts.
- C. The Contractor shall be responsible for remedying conflicts that could have been prevented by timely reviews of existing conditions. All remedies which vary from the Contract Documents shall be approved by the Architect and the Owner's Representative.

**1.11 JURISDICTIONAL REPORTING REQUIREMENTS**

- A. Certification of occupancy shall not be issued prior to all inspections normally required in the course of construction by the Authority Having Jurisdiction.

**1.12 PROGRESS MEETINGS**

- A. Purpose: Project meetings will be held each week, from beginning of construction to final acceptance, to discuss items of mutual interest regarding coordination and progress of the work.
  - 1. The Contractor shall fully brief the Architect and BSD Representative on the progress of the Work.
- B. Day of Week: To be mutually determined by the Architect, Owner, and the Contractor.
- C. Attendance: The Owner, Architect, Contractor, and his superintendent shall attend, or their representatives. Other subcontractors, suppliers, or manufacturer's representatives shall attend when requested by the Contractor, Owner, or Architect.
- D. Place: Project site or as otherwise designated by the Owner.
- E. Chairman: The Contractor shall chair the meeting.

**PROJECT MANAGEMENT AND COORDINATION**

- F. Meeting Date Changes: Contact Owner's Representative to request any changes in the meeting date; provide 24 hour notice. The Owner's Representative will set the new date.
- G. Meeting Report: The Contractor will later issue a meeting report to the Contractor and Owner. Submit via Ebuilder.
- H. The Contractor shall be responsible for notifying subcontractors and other representatives of scheduled construction meetings where their attendance is requested.

**END OF SECTION**

**PROJECT MANAGEMENT DATABASE (E-BUILDER)**

**PART 1 – GENERAL**

**1.1 SECTION INCLUDES**

- A. Summary.
- B. General Requirements.
- C. System Requirements.
- D. System Access.
- E. System Use.

**1.2 SUMMARY**

- A. Project Management Communications: The Owner, Contractor and Architect shall use the Internet web based project management communications tool, E-Builder® ASP software and protocols included in that software during this project. The use of project management communications as herein described does not replace or change any contractual responsibilities of the participants.
- B. Purpose: The intent of using E-Builder® is to improve project work efforts by promoting timely initial communications and responses and to reduce the number of paper documents while providing improved record keeping by creation of electronic document files.
- C. Contractor shall use this system to conduct the normal communication and work process flows that are used in completing the design and construction of our facilities. Division 1 should reflect that the Contractor use e-Builder to conduct the following work processes:
  - 1. Submission of shop drawings and other submittals and receiving the processed submittals.
  - 2. Submission of Requests for Information (RFI) and receiving RFI responses from the Owner and A/E.
  - 3. Submission of invoices and approval or rejection of same.
  - 4. Distribution of meeting minutes.
  - 5. Submission of as-built record drawings.
  - 6. Submission of test results and Operation and Maintenance (O&M) manuals (electronic format).
  - 7. Submission of Change Orders (COs) and contract amendment and approval or rejection of same.
  - 8. Transmission of formal letters and notices between the District and the Contractor.
  - 9. In the event of occasional operational problems with e-Builder, transmission of the above documents may be done for a temporary period of time by hand carrying, email, normal mail or express mail. Prior approval must be obtained from the District before utilizing this backup communication system and a resumption of e-Builder use is to initiate as soon as the operational problems are corrected.

**1.3 GENERAL REQUIREMENTS**

- A. Project management communications is available through E-Builder® as provided by "E-Builder®" in the form and manner required by the Owner.
- B. The project communications database is on-line and fully functional. User registration, electronic and computer equipment, and Internet connections are the responsibility of each project participant. The sharing of user accounts is prohibited.

**PROJECT MANAGEMENT DATABASE (E-BUILDER)**

- C. Support: E-Builder® will provide on-going support through on-line help files.
- D. Authorized Users: Access to the web site will be by individuals who are licensed users as required by the Owner.
- E. Licenses Granted by Owner: Owner shall pay for and provide licenses for the following members of the project team:
  - 1. Lead member and backup member of Architect's design team responsible.
  - 2. Contractor's project manager or lead member and a backup member of Contractor's project staff .
  - 3. Others as deemed appropriate by Owner.

**1.4 SYSTEM REQUIREMENTS**

- A. System Configuration:
  - 1. PC system 500 MHz Intel Pentium III or equivalent AMD processor.
  - 2. 128 MB Ram .
  - 3. Display capable of SVGA (1024 x 768 pixels) 256 colors display.
  - 4. 101 key Keyboard .
  - 5. Mouse or other pointing device.
- B. Operating system and software configuration:
  - 1. All software shall be properly licensed with vendors or developers. Use of "E-Builder" does not convey any rights or licensure for use of any software, hardware or internet service provider.
  - 2. Software Configuration:
    - a. Most current version of Microsoft Internet Explorer (current version is a free distribution for download). This specification is not intended to restrict the host server or client computers provided that industry standard HTTP clients may access the published content.
    - b. Most current version of Adobe Acrobat Reader (current version is a free distribution for download).
    - c. Other plug-ins specified by E-Builder® as applicable to the system (current versions are a free distribution for download from [www.e-builder.net](http://www.e-builder.net)).
    - d. Users are recommended to have properly licensed versions of the standard Microsoft Office Suite (current version must be purchased) or the equivalent.

**1.5 SYSTEM ACCESS**

- A. Minimum Equipment and Internet Connection: In addition to other requirements specified in this Section, the Contractor shall be responsible for providing suitable computer systems for each licensed user at the users normal work location with high-speed Internet access, i.e. DSL, local cable company's Internet connection, or T1 connection.
- B. Authorized users will be contacted directly by the web site provider, E-Builder®, who will assign the temporary user password.
- C. Individuals shall be responsible for the proper use of their passwords and access to data as agents of the company in which they are employed.

**PROJECT MANAGEMENT DATABASE (E-BUILDER)**

**1.6 SYSTEM USE**

- A. Owner's Administrative Users: Owner administrative users have access and control of user licenses and all posted items. **DO NOT POST PRIVATE OR YOUR COMPANY CONFIDENTIAL ITEMS IN THE DATABASE!**
- B. Improper or abusive language toward any party or repeated posting of items intended to deceive or disrupt the work of the project will not be tolerated and will result in deletion of the offensive items and revocation of user license at the sole discretion of the Administrative User(s). Costs incurred or associated with such issues shall be the financial responsibility of the party responsible for the transgression.
- C. Communications: Communication for this project for the items listed below shall be solely through E-Builder®:
  - 1. RFI, Requests for Information.
  - 2. Change Order Requests.
  - 3. Architect's Supplemental Instructions.
  - 4. Calendar of Events (meetings, events, open houses, public site tours etc.).
  - 5. All other communication shall be conducted in an industry standard manner.
- D. Document Integrity and Revisions:
  - 1. Documents, comments, drawings and other records posted to the system shall remain for the project record. The authorship time and date shall be recorded for each document submitted to the system. Submitting a new document or record with a unique ID, authorship, and time stamp shall be the method used to make modifications or corrections.
  - 2. The system shall identify revised or superseded documents and their predecessors.
  - 3. Server or Client side software enhancements during the life of the project shall not alter or restrict the content of data published by the system. System upgrades shall not affect access to older documents or software.
- E. Document Security: The system shall provide a method for communication of documents. Documents shall allow security group assignment to respect the contractual parties communication except for Administrative Users.
- F. Document Integration: Documents of various types shall be logically related to one another and discoverable.
- G. Notifications and Distribution: Document distribution to project members shall be accomplished both within the extranet system and via email as appropriate. Project document distribution to parties outside of the project communication system shall be accomplished by secure email of outgoing documents and attachments, readable by a standard email client.
- H. Ownership of Documents and Information: All documents, files or other information posted on the system shall become the property of the Owner.

**PART 2 – PRODUCTS** (Not Used)

**PART 3 – EXECUTION** (Not Used)

**END OF SECTION**



**PHOTOGRAPHIC DOCUMENTATION****PART 1 – GENERAL****1.1 SUMMARY**

- A. Section Includes:
  - 1. Preconstruction photography.
  - 2. Construction photography of work-in-progress.

**1.2 GENERAL**

- A. Provide photographs at locations designated by Architect, including aerial views.
- B. Photographer: Specialist, experienced in taking construction photography.
- C. Equipment:
  - 1. As necessary to photograph both interior and exterior exposures.
  - 2. Utilize full range of lenses, including wide angle and telephoto.

**1.3 SUBMITTAL REQUIREMENTS**

- A. Make photo submittals, to Owner and Architect, along with each monthly Application for Payment.
- B. Electronic Format:
  - 1. Submit electronic files in jpeg format produced by digital camera with minimum resolution of not less than 3200 by 2400 pixels with minimum sensor size of 12 megapixels.
  - 2. Submit without alteration, manipulation, editing, or modifications using image editing software.
  - 3. Date and Time: Include date and time in file name for each image.
  - 4. File Names: Name media files with date, project area and sequential numbering suffix.

**1.4 PRECONSTRUCTION PHOTOGRAPHS**

- A. Take photographs prior to beginning Work of this Contract.
- B. Provide 10 Project Site photographs.

**1.5 CONSTRUCTION PHOTOGRAPHS**

- A. Take construction photographs, beginning one month after last preconstruction photograph, and continuing for duration of the Work.
- B. Take minimum of 10 photographs, including one aerial photograph, each month. Take additional photographs as needed to fully document Project.
- C. Put a date stamp on photos.
- D. Locate photographs as necessary to document each phase of construction and to show progress of the Work.

**1.6 PROJECT COMPLETION**

- A. Provide 10 project site photographs.

**PHOTOGRAPHIC DOCUMENTATION**

**PART 2 - PRODUCTS (Not Used)**

**PART 3 - EXECUTION (Not Used)**

**END OF SECTION**



**SUBMITTAL PROCEDURES****PART 1 - GENERAL****1.1 WORK INCLUDED**

- A. Submit overall construction schedule, 3-week work schedule, shop drawings, product data, samples, schedule of values, record documents, and products list as specified.
  - 1. Submit to Architect via Ebuilder only through Contractor.
  - 2. Do not submit directly to Consulting Engineers without prior approval by the Architect for each individual submittal.
  - 3. The Architect/Consultant will forward a marked up set of submittals to the District Representative for review and approval after review by the Architect and Consultant(s).

**1.2 QUALITY ASSURANCE**

- A. Within 15 days of the Award of Contract, submit schedules of values, list of principal subcontractors and suppliers, progress schedule, copies of building permits, and similar start-up authorization via Ebuilder.

**PART 2 - PRODUCTS****2.1 CONSTRUCTION SCHEDULE**

- A. Content: Within 20 days of the award of contract, submit a comprehensive progress schedule indicating a time bar for each significant category of work to be performed via Ebuilder. Show product and installation dates for major products. Show dates for each construction activity, Substantial Completion and punch list preparation, Final Completion, and Occupancy.
- B. Designate in the Construction Schedule, the dates for submission and review of Shop Drawings, product data and samples that are needed for the product. Show critical submittal dates or prepare a separate coordinated listing of critical submittal dates.
  - 1. Any critical path submittals shall be identified as critical in the Ebuilder Submittal Process.
- C. Updating: Indicate progress of each activity and show revised completion dates. Provide listing of current and anticipated accelerations and delays. Describe proposed corrective action when required. Revise at intervals matching payment requests and redistribute with each payment request.

**2.2 MEETING MINUTES**

- A. Meeting minutes to be prepared by Contractor and distributed to all meeting attendees via Ebuilder with 2 days. Action items uploaded to Ebuilder by the end of that same day.

**2.3 SCHEDULE OF VALUES**

- A. Submit a Schedule of Values covering various parts of work including quantities aggregating the total sum of the Contract to Ebuilder. Show dollar value and percent of total for each unit of work scheduled. This Schedule will be the basis for the Contractor's Application for Payment.
- B. Submit on the latest edition of AIA Document G703, Continuation Sheet, within 15 days of Award of Contract and with each payment request. Revise each time schedule is affected by change order or other revision.
- C. Upon request by the Architect, support values given with data that will substantiate their correctness.

**SUBMITTAL PROCEDURES**

**2.4 PAYMENT REQUESTS**

- A. Submit a request each calendar month to Ebuilder. Use the latest edition of AIA Document G702, Application and Certificate for Payment, fully completed, notarized, and executed and G703, Schedule of Values.

**2.5 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES**

- A. General:
  - 1. Review, stamp with Contractor's stamp, and sign each submittal to certify Contractor has reviewed submittal for compliance with Contract Documents prior to submitting to the Architect. Submittals issued without the Contractor's review may be returned to the Contractor without being reviewed by the Architect. Submit to Ebuilder.
  - 2. Provide 3" x 4" clear space on each submittal for the Architect's stamp.
  - 3. Provide additional copies as required by governing authorities.
- B. Shop Drawings-Submit via Ebuilder.
  - 1. Submit shop drawings showing connections, details, dimensions, finishes, fasteners, etc.
  - 2. Maintain 1 print as a mark-up copy for the "Record Drawings".
  - 3. In the event that the submittal is a partial submittal, identify related shop drawings to be submitted at a later date.
- C. Product Data-Submit via Ebuilder.
  - 1. Submit manufacturer's catalog sheets, brochures, diagrams, schedules, performance charts, illustrations, and other description data on manufactured products and systems.
  - 2. Mark to indicate the actual product to be provided. Show selections from among options in the manufacturer's printed product data.
  - 3. Maintain 1 copy at the project site for reference purposes.
- D. Office Samples-Submit via Ebuilder:
  - 1. Maintain one returned set at the project site for purposes of quality control comparisons.
  - 2. Sample submittals are for Architect's observation of color, texture, pattern, and "kind".
  - 3. Upload copy of transmittal and digital photographs of all submitted samples to e-Builder after physical samples have been submitted to Architect.
- E. Miscellaneous Submittals: Provide copies of miscellaneous submittals as follows:
  - 1. Warranties: Submit 3 executed copies, plus additional copies as required for maintenance manual.
  - 2. Field Records: Submit 3 copies, including 1 copy that will be returned for inclusion in the submittal of "Record Documents".
  - 3. Maintenance Manuals: Submit 3 bound copies.
  - 4. "Record Drawings": Submit original maintained marked-up prints.
  - 5. Construction Schedule and Schedule of Values: Submit 4 copies to the Architect.

**2.6 3-WEEK WORK SCHEDULE**

- A. Each week, provide to the Architect a 3-Week Work Schedule on a form approved by the Architect. Submit via Ebuilder. Each 3-Week Work Schedule is to show the description of all phases of the work to be accomplished during the week submitted and the 2 following weeks. The 3-Week Work Schedule is to be updated every week and presented to the Architect.
  - 1. Indicate any suspected utility service interruption on the 3-Week Work Schedule.

**SUBMITTAL PROCEDURES**

**PART 3 - EXECUTION**

**3.1 CONTRACTOR'S SUBMITTAL**

- A. Review submittals prior to submission and provide stamp of approval signed or initialed by the Contractor indicating the Contractor has inspected the submittals and certifying that they are complete, correct, in compliance with the Contract Documents and suitable for the Project.
- B. Verify field measurements and other field construction criteria.
- C. Submit submittals required by each Specification Section to the Architect. Notify the Architect in writing at time of submission of deviation in submittals from requirements of the Contract Documents.
- D. The Architect/Consultant shall provide a marked up set of submittals to the District Representative for review and approval after review by the Architect/Consultant.
- E. Submittals shall be arranged by specification section with the specification sections identified on divider tabs. Product Submittals shall include catalog data sheet clearly marking the following information for the exact equipment being installed: manufacturer, type, style, complete catalog number, dimensions, physical description, and specifications for each item and each option submitted. Submittals shall reference equipment number as designated on Project Drawings, equipment schedules, or specifications for any and all equipment identified by unique designation in project documents. Contractor must submit the proposed startup documentation for the equipment upon submittal for that equipment. Include the manufacturer's recommended installation and startup procedures with associated checklists for each unique piece of equipment under a separate tab titled "Installation/Startup". These procedures and forms shall be for the specific piece of equipment to be provided.
  - 1. Submittals shall be divided out and listed separately in the Ebuilder Submittal Register, and each submittal shall be uploaded separately to the Submittal Process in Ebuilder.
- F. Submittals to be provided as a complete package. When individual sections or incomplete submittals are provided, include divider or space holder for missing section(s) with sheet indicating equipment number and anticipated delivery date for submittal.

**3.2 ARCHITECT'S REVIEW**

- A. Architect will review submittals for design concept and conformance with the Contract Documents and return submittals to the Contractor for distribution with corrections noted thereon.
- B. Stamp: The Architect will stamp each submittal to be returned with a uniform, self explanatory action stamp, appropriately marked and executed to indicate the status of the submittal. The stamp indicates and requires the follow action:
  - 1. No Exception Taken: No further action is required.
  - 2. Make Corrections Noted: Make the corrections upon fabrication of the material only.
  - 3. Rejected: The material submitted is not acceptable and another material submission is required.
  - 4. Revise and Resubmit: The material submittal is not acceptable and it is to be elaborated upon or corrected and resubmitted prior to material fabrication.
  - 5. Submit Specified Item: Submittal is rejected and the material specified is to be submitted.
  - 6. Checking is only for general conformance with the design concept of the Project and general compliance with the information given in the Contract Documents. Any action shown is subject to the requirements of the plans and specifications. Contractor is responsible for dimensions which shall be confirmed and correlated at the job site, fabrication processes and techniques of construction, coordination of Contractor's work with that of all other trades and the satisfactory performance of Contractor's work.

**SUBMITTAL PROCEDURES**

- C. Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the Architect's review of submittals unless the Contractor has made written request for the deviations and the Architect gives written acceptance of specific deviations requested.

**3.3 CORRECTIONS**

- A. Immediately incorporate all required corrections in the submittals and resubmit for further review, if required.

**3.4 TIME SCHEDULE FOR SUBMITTALS**

- A. Construction Schedule: Submit to the Architect via Ebuilder no later than 20 calendar days after Award of Contract.
- B. Shop Drawings: Submit to the Architect via Ebuilder for review. The Architect will review within 15 calendar days. Schedule submissions to allow ample time for ordering and delivery of materials after review.
- C. Product Data: Submit to the Architect via Ebuilder for review. The Architect will review within 15 calendar days. Schedule submissions to allow ample time for ordering and delivery of materials after review.
- D. Office Samples: Submit to the Architect via Ebuilder for review. The Architect will review within 15 calendar days. Schedule submissions to allow ample time for ordering and delivery of materials after review.
- E. Schedule of Values: Submit to the Architect via Ebuilder no later than 15 calendar days after receipt of the Notice to Proceed.

**3.5 SUBMITTAL SCHEDULE**

- A. Submittals required by Specifications and the Drawings shall be made regardless of whether or not they are scheduled herein. Each specification section should be reviewed for exact submittal requirements. All submittals must be reviewed by the Architect prior to being used and must be submitted in sufficient time to preclude a delay in meeting the approved Construction Schedule.

**END OF SECTION**

**SPECIAL PROCEDURES****PART 1 - GENERAL****1.1 SUMMARY**

- A. Asbestos: No asbestos containing materials may be used in the construction or remodel of any facilities located within the Beaverton School District. Due to the age of the facility no asbestos containing materials are expected.
1. The Beaverton School District retains an Asbestos Abatement Consultant to test presumed asbestos containing material (PACM) and to oversee all asbestos abatement work that takes place within our facilities. This consultant is to be an integral part of the construction process. They are to be notified before any asbestos abatement takes place within the designated facility. If material is found during the construction process that has not been specifically identified as asbestos containing material, but is presumed to contain asbestos, then a bulk sample must be sent for laboratory analysis before the material may be removed or repaired. The Asbestos Abatement Consultant is charged with keeping records which are forwarded to the AHERA Designated Person for the Beaverton School District. This information is crucial to the maintenance of the BSD asbestos database for all facilities.
  2. The Contractor must have a full-time construction project manager on site to oversee the construction that takes place within the facility. It will be the responsibility of the construction project manager to notify the Asbestos Abatement Consultant in conjunction with the Abatement Contractor so that the Asbestos Abatement Consultant is on site to oversee the abatement of the asbestos and to document the material removed for the BSD asbestos database. **Asbestos abatement is to be completed by the General Contractor and the cost to be incurred by the General Contractor.**
  3. Procedures to follow if there has been an asbestos release event
    - a. Shut down all heating, ventilation and air conditioning units that supply return or draw air to, or from the area in question.
    - b. Keep the area in question closed off. Post signs to restrict any person from accidentally walking into the contaminated area.
    - c. Notify the BSD Representative and the Asbestos Abatement Consultant for the District. They will make the arrangements for the clean up of the asbestos contamination.
  4. Construction Contractor shall be held liable for any actions of its agent, personnel or subcontractors and all costs, expenses, damages, claims and causes of action rising out of an asbestos release that occurs during performance of their work. All costs incurred by the District to clean up the asbestos release shall be the responsibility of the Contractor.
- B. Environmental Pollutants:
1. Contractor shall obtain the District's written consent prior to bringing onto the work site any environmental pollutants or hazardous substances or materials.
  2. Properly handle, use, and dispose of all environmental pollutants and hazardous substances or materials brought onto the work site, in accordance with all applicable federal, state, or local statutes, rules, or ordinances.
  3. Be responsible for any and all spills, releases, discharges, or leaks of (or from) environmental pollutants or hazardous substances or materials which Contractor has brought on the work site.
  4. Promptly clean up, without cost to the District, such spills, releases, discharges, to the District's satisfaction and in compliance with all applicable federal, state, or local statutes, rules, or ordinances.
  5. Contractor shall be liable for any and all costs, expenses, damages, claims and causes of action, or any of them related to or arising out of a spill, release, discharge or leak of (or from) any environmental pollutant or hazardous substance or material, to the extent such spill release, discharge, or leak was caused or contributed to by the Contractor's negligence or failure to perform in accordance with the contract documents.

**SPECIAL PROCEDURES**

6. Contractor must report, when safe to do so, all quantity releases via telephone to the BSD Representative. A written follow-up report is to be submitted to the BSD Representative within 48 hours of the telephone notification. At a minimum, the report must contain the following information:
  - a. Description of times released (identity, quantity, and all other documentation required by law).
  - b. Whether amount of items released is reportable to EPA/DEQ, and if so, when it was reported.
  - c. Exact time and location of release, including a description of the area involved.
  - d. Containment procedures initiated.
  - e. Summary of communications about the release that Contractor has had with members of the press or State officials other than District.
  - f. Description of clean-up procedures employed, or to be employed at the site, including disposal location of spill residue.
  - g. Personnel injuries, if any, resulting from or aggravated by, the release.
- C. Environmental Clean-up:
  1. As part of the Final Completion Notice, or as a separate written notice submitted with or before the Notice of Completion, the Contractor shall notify the District that all environmental pollution clean-up which was performed as part of this construction project has been disposed of in accordance with all applicable rules, regulations, laws and statutes of all agencies having jurisdictions over such environmental pollution. The notice shall indemnify and hold harmless the District from any claims resulting from the disposal of the environmental pollution including removal, encapsulation, transportation, handling, and disposal.
  2. Construction Contractor will be held responsible for any and all releases of environmental pollution during performance of the Contract that occur as a result of, or are contributed to, by actions of its agent, personnel, or subcontractors.
  3. All costs incurred by the District in meeting applicable regulations, in correcting any unhealthy or unsafe working conditions, or costs incurred by the District to complete any of the Contractor's work, will be charged to the Contractor.
- D. Hazardous Materials:
  1. In the event that PCB ballasts, lead paint, heavy metals, underground storage tanks, or other hazardous materials are encountered during construction, contact the BSD Representative who will notify BSD Environmental Management. Separate arrangements will be made to remove the hazardous material and clean the facility in a manner that is safe and consistent with Beaverton School District policies and all regulatory authorities.
  2. Any time "assumed lead" painted surfaces are disturbed the work must be done by a certified firm with a trained and certified contractor. In addition the areas of the building that will be affected must be posted with appropriate signage warning of the potential hazard and parents and guardians of the children must receive information about the renovation work that is planned an EPA pamphlet about renovation.
- E. In the event that an event occurs contact the National Response Center and obtain a file report number that will be forwarded to the District Representative.

**END OF SECTION**

**SAFETY REQUIREMENTS**

**PART 1 – GENERAL**

**1.1 SAFETY REQUIREMENTS**

The following requirements, as applicable, apply to Work specified herein.

- A. Associated General Contractors of America, Inc., “Manual of Accident Prevention in Construction.”
- B. Workmen’s Compensation Board “Safety Code for Construction Work.”
- C. Oregon State Employment Act Safety Requirements.
- D. Oregon Occupational Safety and Health Act (OROSHA) requirements, as applicable, apply to Work specified herein.

**END OF SECTION**





**SECURITY PROCEDURES**

**PART 1 - GENERAL**

**1.1 SECURITY REQUIREMENTS**

- A. All personnel under the employment of the Contractor and its Subcontractors that travel to, or spend time at the project site are to wear photo ID badges while on the work site. Individuals not wearing badges will be removed from the project work site. ID badges are to contain:
  - 1. Individual's full name (no nicknames).
  - 2. Individual's company affiliation.
  - 3. Recent photograph of the individual; taken within the last 4 years.
- B. All personnel under the employment of the Contractor and its Subcontractors that spend time at the project site, must be run through formal background screening by the Contractor and pass that screening review, before being allowed on the work site. Background screening is to be done by a professional screening firm meeting the following qualifications:
  - 1. Must have a minimum of five years of screening experience specifically for construction industry clients.
  - 2. Must have a minimum of fifteen employees.
  - 3. Must be able to provide access to an internet based screening management software system which has a feature to allow access by the District to view the pass-no pass result for each screened Contractor/Subcontractor employee working on a District project.
  - 4. Must be accredited by the National Association of Professional Background Screeners (NAPBS).
- C. Each individual will be screened for having committed any crime as listed in ORS 342.143, most recent edition.

**1.2 CONSTRUCTION/MAINTENANCE BUILDING SECURITY RULES**

- A. The Contractor shall enforce strict discipline and good order among the Contractor's employees, Subcontractors, and other persons carrying out the contract on District property. The District may require that the Contractor immediately remove from the project site and District property any employee or other person carrying out the contract that the District considers objectionable.
- B. District Personnel (i.e., Building Administrator, Custodian, or a building monitor etc.) must be present when a contractor is performing work within an existing school facility.
- C. Only District Personnel will deactivate the security system upon arriving and reactivate the system when they leave the facility.
  - 1. If the responsible District Personnel for a particular day changes during the day, the District Personnel shall coordinate this change in responsibility and advise the Contractor's superintendent.
- D. Contractor personnel will not be furnished District security badges and/or access codes to the building security system. All personnel under the employment of the Contractor and its subcontractors that travel to or spend time at the project site are to wear ID badges while on the work site. ID badges are to contain:
  - 1. Individuals full name.
  - 2. Individuals company affiliation.
- E. The Contractor shall have a responsible party such as a superintendent, foreman, or supervisor on site during any work being performed by either their own forces or that of their subcontractors.
- F. The superintendent shall check in with the responsible District Personnel upon arrival and advise when all work is complete, contract personnel have left, and the area is secure.

**SECURITY PROCEDURES**

- G. The Contractor's superintendent shall be responsible for security in areas where work is being performed as well as ingress and egress to that area.
- H. At the BSD Representative's discretion, the superintendent may be issued a building key to allow access to area's where work is being performed.
- I. The superintendent shall maintain a daily log defining what areas within the building were accessed by Contractor personnel, which personnel from their firm were in the building, and which subcontracting firms were in the building.
- J. Each of the Contractor's employees, Subcontractors' employees, and principals/owners involved at the site may, at the option of the District, be subject to a security check, at any time, through the Beaverton Police Department or other venue.

**1.3 BACKGROUND CHECKS**

- A. In an effort to ensure the safety of children at Beaverton Schools, ALL Contractors, including, but not limited to, trade contractors, material vendors, professional service providers, architects or engineers, subcontractors or sub-consultants, retained by the District shall complete a criminal background check prior to beginning work. Furthermore, Contractors shall adhere to the following rules while on BSD campuses. The District may remove any Contractors as defined above, from any BSD property, for not complying with these requirements.
- B. Background Checking Procedure:
  - 1. Contractor shall complete a Confidential Criminal Background Check Certification Form (copy attached following this Section) on each employee and provide the information to a third-party background checking company (see list of possible companies on Page 3).
    - a. Background checks need to cover the past 7 years and include offenses registered in the federal, county, sex offender and the Department of Corrections lists.
    - b. Fingerprinting is left up to the discretion of the District, however not required in most instances.
    - c. An existing background check may qualify an employee for badging if:
      - i. The background check was conducted within the last year
      - ii. The background check was conducted in accordance with work for another public or private school district within the State of Oregon
      - iii. The background check covered the list of crimes rendering ineligibility as outlined on Page 2 of the Confidential Criminal Background Check Certification Form
      - iv. The employee has not taken up residency outside the State of Oregon since the time the background check was conducted
  - 2. Once an employee of the Contractor passes the Criminal Background Check, Contractor will provide to the District a letter on company letterhead with a listing of these names.
    - a. The District will not collect the background check certifications. However, the District reserves the right to request the background check certifications at any time.
  - 3. After passing background checks, all Contractors and their employees are to be badged when onsite. Badges are to be prepared by the Contractor (template attached). Badges must include individual's legal name (not a nick-name), company name that they work for, location(s) that the Contractor will be working, and a recent (within the last 4 years) photo of the individual. Background checks are valid for one year.
- C. Contractor shall pay and perform or have performed criminal background checks for every employee on all active campus (i.e., children are present) projects prior to that employee's admittance to the project site. Once an employee passes the criminal background check they will create an ID badge which they must wear while they are on site at all times. Contractor may be fined up to \$500 for every worker working on site without the proper ID badge. The following are the convicted crimes that may not appear on the background check.

SECURITY PROCEDURES

- D. CONVICTIONS RENDERING INELIGIBILITY per ORS 342.143:
- 163.095 Aggravated murder
  - 163.115 Murder
  - 163.185 Assault in the first degree
  - 163.235 Kidnapping in the first degree
  - 163.355 Rape in the third degree
  - 163.365 Rape in the second degree
  - 163.375 Rape in the first degree
  - 163.385 Sodomy in the third degree
  - 163.395 Sodomy in the second degree
  - 163.405 Sodomy in the first degree
  - 163.408 Unlawful sexual penetration in the second degree
  - 163.411 Unlawful sexual penetration in the first degree
  - 163.415 Sexual abuse in the third degree
  - 163.425 Sexual abuse in the second degree
  - 163.427 Sexual abuse in the first degree
  - 163.432 Online sexual corruption of a child in the second degree
  - 163.433 Online sexual corruption of a child in the first degree
  - 163.435 Contributing to the sexual delinquency of a minor
  - 163.445 Sexual misconduct
  - 163.465 Public indecency
  - 163.515 Bigamy
  - 163.525 Incest
  - 163.547 Child neglect in the first degree
  - 163.575 Endangering the welfare of a minor
  - 163.670 Using child in display of sexually explicit conduct
  - 163.675 Sale of exhibition of visual reproduction of sexual conduct by child
  - 163.680 Paying for viewing sexual conduct involving a child
  - 163.684 Encouraging child sex abuse in the first degree
  - 163.686 Encouraging child sex abuse in the second degree
  - 163.687 Encouraging child sex abuse in the third degree
  - 163.688 Possession of materials depicting sexually explicit conduct of a child in the first degree
  - 163.689 Possession of materials depicting sexually explicit conduct of a child in the second degree
  - 164.325 Arson in the first degree
  - 164.415 Robbery in the first degree
  - 166.005 Treason
  - 166.087 Abuse of corpse in the first degree
  - 167.007 Prostitution
  - 167.008 Patronizing a prostitute
  - 167.012 Promoting prostitution
  - 167.017 Compelling prostitution
  - 167.057 Luring a minor
  - 167.062 Sadoomasochistic abuse or sexual conduct in live show
  - 167.075 Exhibiting an obscene performance to minor.
  - 167.080 Displaying obscene materials to minors
  - 167.090 Publicly displaying nudity or sex for advertising purposes
  - 475.808 Unlawful manufacture of hydrocodone within 1,000 feet of school
  - 475.810 Unlawful delivery of hydrocodone
  - 475.812 Unlawful delivery of hydrocodone within 1,000 feet of school
  - 475.818 Unlawful manufacture of methadone within 1,000 feet of school
  - 475.820 Unlawful delivery of methadone
  - 475.822 Unlawful delivery of methadone within 1,000 feet of school
  - 475.828 Unlawful manufacture of oxycodone within 1,000 feet of school
  - 475.830 Unlawful delivery of oxycodone
  - 475.832 Unlawful delivery of oxycodone within 1,000 feet of school

**SECURITY PROCEDURES**

- 475.846 Unlawful manufacture of heroin
- 475.848 Unlawful manufacture of heroin within 1,000 feet of school
- 475.850 Unlawful delivery of heroin
- 475.852 Unlawful delivery of heroin within 1,000 feet of school
- 475.854 Unlawful possession of heroin
- 475.856 Unlawful manufacture of marijuana
- 475.858 Unlawful manufacture of marijuana within 1,000 feet of school
- 475.860 Unlawful delivery of marijuana
- 475.862 Unlawful delivery of marijuana within 1,000 feet of school
- 475.864 Unlawful possession of marijuana within 1,000 feet of school
- 475.866 Unlawful manufacture of 3,4 methylenedioxymethamphetamine
- 475.868 Unlawful manufacture of 3,4 methylenedioxymethamphetamine within 1,000 feet of school
- 475.870 Unlawful delivery of 3,4 methylenedioxymethamphetamine
- 475.872 Unlawful delivery of 3,4 methylenedioxymethamphetamine within 1,000 feet of school
- 475.874 Unlawful possession of 3,4 methylenedioxymethamphetamine
- 475.876 Unlawful manufacture of cocaine
- 475.878 Unlawful manufacture of cocaine within 1,000 feet of school
- 475.880 Unlawful delivery of cocaine
- 475.882 Unlawful delivery of cocaine within 1,000 feet of school
- 475.884 Unlawful possession of cocaine
- 475.886 Unlawful manufacture of methamphetamine
- 475.888 Unlawful manufacture of methamphetamine within 1,000 feet of school
- 475.890 Unlawful delivery of methamphetamine
- 475.892 Unlawful delivery of methamphetamine within 1,000 feet of school
- 475.894 Unlawful possession of methamphetamine
- 475.904 Unlawful manufacture or delivery of controlled substance within 1,000 feet of school
- 475.906 Penalties for distribution to minors 475.992 Unlawful possession, manufacture or delivery *of a controlled substance*
- 161.405 Attempt to commit any of the above listed crimes.

E. Background Checking Company Information:

- 1. Any background check vendors are acceptable so long as the criteria of the background check matches that outlined in the "Background Checking Procedure". Suggested Vendors include:
  - a. Advanced Reporting (<https://advrep.com/orschools/>)  
PO Box 12398  
Salem, OR 97309  
503-375-0451
  - b. Criminal Information Services (<http://www.criminalinfo.com/index.php>)  
PO Box 7235  
Beaverton, OR 97007  
503-591-1355

1.4 BUILDING SECURITY RULES

- A. The Contractor shall enforce strict discipline and good order among the Contractor's employees, subcontractors and other persons carrying out the contract while on District property. The District may require that the Contractor's employee or other person carrying out the contract be immediately removed from the project site and District property if the District finds them to be objectionable.
- B. If onsite during school hours/during school session, Contractor will check-in with the main office. Anytime a visit of this nature is planned it should be scheduled with the District Project Manager at least 24 hours in advance. If system shut downs are required notice of at least 48 hours is required.

**SECURITY PROCEDURES**

- C. A District representative must be present onsite when a Contractor is performing work within an existing school facility. This representative will deactivate the security system upon arrival and re-activate it upon leaving. This process cannot be performed by a Contractor or anyone other than a District representative.
- D. Contractor will provide badges for each employee and person carrying out the contract. These badges are to be visible and worn at all time when onsite.
- E. The Contractor shall have a Responsible Party (i.e., superintendent, foreman, supervisor) onsite at all times during any work being performed by either their own forces or that of their subcontractors.
- F. The Responsible Party shall check-in with the District representative upon arrival. They will check-out with the District representative when all work is complete, Contractor personnel has left, and the area is secure.
- G. The Responsible Party shall be accountable for the security in area where work is being performed as well as ingress and egress to that area.
- H. A District representative will be issued a building key to allow access to any areas where work is being performed.
- I. The Contractor shall maintain a daily log defining what areas within the building were accessed by Contractor and Subcontractor personnel.
- J. Each of the Contractor's employees, subcontractors' employees and principals/owner involved at site may, at the option of the District, be subject to a security check, at any time, through the District Security Department, Beaverton Police Department, Washington County Sheriff's Department or other venue.

**1.5 OTHER SECURITY REQUIREMENTS**

- A. Smoking and any use of tobacco products is not allowed within 50 feet of the campus property. Contractor may be fined up to \$500 for each incident of tobacco use within the area of work by the Contractor or Subcontractors.
- B. Firearms are not allowed on campus property. Law enforcement will be contacted if any contractor personnel are in possession of a firearm on site. (This includes firearms locked up in a vehicle.)
- C. Abusive, inappropriate, and/or foul language is strictly prohibited on active campus projects. Employees who abuse this rule will be asked to leave the project site.
- D. Contractor is responsible to maintain security of building per BSD operating procedures. Failure to do so will result in a fine being levied by BSD.

**END OF SECTION**



**DELEGATED DESIGN PROCEDURES**

**PART 1 - GENERAL**

**1.1 SUMMARY**

- A. This Section includes administrative and procedural requirements for Delegated Design components of the Work.
- B. Sections with delegated design components include but are not limited to the following:
  - 1. Division 22 - Plumbing: Seismic Anchorage.
  - 2. Division 23 - HVAC: Seismic Anchorage.
  - 3. Division 26 - Electrical: Interior electrical work associated with the Seismic Upgrade
  - 4. Division 28 - Electronic Safety and Security: Connection and programming of the new card reader at the modified entry door
- C. Project Record Requirements (also see 01 70 00 - Execution and Closeout Requirements).

**1.2 DEFINITIONS**

- A. Delegated Design: Certain components of the Work for which Contractor shall coordinate and assume or assign responsibility for design, engineering, calculations, permitting, submittals, fabrication, transportation, and installation. (Also called "Design-Build" components).
  - 1. Delegated Design components shall be complete systems that perform their intended functions.
- B. Permit Authority: All authorities having local jurisdiction (AHJ).
- C. Architect or Engineer of Record: BBL Architects or their consulting engineer.

**1.3 PERFORMANCE REQUIREMENTS**

- A. Permit: Submit design and calculations to the AHJ and secure permit for Delegated Design component:
  - 1. Separate approval is required for each Delegated Design component.
  - 2. Pay for permit and permit review.
- B. Comply with current codes and regulations, except where more stringent requirements are specified.
- C. Engineer Delegated Design portions for gravity, lateral and seismic loads.
  - 1. Load criteria is indicated in Structural Drawings. If not indicated, request criteria.
  - 2. Indicate reactions to structure.
  - 3. Provide services of a qualified professional engineer licensed in the Project jurisdiction.
- D. Calculate and complete energy forms required by AHJ.
- E. Execute the design intent as indicated in Project Drawings and Specifications.
- F. Obtain Permits and inspections and pay fees required by AHJ.

**DELEGATED DESIGN PROCEDURES****1.4 SUBMITTALS**

- A. Comply with pertinent provisions of Section 01 33 00 - Submittal Procedures.
  - 1. Submit permit submittal to Architect for review prior to submitting to Permit Authority.
  - 2. Architect will return copies to contractor for submittal to Permit Authority with "Reviewed" stamp.
  - 3. Delegated Design permit submittal is in addition to product data, shop drawing and sample submittals required for construction.
- B. Indicate design criteria, design assumptions, details, calculations, submittals, instructions for fabrication, assembly, installation and interface with other trades, unless noted otherwise in the specific Specification Section.
- C. Design and Calculations: Engineer's seal and calculations for that portion of Work by engineer licensed to practice in the State of Oregon.
  - 1. Submittals without required calculations, without the Delegated Design Engineer's seal, or which have not been reviewed by Contractor will not be reviewed by Architect or Engineer of Record.
- D. Permit Authority Requirements:
  - 1. Comply with Permit Authority policies regarding Delegated Design components of building projects.
  - 2. Provide a minimum of three sets of design drawings clearly and legibly showing all members, dimensions, connections, materials used, and indicating how the part is attached to the main structure. Confirm with permitting agency for required number of permit review sets required.
    - a. Drawings shall be prepared, designed, and sealed by an Engineer licensed by the State of Oregon.
    - b. Drawings shall be signed indicating General Design Conformance by Architect or Engineer of Record.
    - c. Shop drawings or erection drawings are not acceptable as Delegated Design drawings.
  - 3. Provide a minimum of three of sets of calculations including criteria, design assumptions, substantiating computations, and such additional data sufficient to show the correctness of the plans and compliance with the structural provisions of the Building Code. Confirm with permitting agency for required number of calculation sets required.
    - a. Calculations shall be prepared and sealed by the Delegated Design Engineer who prepared and sealed the drawings.
    - b. Calculations shall be signed by the Architect or Engineer of Record indicating acceptance of design concepts, loading criteria, and compatibility of designs.
  - 4. Submit a Contractor Design Summary Sheet (when required by Permit Authority) listing Delegated Design subcontractors and their registered Delegated Design Engineer's name and phone number prior to main permit issuance.
- E. Architect's or Engineer of Record's review of Delegated Design submittals will be for design intent and shall not lessen nor shift the responsibility from Contractor or the assigned subcontractor to Owner nor to the design professional. The Owner shall not be responsible for paying for any delays, additional products, additional hours of work, or overtime, restocking or rework required due to failure by the Contractor or the sub-contractor to coordinate their Work with the Work of other trades on the project requiring permit by agency or to provide the Delegated Design portion or component in a timely manner to meet the schedule of the project.



**DELEGATED DESIGN PROCEDURES**

- F. Project Record Documents and Electronic Format Requirements for Delegated Design Components and Systems.
1. Provide the Owner with two (2) copies of all Record Document drawings and specifications in electronic form on CD Rom as follows:
    - a. Content:
      - 1) Record Documents shall contain all revisions made to the project by Addenda, Change Orders, shop drawing review and other modifications. The files shall be compiles as follows:
        - (a) Update all delegated design CAD files indicating the as-built conditions.
        - (b) The Contractor shall add the following, (see Format):
          - (1) Measured horizontal and vertical dimensions and locations of delegated design components and systems.
          - (2) Measured locations of appurtenances concealed in construction, referenced to visible and accessible features of the Work.
          - (3) Field changes of dimension and detail
          - (4) Details not on original Contract drawings and associated with the delegated design.
          - (5) Note to be included on each Sheet of Record Documents: "Project Record Documents - This document has been prepared using information furnished by (list Design Source Contractor Name, date, etc.)."
    - b. Format:
      - 1) Files saved in latest AutoCAD format.
      - 2) All external reference files are to be bound, but need not be exploded.
      - 3) There should be only one (1) file for each and every drawing sheet. The file name will include the sheet number. For example A41.dwg., E32 dwg. or L2 dwg. will include the Architects' project number is optional but should be consistent through-out all drawings.
      - 4) No more than one (1) Paper Space layout per drawing. Files are to be saved as they should look ready to plot, and will exactly match the plotted Record Documents.
      - 5) Information added to the CAD files by the contractors, such as measured depths of foundations and utility location dimensions, should be put on a separate layer. These are to begin with an X, for example "X-GenC-Note" for notes, or "X-GenC-Dims" for dimensions.
      - 6) Other CAD information modified or moved by the Contractor should be located on its original layers.
- G. AHJ Approved Documents: Submit one copy of final approved documents from AHJ via e-Builder.

1.5 **QUALITY ASSURANCE**

- A. Documentation: Comply with the following:
1. Uniform Drawing System
  2. Minimum text size: 1/8 inch
  3. Legible when microfilmed
  4. Other requirements by Permit Authority
- B. Design Requirements: Refer to requirements within individual specification sections.

**DELEGATED DESIGN PROCEDURES**

- C. Delegated Design Engineer Qualifications: A professional engineer who is legally qualified to practice in State of Oregon and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of Delegated Design components that are similar to those indicated for this Project in material, design, and extent.

**1.6 SCHEDULING AND COORDINATION**

- A. Comply with Permit Authority requirements current at time of submission.
- B. Submit material required by Permit Authority so that Permit Authority's review will not adversely affect construction schedule.
  - 1. Prior to submittal, meet with Permit Authority to identify Delegated Design components and review submittal requirements.
- C. Completed submission of Delegated Design documents prior to issuance of the building permit, when required by Permit Authority.
  - 1. Permit for Delegated Design must be issued and paid prior to fabrication.
- D. Owner will not be responsible for paying for any delays, additional products, additional hours of work, overtime, restocking or rework required due to failure by the Contractor to coordinate Delegated Design work or to execute Delegated Design work in a timely manner.

**PART 2 - PRODUCTS (NOT USED)**

**PART 3 - EXECUTION (NOT USED)**

**END OF SECTION**

**REGULATORY REQUIREMENTS****PART 1 – GENERAL****1.1 WORK INCLUDED**

- A. Permit Applications: The Owner's Architect, Engineers, and Consultants will typically file the applications and the District will directly pay the regulating agency for the following:
  - 1. Plan review fees.
- B. Permits and Fees: The Contractor will pay the following permit fees and will invoice the District who will compensate the Contractor as a direct expense (no markup) item that is **not** included in the Contract:
  - 1. Building permit.
  - 2. All other permits, fees and licenses required of the Contractor to perform the work will be paid by the Contractor and included in contract value.
  - 3. BSD will reimburse the Contractor for the actual cost of the building permit, permanent utility connection permits and fees, and permits required for construction of work in the public right and associated bonds or assurances. Any other required permits including trade permits and governmental fees, licenses and inspections necessary for proper execution and completion of the Work, and any penalties, extensions or fines assessed to the above permits or fees shall be paid by the Contractor.
    - 1. The Contractor shall submit an invoice for direct payment of the BSD reimbursed permits, along with a copy of the permit and receipt from the issuing jurisdiction. Payment of permit fees is a Reimbursable Expense of actual cost only and will not be incorporated into the Contract by Change Order.
  - 4. The Contractor shall secure and closeout all permits. BSD will pay building plan review and application fees applicable to the project.
    - 1. Typical Permits and Fees to be paid by Contractor as a part of the cost of the work, including but not limited to:
      - a. Deferred Submittal Fees
      - b. Demolition Permit Fee
      - c. Other permits or fees required during the construction phase
- B. The Contractor shall be responsible for securing and paying for all permits and fees in a timely manner so not to impede the progress of the Work.
- C. BSD will pay the initial building and/or plan check fees. Contractor shall pay for design build or subsequent application and/or plan check fees.

**END OF SECTION**



**REFERENCES**

**PART 1 - GENERAL**

**1.1 SECTION INCLUDES**

- A. Codes, Ordinances and Regulations.

**1.2 RELATED DOCUMENTS**

- A. Bidding Requirements.
- B. Conditions of the Contract.
- C. Drawings and Specifications.

**1.3 CODES, ORDINANCES AND REGULATIONS**

- A. All work shall comply with the Codes, Ordinances and Regulations
  - 1. General Construction Work:
    - a. 2019 Oregon State Structural Specialty Code (Based on the 2018 International Building Code).
    - b. State of Oregon Rules and Regulations of the State Board of Health.
    - c. Local Air Pollution Control and Agency and/or the Department of Environmental Quality, State of Oregon.
    - d. Department of Labor and Industries, State of Oregon.
    - e. Oregon Occupational Safety and Health Administration.
- B. Comply with all applicable fire codes, plumbing codes, mechanical codes and electrical codes.
- C. Comply with requirements of Washington County and State of Oregon Departments of Health. Comply with the requirements of the State of Oregon regarding the listing and handling of hazardous materials.
- D. Comply with requirements of the State of Oregon, Department of Environmental Quality.
- E. All temporary facilities and construction procedures shall comply with requirements of local and State Health codes and the United States Department of Labor, Occupational Safety and Health Administration (OSHA) Standards. (EPA).

**1.4 SPECIFICATION OF HIGHER STANDARD**

- A. Drawings and Specifications govern whenever Drawings and Specification require higher standards than are required by referenced codes and regulations.

**PART 2- PRODUCTS (Not Used)**

**PART 3- EXECUTION (Not Used)**

**END OF SECTION**



**QUALITY CONTROL**

**PART 1 - GENERAL**

**1.1 WORK INCLUDED**

- A. The Owner will select, employ, and pay for services of an independent testing laboratory to perform inspections, sampling, testing, and other services required by the local building code and the Project Manual.
  - 1. Special inspections by independent inspection and testing laboratory services shall be provided by the District.
  - 2. The District may contract an independent consultant to review design and construction of the building envelope with particular emphasis in the areas of water intrusion.
- B. Specific quality control requirements are specified in individual Project Manual Sections.
- C. Inspection and testing services are intended to determine compliance of the Work with requirements specified.
- D. Refer to the Structural Notes on the Drawings (Sheet S0.2) for the special inspection and testing plan.

**1.2 SUBMITTALS**

- A. Submit a certified written report of each inspection, test, or similar service to the Architect, Structural Engineer, Contractor, and the Owner. Include additional copies of each report to governing authorities when so directed.
- B. Report Data: Written inspection or test reports shall include:
  - 1. Name of testing agency or test laboratory.
  - 2. Date and location of samples, tests, or inspections.
  - 3. Names of individuals present.
  - 4. Complete inspection or test data.
  - 5. Test results.
  - 6. Interpretations.
  - 7. Recommendations.

**PART 2 - PRODUCTS**

**2.1 SCOPE**

- A. Nature and Scope of Testing Services: In accordance with the requirements of governing authorities having jurisdiction over the work and as otherwise specified and consistent with reasonable standards of engineering practice.

**PART 3 - EXECUTION**

**3.1 SPECIAL INSPECTION AND TESTING**

- A. Special inspection will be provided by the owner based on the requirements of the OSSC summarized in the Special Inspection and Testing Program on Structural Notes, Sheet S0.2. Contractor shall provide sufficient notice and access for the Special Inspector to perform these inspections.

**3.2 TESTING LABORATORY'S RESPONSIBILITIES**

- A. Conduct, interpret tests, and report deviations or conditions that may lead to deviations from the Contract Documents to the Architect immediately by telephone.

**QUALITY CONTROL**

- B. State in each test report whether or not tests showed conformance with requirements of the Contract Documents and specifically note deviations, if any, from these requirements.

**3.3 CONTRACTOR'S OBLIGATIONS**

- A. Cooperate with any representative of the Owner or the Testing Laboratory. Furnish tools, materials, equipment, and assistance.
- B. Notify the Architect, Testing Laboratory, and Owner 48-hours prior to each expected placement, installation, or fabrication phase requiring inspection tests as indicated herein.
- C. Where tests reveal defects requiring replacement, retest as required under this Contract at no change in Contract amount and reimburse Owner, Architect, and Consultants costs for preparation and supervision.
- D. When the initial tests indicate non-compliance with the Contract Documents, any subsequent retesting occasioned by non-compliance shall be performed by the same agency and the cost thereof borne by the Contractor.
- E. Representatives of the testing agency shall have access to the work at all times. The Contractor shall provide facilities for such access in order that the agency may properly perform its functions.
- F. Any testing laboratory stand-by time due to the Contractor's delays shall be paid for by the Contractor.
- G. Inspection or testing performed exclusively for the Contractor's convenience shall be the sole responsibility of the Contractor.

**3.4 TEST OBSERVATIONS**

- A. If the Architect wishes to observe the inspections, tests, or approvals required by this paragraph, he will do so promptly and, where practicable, at the source of supply.
- B. Neither the observations of the Architect in his Administration of the Construction Contract, nor inspections, tests, or approvals by persons other than the Contractor shall relieve the Contractor from his obligations to perform the Work in accordance with the Contract Documents.

**3.5 EVALUATION OF TESTS AND INSPECTIONS**

- A. Results of laboratory or field control tests and inspections shall be the principal basis upon which satisfactory completion of the Work shall be judged.
- B. If results of tests and inspections indicate the Work is below requirements of the Contract Documents, that portion of the Work is subject to condemnation.

**3.6 ADJUSTMENTS**

- A. Remove and replace Work so condemned at Contractor's expense including costs of subsequent tests and inspections until the Work meets requirements of the Contract Documents.



**QUALITY CONTROL****3.7 STRUCTURAL OBSERVATION PROGRAM**

- A. The Structural Engineer of Record (SER) shall perform structural observation based on the requirements of the 2018 International Building Code (IBC) and the 2019 Oregon Structural Specialty Code (OSSC). Refer to General Structural Notes on Sheet S0.2 for tabulation of structural observation items and additional requirements. Structural observations shall be made at the stages of Construction therein listed. Provide sufficient notice and access to the Structural Engineer of Record (SER) for the SER to perform required observations.

**END OF SECTION**



**TEMPORARY UTILITIES****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Remodels and Renovations: BSD will provide access to water and electrical as required. Contractor to provide all other temporary utilities.
- B. Contractor to provide all temporary job site facilities, materials, systems and services as required to complete the work and as hereinafter listed. Upon completion of the work, remove all temporary structures and materials. All necessary temporary facilities shall be furnished and paid for by the subcontractor unless specifically noted herein to be paid for by the Owner. All temporary facilities to be in place prior to construction.

**1.2 SITE MAINTENANCE**

- A. Progress Cleaning:
  - 1. Maintain areas free of waste materials, debris and rubbish. Maintain site in a clean and orderly condition ON A DAILY BASIS.
  - 2. Remove debris and rubbish from pipe chases, plenums, attics, crawl spaces and other closed or remote spaces, prior to enclosing the space ON A DAILY BASIS.
  - 3. Broom and vacuum clean interior areas prior to start of surface finishing and continue cleaning to eliminate dust ON A DAILY BASIS.
  - 4. All construction debris and storage will be kept in an orderly, neat and organized fashion, and within the areas of work. Areas of work shall be free of construction debris ON A DAILY BASIS AT A MINIMUM.
  - 5. At existing building sites, Contractor shall provide secured construction dumpsters and shall not intermingle trash with school dumpsters.

**END OF SECTION**



**CONSTRUCTION FACILITIES****PART 1 - GENERAL****1.1 DESCRIPTION**

- A. Temporary Construction Offices: Contractor shall provide temporary construction offices. Coordinate location with BSD Representative.
- B. Contractor to provide drawing of acceptable areas for contractor staging, trailer locations and contractor parking on site plan(s). Owner will review.
- C. Project Personal Identification. All contract personnel shall wear an ID badge that is a distinctive color with the word "Contractor" on the badge. The badge must be worn by any contract personnel within existing buildings. Contractor's Superintendent to issue badges and maintain process.

**1.2 SANITARY FACILITIES**

- A. Workmen will not be permitted to use existing toilet facilities of the existing building. Provide portable facilities and drinking water as required for workmen. Keep facilities clean and in sanitary condition. Remove from the site upon completion of the Work.
- B. Comply with governing regulations including safety and health codes for the type, number, location, operation, and maintenance of fixtures and facilities.
- C. Supply toilet tissue, hand sanitizer, and similar disposable materials as appropriate for each facility. Provide covered waste containers for used material.

**1.3 TEMPORARY TELEPHONE**

- A. Contractor shall not use existing phone service. A separate cell and fax service will need to be provided by the Contractor at the job site office.

**1.4 TEMPORARY WATER**

- A. Existing water services may be used. Make temporary connection, as required. Exercise control over usage to conserve water.

**1.5 TEMPORARY ELECTRICAL POWER SERVICE**

- A. Existing electrical services may be used. Make temporary connection, as required. Exercise control over usage to electricity.
- B. Provide temporary lighting throughout construction period as required by governing agencies.

**PART 2 - PRODUCTS (Not Used)****PART 3 - EXECUTION****3.1 INSTALLATION**

- A. Use qualified tradesmen for installation.

**CONSTRUCTION FACILITIES**

- B. Locate temporary services and facilities where they will serve the project adequately and result in minimum interference with the Work.
- C. Temporary Utility Installation:
  - 1. Engage the local utility company to install temporary service or to make connections to existing service.
  - 2. Arrange with the companies and existing users for an acceptable time when service can be interrupted to make connections.
  - 3. Establish a service implementation and termination schedule. As early as possible change to use of permanent service, to enable removal of the temporary utility, and to eliminate any possible interference with completion of the Work.
  - 4. Provide adequate capacity at each stage of construction.
  - 5. Prior to availability at the site, provide trucked-in services for start up of construction operations.
  - 6. Obtain and pay for easements required to bring temporary utilities to the site where the Owner's easement cannot be utilized for that purpose.

**3.2 OPERATION, TERMINATION, AND REMOVAL**

- A. Supervision:
  - 1. Limit availability of temporary services and facilities to essential and intended uses to minimize waste and abuse.
  - 2. Do not permit temporary installations to be abused or endangered.
- B. Maintenance:
  - 1. Operate and maintain temporary services and facilities in good operating condition and in a safe and efficient manner until removal is authorized.
  - 2. Do not overload services or facilities.
  - 3. Protect from damage by freezing temperatures and similar elements.
  - 4. Do not allow unsanitary conditions, public nuisances, or hazardous conditions to develop or persist on the site.
  - 5. Maintain operation of temporary enclosures, heating, cooling, humidity control, ventilation, and similar facilities on a 24 hour basis where required to achieve indicated results and avoid the possibility of damage to the Work or to temporary facilities.

**3.3 TERMINATION AND REMOVAL**

- A. Remove each temporary service and facility promptly when need has ended, or when replaced by use of a permanent facility, but no later than Substantial Completion.
- B. Complete, or if necessary, restore permanent work delayed because of interference with the temporary service or facility.
- C. Repair damaged work, clean exposed surfaces, and replace work that cannot be repaired.
- D. At Substantial Completion, clean and renovate permanent services and facilities that have been used to provide temporary services and facilities during the construction period.

**END OF SECTION**

**COMMON PRODUCT REQUIREMENTS****PART 1 – GENERAL****1.1 MATERIAL AND EQUIPMENT SELECTION**

- A. Comply with Standards and these Specifications including size, make, type, and quality specified, or as accepted in writing by the Architect.
- B. All products shall be new and of current manufacture unless otherwise specified.
- C. All similar products shall be of the same manufacturer.
- D. Manufactured and Fabricated Products:
  - 1. Design, fabricate, and assemble in accordance with the best engineering and shop practices.
  - 2. Manufacture like parts of duplicate units to standard sizes and gauges and to be interchangeable.
  - 3. All similar products shall be of the same manufacturer. Two or more items of the same kind shall be considered identical and by the same manufacturer.
  - 4. Provide products suitable for service conditions.
  - 5. Adhere to equipment capacities, sizes, and dimensions shown or specified unless variations are specifically approved in writing.
- E. Do not use material or equipment for any purpose other than that for which it is designed or is specified.
- F. Fabricate and install equipment to deliver its full rated capacity at the efficiency for which it was designed.
- G. Select and install equipment to operate at full capacity without excessive noise or vibration.
- H. Provide electrical products with Underwriter's Laboratories Label or as approved by the local inspection authority.
- I. Any software provided with products shall be provided with appropriate licensing and use agreements for a minimum of 10 years.

**1.2 MANUFACTURER'S INSTRUCTIONS**

- A. Perform work in accordance with manufacturer's printed installation instructions, obtain and distribute copies of such instructions to parties involved in the installation, including 3 copies to the Architect.
- B. Maintain one set of complete instructions at the job site during installation and until completion.
- C. Handle, install, connect, clean, condition, and adjust products in strict accordance with manufacturer's printed instructions and in conformity with specified requirements.
  - 1. Consult with the Architect for further instructions should job conditions or specified requirements conflict with manufacturer's instructions.
  - 2. Do not proceed with work without clear instructions.
- D. Do not omit any preparatory step or installation procedure unless specifically modified or exempted by the Contract Documents.

**END OF SECTION**





**PRODUCT OPTIONS**

**PART 1 – GENERAL**

**1.1 PRODUCT OPTIONS**

- A. Specifications for public improvement contracts may not expressly or implicitly require any product by any brand name or mark, nor the product of any particular manufacturer or seller unless the product meets exemption criteria under ORS 279C.345. Consult with BSD representative if seeking an exception.
- B. “Any brand” with standard of quality, performance and other characteristics clearly described, is the preferred specification and requires no specific approval by the BSD representative.
- C. Single Product Named: For products specified by naming one product or manufacturer and "or accepted substitute", the Contractor must submit a request for substitution for any product or manufacturer not specifically named. Submittal is to be in accordance with this Section. “Brand X” or approved equal specification may be used, when the use is advantageous for the District, because the brand name describes the standard of quality, performance and other characteristics of the product needed by the District. Specific approval by BSD representative is required.
- D. Two or More Products Named: For products specified by naming several products or manufacturers and "or accepted substitute", select any one of the products or manufacturers named, provided the product selected complies with the specifications. If another product or manufacturer not named is to be used, the Contractor must submit a request for substitution for that product or manufacturer in accordance with this Section.
- E. “Or Accepted Substitute” and "Or Equal" Provisions: Where products or manufacturers are specified by name accompanied by the term “or accepted substitute” or "or equal", provide either the product named or comply with the requirements for gaining approval of "substitutions" for the use of an unnamed product. BSD approval is required. May be used when the use is advantageous to the District, because the brand name describes the standard of quality, performance, and other characteristics of the product needed by the District. “Brand X” only specifications should rarely be used and only under conditions listed in ORS 279C.345 Specifications for contracts; exemptions.

It is unlikely that the exemption will encourage favoritism in the awarding of public improvement contracts or substantially diminish competition for public improvement contracts;

The specification of a product by brand name or mark, or the product of a particular manufacturer or seller, would result in substantial cost savings to the contracting agency;

There is only one manufacturer or seller of the product of the quality required; or

Efficient utilization of existing equipment or supplies requires the acquisition of compatible equipment or supplies.

- F. No materials or products containing any hazardous materials are to be used in the construction of this project. If any material or product specified in this Project Manual is known to contain hazardous materials, it shall be brought to the attention of the Architect and Owner before ordering or fabricating that material or product.

**END OF SECTION**



**OWNER FURNISHED PRODUCTS**

**PART 1 - GENERAL**

1.1 DESCRIPTION

- A. Owner shall furnish items as herein listed.

1.2 SUBMITTALS

- A. Product Data: Owner shall provide available product data to Contractor for reference.
- B. Shop Drawings: Owner shall provide available product shop drawings and installation diagrams to Contractor for reference.
- C. Installation Instructions: Owner shall provide available product installation instructions to Contractor for reference.

**PART 2 – PRODUCTS**

2.1 OWNER FURNISHED PRODUCTS:

- A. Owner Furnished – Contractor Installed Products:

<u>Items</u>	<u>Anticipated Delivery Date</u>
AED in recessed cabinet	TBD

- C. Salvaged Existing Items – Contractor Installed Products:

<u>Items</u>	<u>Anticipated Delivery Date</u>
Gym Equipment shown on the drawings	NA - Salvaged Item
Phone	NA - Salvaged Item
Clock	NA - Salvaged Item
Markerboards and tackboards	NA - Salvaged Item
Stage audio and lighting controls	NA - Salvaged Item
Stage Curtain (Back drop curtain)	NA - Salvaged Item

**PART 3 – EXECUTION**

3.1 INSTALLATION

- A. Install Owner Furnished – Contractor Installed Products: Install at locations indicated on Drawings. Provide all required plumbing and wiring to make products operational.

**END OF SECTION**



**PRODUCT DELIVERY REQUIREMENTS**

**PART 1 - GENERAL**

**1.1 TRANSPORTATION**

- A. Arrange deliveries of products in accord with construction schedules; coordinate to avoid conflict with work and conditions at the site.
  - 1. Deliver products in undamaged condition and in manufacturer's original containers or packaging with identifying labels intact and legible.
  - 2. Immediately upon delivery, inspect shipments to assure compliance with requirements of the Contract Documents and to assure products are properly protected and undamaged.
- B. Provide equipment and personnel to handle products by methods to prevent soiling or damage to products or packaging.

**END OF SECTION**



**PRODUCT STORAGE AND HANDLING REQUIREMENTS****PART 1 - GENERAL****1.1 STORAGE AND PROTECTION**

- A. Store products in accordance with manufacturer's instructions with their seals and labels intact and legible.
  - 1. Store products subject to damage by the elements in weather tight enclosures.
  - 2. Maintain temperature and humidity within the ranges required by the manufacturer's instructions.
  - 3. Protect equipment and systems from moisture, chemical, or mechanical damage before and after installation.
  - 4. Protect shafts and bearing housings from rust.
- B. Exterior Storage:
  - 1. Store fabricated products above the ground on blocking or skids to prevent soiling or staining. Cover products that are subject to deterioration with impervious sheet covering. Provide adequate ventilation to avoid condensation.
  - 2. Store loose granular materials in a well-drained area on solid surfaces to prevent mixing with foreign matter.
- C. Inspection: Arrange storage in a manner to provide easy access for inspection. Make periodic inspections of stored products to assure that products are maintained under specified conditions and free from damage or deterioration.
- D. Protection after Installation:
  - 1. Provide substantial coverings as necessary to protect installed products from damage by traffic or subsequent construction operations.
  - 2. Plug or cap pipe and conduit openings to prevent the entrance of foreign matter.
  - 3. Remove when no longer needed.

**END OF SECTION**





**CLEANING AND WASTE MANAGEMENT****PART 1 - GENERAL****1.1 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL**

- A. District sustainability goals require that this Project generate the least amount of waste possible. Every effort shall be made to minimize waste generated due to poor planning, breakage, mishandling, contamination, or other factors. Waste that is generated shall be reused, salvaged, or recycled when economically feasible. Waste disposal in landfills shall be minimized in accordance with Metro requirements.

**PART 3 - EXECUTION****3.1 FINAL CLEANING**

- A. Contractor to provide final cleaning of Work prior to Substantial Completion Inspection.
  - 1. Use cleaning materials that are non-hazardous.
  - 2. Clean equipment and fixtures to a sanitary condition with cleaning materials appropriate to the surface and materials being cleaned.
  - 3. Clean debris from roofs, gutters, downspouts, and drainage systems.
  - 4. Clean site; sweep paved areas, rake clean landscaped surfaces.
  - 5. Remove waste, surplus materials, trash/rubbish, and construction facilities from the site; dispose of in legal manner, do not burn or bury.
  - 6. Re-clean areas or equipment; after Substantial Completion Inspection, or if dirtied as result of Contractor's work in preparing for final inspection or completion of punch list.

**END OF SECTION**



**STARTING AND ADJUSTING**

**PART 1 – GENERAL**

**1.1 WORK INCLUDED**

- A. Comply with requirements of Division 23 HEATING, VENTILATION, AND AIR-CONDITIONING (HVAC).

**PART 2 – PRODUCTS (Not Used)**

**PART 3 – EXECUTION (Not Used)**

**END OF SECTION**



**PROTECTING INSTALLED CONSTRUCTION**

**PART 1 - GENERAL**

**1.1 DESCRIPTION**

- A. Contractor shall adequately protect materials being stored, completed construction, and/or construction in progress so as to prevent damage from subsequent operations or vandalism. This would include but is not be limited to control of traffic to prevent damage to equipment and surfaces and providing coverings to protect finished surfaces from damage.
- B. If materials or construction is damaged due to inadequate protection or vandalism, the Contractor shall clean and repair the Work and/or, at the BSD's representative's direction, replace the Work.

**END OF SECTION**



**CLOSEOUT PROCEDURES****PART 1 - GENERAL****1.1 CONTRACT CLOSEOUT**

- A. Prerequisites to Substantial Completion:
  - 1. Obtain and submit releases enabling Owner's full and unrestricted use of the work and access to services and utilities, including (where required) occupancy permits, operating certificates, and similar releases.
  - 2. Complete final cleaning up requirements, including touch up of marred surfaces.
  - 3. Upon receipt of Contractor's written request for substantial completion inspection, Architect will either proceed with inspection or advise Contractor of prerequisites not fulfilled.
  - 4. Following initial inspection, Architect will either prepare certificate of substantial completion, or advise Contractor of work which must be performed prior to issuance of certificate; and repeat inspection when requested and assured that work has been substantially completed.
  - 5. Results of completed inspection will form initial "punch list" for final acceptance.
- B. Prerequisites to Contract Closeout:
  - 1. Letter referencing the Architect's last punch list by date, stating that all items listed have been completed and requesting a contract completion inspection.
  - 2. Submit final payment request with final releases and supporting documentation not previously submitted and accepted. Include releases and waivers of liens from Contractors subcontractors and material suppliers, in form approved by the Owner. Include certificates of insurance for projects and completed operations where required.
  - 3. Submit updated final statement, accounting for additional (final) changes to Contract sum.
  - 4. Submit certified copy of Architect's final punch list of itemized work to be completed or corrected, stating that each item has been completed or otherwise resolved for acceptance, endorsed and dated by Architect.
  - 5. Submit consent of surety.
  - 6. Revise and submit evidence of final, continuing insurance coverage complying with insurance requirements.
  - 7. Submit specific warranties, workmanship/ maintenance bonds, maintenance agreements, final certification and similar documents, all complete in final form.
- C. Reobservation Fees: Should Architect perform more than one reobservation due to failure of the Work to comply with the claims of status of completion made by the Contractor,
  - 1. Owner will compensate Architect for such additional services, and
  - 2. Owner will deduct the amount of such compensation from the final payment to the Contractor.
- D. Submissions to Ebuilder: Submit all closeout submittals to Ebuilder.

**END OF SECTION**





**CLOSEOUT SUBMITTALS****PART 1 - GENERAL****1.1 CLOSEOUT DELIVERABLES**

- A. As-built documentation shall include the following as a minimum:
  - 1. Documentation of all deviations from the design and/or shop drawing submittals, including products that were changed and the reason for the change.
  - 2. Copies of final test reports and any deficiency lists.
  - 3. Documentation of all deviations in Operation and Maintenance (O&M) information from that provided with original equipment submittals.
  - 4. Other information as itemized in this Section.

**1.2 WARRANTY, MAINTENANCE, AND OPERATIONAL MANUALS**

- A. General:
  - 1. The purpose is to provide BSD with record information necessary for future operation and maintenance of the Project. Organize warranty and operating and maintenance data into suitable sets of manageable size. Bind properly-indexed data in individual binders. Mark appropriate identification on front and spine of each binder.
  - 2. Include the following types of information:
    - a. Emergency instructions
    - b. Spare parts list
    - c. Summary schedule of all warranties
    - d. Copies of warranties and contact information
    - e. Wiring diagrams
    - f. Recommended "turn around" cycles
    - g. Inspection procedures
    - h. Record Shop Drawings and Installed Product Data
    - i. Fixture lamping schedule
    - j. Ballast and driver schedule
  - 3. Provide in one manual, separate manuals if needed because of size.
- B. Format: Bind each manual in a three-ringed, heavy-duty, vinyl-covered hardboard binder. On the cover imprint the Volume title "Equipment Operation and Maintenance Manual"; name of Project, BSD, Architect (include name of appropriate consultant engineer on mechanical and electrical manuals); and date of Substantial Completion; include Contractor's name and date. On bound edge, imprint name of project, BSD, and year of Substantial Completion.
  - 1. Pages that are neat and clean sheets, 8-1/2-by-11-inch maximum size, or accordion foldouts to same size for larger sheets. Use pocket folders for folded sheet information that is larger than 11"x17."
  - 2. Items to be identified with tabbed dividers showing section name and number of appropriate specification sections. Arrange dividers and items in order they occur in specifications.
  - 3. Provide consecutive page number in lower right corner of each page.
- C. Manual will generally include:
  - 1. A table of contents for each volume.
  - 2. A list of all Subcontractors with contact information including emergency phone number at the beginning of each volume.
  - 3. All information needed to operate and maintain systems and equipment provided in the Project presented and arranged in a logical manner for efficient use by the BSD's operating personnel.
  - 4. A list of manufacturers with phone numbers and addresses of local distributors, services representatives, parts dealers, etc. Include 24-hour service representatives when available.
  - 5. Equipment manufacturer, make, model number, size, and nameplate data.

## CLOSEOUT SUBMITTALS

6. Description of system, configuration and operation, including component identification and interrelations. A master control schematic drawings(s) will normally be required for this purpose.
  7. Dimensional and performance data for specific unit provided. Extraneous catalog data must be eliminated.
  8. Manufacturer's recommended cleaning methods and materials.
  9. Manufacturer's recommended operating instructions as appropriate.
  10. Manufacturer's recommended maintenance requirements and preventative maintenance recommendations including lubrication and other servicing data.
  11. Complete parts list, including reordering information, recommended spares, and anticipated useful life (if available). Include name, telephone, and fax numbers of manufacturer's authorized service/parts distribution outlets nearest to Project.
  12. Emergency instructions.
  13. Warranties/guarantees.
  14. Extra stock receipts.
  15. Training schedule.
- D. Manual to include the following tabs:
1. Table of contents
  2. Contact list
  3. Certificate of substantial completion
  4. Contractor statement of warranty
  5. Lead and asbestos free certification letter
  6. Certificate of occupancy
  7. Final permit inspection approvals
  8. Product data and warranties
    - a. Product data, warranty and shop drawings to be included.
    - b. Electronic Manuals: For each product, provide a pdf for the O&M and a pdf for the warranty, each named according to CSI/Specification number. Include a pdf of shop drawings if applicable.
- E. Review Procedures:
1. Prior to binding, submit an electronic O&M Manual for preliminary review/acceptance; submit via eBuilder. Preliminary copy shall be complete, except include temporary cover showing intended layout for final cover and bound edge.
  2. Upon approval of preliminary copy, prepare and submit to BSD **one** final **copy** of each manual.
- F. Provide final O&M Manual, final and complete as built files, specifications, as built drawings set in PDF format, redlined record drawings and permit drawings. Submit via eBuilder.
1. Final and complete sets of as built drawings shall accurately and cleanly reflect as-built conditions.
  2. The AHJ Stamped Drawings are acceptable in either print or electronic format.
- G. Submissions to Ebuilder: Submit all closeout submittals to Ebuilder.

## 1.3 CERTIFICATIONS

- A. Asbestos Free Certification:
1. Absolutely no materials containing asbestos are to be provided or installed as part of this Project. The Contractor shall ensure that no subcontractor or any of Contractor's own forces installs any materials containing asbestos. At final closeout of the Project, the Contractor shall provide to the School District certification that no materials containing asbestos have been installed in the Project and that the Project is asbestos free as required by the State of Oregon.

**CLOSEOUT SUBMITTALS**

- B. Lead Free Certification: Absolutely no materials containing lead are to be provided or installed as part of this Project. The Contractor shall ensure that no subcontractor or any of Contractor's own forces installs any materials containing lead. At final closeout of the Project, the Contractor shall provide to the School District certification that no materials containing lead have been installed in the Project and that the Project is lead free as required by the State of Oregon.
- B. Certificate of Occupancy.
- C. Final permit inspection and approvals.

**1.4 PROJECT RECORD DOCUMENTS**

- A. General:
  - 1. Contractor shall not use Record Documents for construction purposes; protect from deterioration and loss in a secure location; provide access to Record Documents for BSD's reference during normal working hours.
- B. Contractor's Redlines and As-Builts:
  - 1. Contractor to maintain a clean, undamaged set of prints of Contract Drawings and Shop Drawings for preparation of Contractor's Redlines and As-Builts. Mark the set to show the actual installation where the installation varies substantially from the Work as originally shown. Mark whichever drawing is most capable of showing conditions fully and accurately. Where Shop Drawings are used, record a cross-reference at the corresponding location on the Contract Drawings. Give particular attention to concealed elements that would be difficult to measure and record at a later date.
  - 2. Mark Contractor's Redlines and As-Builts with red erasable pencil. Use other colors to distinguish between variations in separate categories of the Work.
  - 3. Mark new information that is important to the BSD, but was not shown on Contract Drawings or Shop Drawings.
  - 4. Note related Change Order numbers where applicable.
  - 5. Contractor's Redlines and As-Builts shall be the same size. Paper sizes are limited to ANSI B Plot (11"x17"), ANSI D Plot (24"x36"), and ARCH E1 Plot (30"x42").
  - 6. Organize sheets into manageable sets, bind with durable paper cover sheets, and print suitable titles, dates, and other identification on the cover of each set.
  - 7. Create copy of mechanical, electrical, and plumbing "As Built" Sets and submit directly to BSD Representative at Substantial Completion via eBuilder.
    - a. Final and complete sets of as built drawings shall accurately and cleanly reflect as-built conditions.
  - 8. Deliver complete Contractor's Redlines and As-Builts to the Architect. An electronic copy of Contractor's Redlines and As-Builts to be given to the Owner at the end of the Project via eBuilder.
    - a. Final and complete sets of as built drawings shall accurately and cleanly reflect as-built conditions.
  - 9. Architect will thereafter prepare Record Set incorporating Contractor's Redlines and As-Builts.
- C. Record Specifications:
  - 1. Contractor to maintain one complete copy of the Project Manual, including addenda, and one copy of other written construction documents such as Change Orders and modifications issued in printed form during construction. Mark these documents to show substantial variations in actual Work performed in comparison with the text of the Specifications and modifications. Give particular attention to substitutions, selection of options and similar information on elements that are concealed or cannot otherwise be readily discerned later by direct observation. Note related Record Drawing information and Product Data.

**CLOSEOUT SUBMITTALS**

2. Upon completion of the Work, submit Record Specifications for the BSD's records. Submit electronic copy via eBuilder at end of Project.
- D. Record Product Data:
1. Contractor to maintain one copy of each Product Data submittal. Mark these documents to show significant variations in actual Work performed in comparison with information submitted. Include variations in products delivered to the site, and from the manufacturer's installation instructions and recommendations. Give particular attention to concealed products and portions of the Work which cannot otherwise be readily discerned later by direct observation. Note related Change Orders and mark-up of Record Drawings and Specifications.
  2. Upon completion of mark-up, submit complete set of Record Product Data to the Architect for the BSD's records. An electronic copy on a thumb drive of Record Product Data to be given to the Owner at the end of the Project.
  3. Any marked-up data to be provided in O&M manual. Do not submit varying versions of the same product data.
- E. Miscellaneous Record Submittals:
1. Refer to other Specification Sections for requirements of miscellaneous record-keeping and submittals in connection with actual performance of the Work. Immediately prior to the date or dates of Substantial Completion, complete miscellaneous records and place in good order, properly identified and bound or filed, ready for continued use and reference. Submit to the Architect for the BSD's records.
- F. Submit 1 hard copy of Final and Complete As-Built Drawing Set to BSD Representative.
1. Provide pdf in eBuilder.
- G. Submit 1 hard copy of Permit Drawing Set with original stamp, signature and date to BSD Representative.
1. The AHJ Stamped Drawings are acceptable in either print or electronic format.
- H. Schedule/Log of Closeout Submittals: Prepare Schedule/Log of Required Submittals specifically related to Closeout and include preparation as a line item in Schedule of Values.

**END OF SECTION**

**PLUMBING MATERIALS AND METHODS****PART 1 GENERAL****1.01 DESCRIPTION**

- A. The provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the plumbing work specified in this Division.
- B. The requirements of this Section apply to the plumbing systems specified in these Specifications and in other Division 22 sections.
- C. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the Drawings and/or in these Specifications, including all labor, supervision, services, permits, fees, and incidentals necessary and required to provide a complete and operable facility with complete systems as shown, specified, and required by applicable codes.
- D. Advise subcontractor, suppliers, and vendors involved in the work specified in this Section of the applicable requirements.

**1.02 QUALITY ASSURANCE**

- A. All work and materials shall conform to all applicable local and state codes and all federal, state and other applicable laws and regulations. All clarifications and modifications which have been cleared with appropriate authorities are listed under the applicable sections. All electrical products shall bear the label of a recognized testing laboratory such as UL or CSA.
- B. Whenever the requirements of the Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.
- C. Codes and Standards: Comply with the provisions of the following referenced codes, standards and specifications:
  - 1. Federal Specifications (FS)
  - 2. American National Standards Institute (ANSI)
  - 3. National Electrical Manufacturer's Association (NEMA)
  - 4. National Fire Protection Association (NFPA)
  - 5. Underwriters Laboratories, Inc. (UL)
  - 6. Factory Mutual (FM)
  - 7. International Building Code (IBC) with State and Local Amendments
  - 8. International Mechanical Code (IMC) with State and Local Amendments
  - 9. Uniform Plumbing Code (UPC) with State and Local Amendments
  - 10. American Society for Testing and Materials (ASTM)
  - 11. Americans with Disabilities Act (ADA)
  - 12. International Fire Code (IFC) with State and Local Amendments
  - 13. Energy Policy Act (EPAct)
  - 14. Manufacturers Standardization Society (MSS)
  - 15. National Sanitation Foundation (NSF)
  - 16. American Gas Association (AGA)
- D. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name. Where two or more units of the same class of equipment are furnished, use product of the same manufacturer; component parts of the entire system need not be products of same manufacturer. Furnish all materials and equipment, new and free from defect and of size, make, type and quality herein specified or

approved by the Architect. All materials shall be installed in a neat and professional manner.

- E. All apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.
- F. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both.
- G. Drawings: Do not scale drawings for roughing-in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings. See Article 3.01 for more requirements. Coordinate work with shop drawings of other specification divisions.
- H. Field Wiring: It is the intent of these specifications that all systems shall be complete and operable. Refer to all drawings and specifications, especially the electrical drawings, to determine voltage, phase, circuit ampacity and number of connections provided. Provide all necessary field wiring and devices from the point of connection indicated on the electrical drawings. All equipment shall be installed in compliance with the Electrical Code and the equipment's UL listing. Bring to the attention of the Architect in writing, all conflicts, incompatibilities, and/or discrepancies prior to bid or as soon as discovered.

#### 1.03 WORK OF OTHER CONTRACTS

- A. Work under this contract shall be conducted in a manner to allow for the future installations of such equipment or items listed in other sections of this Specification.

#### 1.04 WORK OF OTHER DIVISIONS

- A. Work under this Division shall be conducted in a manner to cooperate with the installation of such equipment or items as specified in other Divisions.
- B. HVAC piping systems, fuel piping systems, fire suppression piping systems, and control devices and control wiring relating to the heating and air conditioning systems are specified under other Divisions of these Specifications except for provisions or items specifically noted on the Drawings or specified herein.
- C. Consult all Drawings and Specifications in this project and become familiar with all equipment to be installed. Coordinate all aspects of the construction with the other trades on the job to ensure that all work and materials required to provide a complete and operational facility are included in the bid.
- D. All sections of Division 22 are interrelated and shall be considered in their entirety when interpreting any material, method, or direction listed in any section of Division 22. Individual sections are not written for specific subcontractors or suppliers but for the General Contractor.

#### 1.05 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES (SUBMITTALS)

- A. Submit in accordance with Division 1 full technical and descriptive shop drawing data on proposed materials and equipment as detailed in each section.
- B. The Contractor shall verify that all equipment submitted can be delivered and installed within the time constraints of the construction period.
- C. Include the manufacturer, type, style, catalog number, complete specification, certified dimensions, and description of physical appearance for each item and option submitted. Reproduction of catalog data sheets shall be clean and legible to show all details, including gauge

of metal used.

- D. Include only information on exact equipment to be installed, not general catalogs of the manufacturer. Where sheets show proposed equipment as well as other equipment, identify proposed equipment with rubber stamp arrow or similar concise method.
- E. Submit with each copy a transmittal letter verifying that all included equipment submittals have been carefully considered for quality, dimensions, function, and have been coordinated with the Drawings and Specifications. Guarantee that proposed materials will meet or exceed the quality and function of those specified.
- F. Include field wiring diagrams and connection diagrams for all control and/or low voltage systems, including floor plans.
- G. Submittal Review: The submittal review process is a means to provide quality control. The action noted to be taken (or where conflicts with the contract documents are not noted) shall not be interpreted by the Contractor as automatic "change orders." Approval of the data for substitution and shop drawings shall not eliminate the Contractor's responsibility for compliance with Drawings or Specifications, nor shall it eliminate the responsibility for freedom from errors of any sort in the data discovered prior to or after the review process. Deviations, discrepancies, and conflicts between the submittals and the Contract Documents shall be called to the Architect's attention in writing at the time of transmittal of the data.
- H. Submittals shall be in the form of PDF documents. Arrange submittals numerically with specification sections identified in tabs. All required sections shall be submitted at one time.  
**Partial submittals will be rejected without review.**

#### 1.06 PRODUCT SUBSTITUTION

- A. Materials other than those specified may be approved for this project providing a written request is submitted to the Architect prior to bid in accordance with Instructions to Bidders. Requests shall include complete specifications, dimensions, manufacturer and catalog number for each item for which approval is desired. If, in the opinion of the Architect, the material is not complete or if it is not an acceptable substitute, he may reject it. The Architect's evaluation will be based solely on the material submitted.

#### 1.07 CHANGE ORDERS

- A. All supplemental cost proposals by the Contractor shall be accompanied by a complete itemized breakdown of labor and materials without exception. At the Architect's request, the Contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor must be separated and allocated for each item of work.

#### 1.08 RECORD DOCUMENTS

- A. Project Record (As-Installed) Drawings:
  - 1. Maintain a set of record drawings on the job site as directed in Division 1.
  - 2. Keep Drawings clean, undamaged, and up to date.
  - 3. Record and accurately indicate the following:
    - a. Depths, sizes, and locations of all buried and concealed piping and all cleanouts, whether concealed or exposed, dimensioned from permanent building features.
    - b. Locations of all valves with assigned tag numbers.
    - c. Changes, additions, and revisions due to change orders, obstructions, etc. Eradicate extraneous information.
    - d. Locations of tracer wire terminal points.

- e. Model numbers of installed equipment.
  - 4. Make Drawings available when requested by Architect for review.
  - 5. Submit as part of the required Project Closeout documents. Final submittal will be in the form of reproducible drawings.
  - 6. Quality of entire set of project record drawings to match the quality of the contract documents; quality to be judged by Architect. Computer-aided design drafting (CADD) shall be used to complete project record drawings. Use standards set in contract documents. Note field modifications, all addenda and change order items on project record drawings. If deficiencies are found in either the quality or the accuracy of the drawings, they will be returned unapproved. Additional review of subsequent submissions shall be at the Contractor's expense.
- B. Operating and Maintenance Manuals: Submit Operating and Maintenance Instructions, including manufacturer's service data, wiring diagrams, and parts lists and vendors for all serviceable items of equipment, valve charts, balancing data, final control diagrams showing final set points, duct and piping pressure test reports, equipment startup records, and any additional equipment added by change order. Provide any performance curves, data, and model numbers from submittals. Comply with provisions of Division one where applicable to the mechanical work. Submittal shall be in the form of a PDF file per specification section. Arrange submittals numerically with equipment type or classification identified in tabs. Manufactures O&M manuals shall be provided as a single PDF file that can be hyper-linked by Owner for reference. O&M manuals that are a series of PDF files will not be accepted.

#### 1.09 WARRANTY

- A. Furnish, prior to application for final payment, three copies of written and signed guarantee effective a period of one year from date of completion and acceptance of entire project; agree to correct, repair and/or replace defective materials and/or equipment or the results of defective workmanship without additional expense to the Owner. Where no response satisfactory to the Owner has occurred within three working days from the written report of a warranty covered defect, the Contractor shall agree to pay for the cost of repair of the reported defect by a Contractor of the Owner's choice.
- B. Where the manufacturer's guarantee exceeds one year, the longer guarantee shall govern and include the Contractor's labor.
- C. Warranty period shall begin once all phases of construction are complete.

### PART 2 PRODUCTS

#### 2.01 GENERAL

- A. General: Provide all new materials and equipment, identical to apparatus or equipment in successful operation for a minimum of two years. Provide materials of comparable quality omitted here but necessary to complete the work. Maximum allowable variation from stated capacities, minus 5% to plus 10% as approved in each case.
- B. Compatibility: Provide products which are compatible with other portions of the work and provide products with the proper or correct power and fuel-burning characteristics, and similar adaptations for the project.
- C. Efficiency: Service (Domestic) Water Heating Equipment shall comply with ASHRAE Standard 90.1-2019 and the State Energy code. Where equipment efficiencies are indicated, the use of alternate or substitute manufacturer's equipment with lower efficiencies is not permitted.



- D. Storage and Handling:
1. Delivery: Deliver to project site with manufacturer's labels intact and legible.
  2. Handling: Avoid damage.
  3. Storage: Inside protected from weather, dirt and construction dust. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

## 2.02 VALVES

- A. General: Provide factory fabricated valves of the type, body material, temperature and pressure class, and service indicated. Bronze gate, globe and check valves shall comply with MSS-SP-80. Ball valves shall comply with MSS-SP-110. Iron gate and globe valves shall comply with MSS-SP-70. Iron check valves shall comply with MSS-SP-71. Butterfly valves shall comply with MSS-SP-67. Valve size same as connecting pipe size.
- B. Acceptable Manufacturers: Milwaukee, Crane, Grinnell, Nibco, Hammond, Stockham, Legend, Watts, and Walworth. Grooved end valves Victaulic, Gruvlock, or accepted substitute. NIBCO numbers are given except as noted. Where possible, provide valves from a single manufacturer.
- C. Valve styles: Domestic hot and cold water.
1. Valves 2" and Smaller:
    - a. Ball: Two-piece, Lead free certified, bronze body, full port, 600 psi WOG, Fig. T/S-585-70.
    - b. Check: Lead free certified, Bronze body, swing check, 200 psi WOG, T/S-413B (bronze disc) or T/S-413Y (Teflon disc).
  2. Valves 2" through 12":
    - a. Ball: Three-piece, Lead free certified, bronze body, full port, 600 psi WOG, T/S-595Y.
    - b. Butterfly: Ductile iron body, aluminum bronze disc, 200 psi WOG, Lugged body – LD-2000, Wafer body – WD-2000, Grooved body – GD-4765.
- D. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.
- E. Selection of Valve Ends (Pipe Connections): Select and install valves with ends matching the types of pipe/tube connections.

## 2.03 HANGERS AND SUPPORTS

- A. General: Provide factory-fabricated horizontal piping hangers, clamps, hanger rod, inserts, supports, etc., of the indicated MSS type and size. The Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry Practice SP-58 and SP-69 are referenced in this section.
- B. Manufacturers: B-Line, Carpenter & Paterson, Grinnell, Michigan, Superstrut, Tolco, Erico, or accepted substitute. Grinnell figure numbers in parentheses where applicable (or other manufacturers as noted).
- C. Corrosion Protection: Provide materials which are zinc plated or factory painted to prevent corrosion. Prevent electrolysis in the support of copper tubing by the use of copper hangers (copper coated is not sufficient), strut cushion, or at least 2 layers of UPC 10 mil tape.
- D. Seismic Requirements: Provide seismic restraints in accordance with OSSC Section 1613. Design restraint systems in accordance with "Seismic Restraint Manual: Guidelines for Mechanical Systems," Second Edition, 1998, SMACNA, or "A Practical Guide to Seismic Restraint" ASHRAE RP-812, 1999.

- E. Horizontal Piping Hangers and Supports:
1. Adjustable Clevis Hanger: MSS Type 1 (Fig. 260).
  2. Adjustable Band Hanger: MSS Type 7 (Fig. 97), fabricated from steel.
  3. Adjustable Swivel-Band Hanger: MSS Type 10 (Fig. 70).
  4. Clamp: MSS Type 4 (Fig. 212, 216).
  5. Double-Bolt Clamp: MSS Type 3 (Fig. 295A, 295H), including pipe spacers.
  6. Adjustable Saddle-Support: MSS Type 36 (Fig. 258) and MSS Type 37 (Fig. 259), including saddle, pipe and reducer. Fabricate base-support from steel pipe and include cast-iron flange or welded-steel plate.
  7. Channel Support System: Galvanized, 12 gauge channel and bracket support systems, single or double channel as indicated on the Drawings or as required by piping and equipment weights. Grinnell "Power Strut" channel. Acceptable Manufacturers: Super Strut, Globestrut, Bee, Kindorf or Unistrut.
- F. Vertical Pipe Clamps:
1. Two-Bolt Riser Clamp: MSS Type 8 (Fig. 261).
  2. Four-Bolt Riser Clamp: MSS Type 42 include pipe spacers at inner bolt-holes.
- G. Hanger Attachment:
1. Hanger Rod: Rolled threads, zinc plated. Right hand threaded.
  2. Turnbuckles: MSS Type 13 (Fig. 230).
  3. Weldless Eye-Nut: MSS Type 17 (Fig. 290).
  4. Malleable Eye-Socket: MSS Type 16 (Fig. 110R).
  5. Clevises: MSS Type 14 (Fig. 299).
- H. Building Attachments:
1. Concrete Inserts: MSS Type 18 (Fig. 282), steel or Grinnell Power-Strut PS349 continuous channel. Acceptable Manufacturers: Michigan Hanger, Globestrut, Unistrut, Super Strut.
  2. Clamps: MSS Type 19 (Fig. 285, 281), Type 20, 21 (Fig. 225, 226, 131), Type 23 (Fig. 86, 87, 88), Type 25 (Fig. 227), Type 27 through 30 where applicable.

### PART 3 EXECUTION

#### 3.01 LAYOUT AND COORDINATION

- A. Site Examination: Before starting work, carefully examine site and all contract Drawings. Become thoroughly familiar with conditions governing work on this project. Verify all indicated elevations, building measurements, roughing-in dimensions and equipment locations before proceeding with any of the work.
- B. Utility Locations: The location of existing utilities, wires, conduits, pipes, ducts, or other service facilities are shown in a general way only on the Drawings and are taken from existing records. Ascertain whether any additional facilities other than those shown on the plans may be present and determine the exact location and elevations of all utilities prior to commencing installation.
- C. Coordination:
1. The Drawings are based on equipment of a certain manufacturer and may be identified as such. Where alternate manufacturers or approved substitutes are incorporated into the work, any required design changes are the responsibility of the Contractor. Such changes may include changes in utility or system connection sizes, location, or orientation, service clearances, structural support or acoustic considerations.
  2. Prepare accurate AutoCAD shop drawings showing the actual physical dimensions required for the installation for piping and plumbing devices. Submit drawings prior to purchase/fabrication/installation of any of the elements involved in the coordination.

- Provide drawing files to other trades for coordination.
3. Cooperate with other trades in furnishing material and information for sleeves, bucks, chases, mountings, backing, foundations and wiring required for installation of mechanical items.
  4. Coordinate all work with other trades and determine in advance where interfacing of the mechanical work and other work are required to be connected together. Provide all materials and equipment to make those connections. Submit shop drawings showing required connections where special conditions exist.
- D. Discrepancies: Report immediately any error, conflict or discrepancy in Plans, Specifications and/or existing conditions. Do not proceed with any questionable items of work until clarification of same has been made. Should rearrangement or re-routing of piping be necessary, provide for approval the simplest layout possible for that particular portion of the work.

### 3.02 GENERAL INSTALLATION

- A. Locating and Positioning Equipment: Observe all Codes, Regulations and good common practice in locating and installing mechanical equipment and material so that completed installation presents the least possible hazard. Maintain adequate clearances for repair and service to all equipment and comply with Code requirements.
- B. Arrangement: Arrange piping parallel with primary lines of the building construction, and with a minimum of 7' overhead clearance in all areas where possible. Unless indicated otherwise, conceal all piping. Locate operating and control equipment properly to provide easy access, and arrange entire mechanical work with adequate access for operation and maintenance. Give right-of-way to piping which must slope for drainage. Set all equipment level or as recommended by manufacturer. Under no conditions shall beams, girders, footings or columns be cut for mechanical items. Casting of pipes into concrete is prohibited unless so shown on Drawings.
- C. Drip Pans: Provide drip pans under all domestic hot water heaters and all above ceiling in-line pumps and cooling coils or as noted on drawings. Locate pan immediately below piping and equipment, and extend a minimum of 6" on each side and lengthwise 18" beyond equipment being protected. Fabricate pans 2" deep, of reinforced 20 gauge galvanized sheet metal with watertight seams and rolled or hemmed edges. Provide 3/4" drainage piping, properly discharged to over floor drain or as shown on the Drawings. Comply with Mechanical Code for overflow protection and pipe sizing.
- D. Adjusting: Adjust and calibrate all automatic mechanical equipment, mixing valves, flush valves, float devices, etc. Adjust flow rates at each piece of equipment or fixture.
- E. Building Vapor Barrier: Wherever the building insulation vapor barrier is penetrated by piping, hangers, conduits, etc., provide clear self-adhesive tape recommended by the insulation manufacturer around the penetrations.

### 3.03 VALVE INSTALLATION

- A. General: Comply with the following requirements:
1. Install valves where required for proper operation of piping and isolation of equipment, including valves in branch lines where necessary to isolate sections of piping, and where shown on the drawings. Install valves at low points in piping systems that must be drained for service or freeze protection.
  2. Locate valves in accessible spaces (or behind access panels) and so that separate support can be provided when necessary.
  3. Install valves with stems pointed up, in the vertical position where possible, but in no case with stems pointed downward from a horizontal plane.

- B. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.
- C. Valve Access: Provide access panels to all valves installed behind walls, in furring or otherwise inaccessible.

### 3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building structural attachments.
  - 1. Install hangers, supports, clamps, and attachments to support piping and equipment properly from the building structure. Use no wire or perforated metal to support piping, and no supports from other piping or equipment. For exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
  - 2. Prevent electrolysis in the support of copper tubing by the use of at least 2 layers of UPC listed 10 mil tape at all bearing surfaces or strut clamp cushion. Copper plated hangers alone are not sufficient.
  - 3. Support fire sprinkler piping independently of other piping and in accordance with NFPA Pamphlet 13.
  - 4. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at panel points only.
- B. Provisions for Movement:
  - 1. Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units. Install specified seismic restraints to restrict excessive movement.
  - 2. Install hangers and supports so that equipment and piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
  - 3. Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded. Comply with the following installation requirements:
    - a. Clamps: Attach clamps, including spacers (if any), to piping outside the insulated piping support. Do not exceed pipe stresses allowed by ANSI B31.
    - b. Insulated Pipe Supports: Insulated pipe supports shall be supplied and installed on all insulated pipe and tubing.
    - c. Load Rating: All insulated pipe supports shall be load rated by the manufacturer based upon testing and analysis in conformance with ASME B31.1, MSS SP-58, MSS SP-69 and MSS SP-89.
    - d. Support Type: Manufacturer's recommendations, hanger style and load shall determine support type.
    - e. Insulated Piping Supports: Where insulated piping with continuous vapor barrier or where exposed to view in finished areas is specified, install hard maple wood insulation shields (Elcen Fig. 216) or steel pipe covering protection shields (MSS type 39) at each hanger.
- C. Pipe Support:
  - 1. Vertical Spacing: Support at base, at equivalent of every floor height (maximum 10' as required by Code) and just below roof line.
  - 2. Screwed or Welded Steel or Copper Piping: Maximum hanger spacing shall be as follows:

- |  |                    |              |               |
|--|--------------------|--------------|---------------|
|  |                    | <u>Steel</u> | <u>Copper</u> |
|  | 1-1/4" and smaller | 7' span      | 6' span       |
|  | 1-1/2" pipe        | 9' span      | 6' span       |
|  | 2" pipe            | 10' span     | 10' span      |
|  | 2-1/2" & larger    | 12' span     | 10' span      |
3. Cast Iron Soil Pipe:
- Hubless and Compression Joint: At every other joint except when developed length exceeds 4', then at each joint.
  - Additional Support: Provide at each horizontal branch and/or at concentrated loads to maintain alignment and prevent sagging.
4. Install additional hangers or supports at concentrated loads such as pumps, valves, etc. to maintain alignment and prevent sagging.
5. Support Rod: Hanger support rods sized as follows:
- |  |                           |                 |
|--|---------------------------|-----------------|
|  | <u>Pipe and Tube Size</u> | <u>Rod Size</u> |
|  | <u>Inches</u>             | <u>mm</u>       |
|  | 1/2" to 4"                | 12.7 to 101.6   |
|  | 5" to 8"                  | 127.0 to 203.2  |
|  | 10" to 12"                | 254.0 to 304.8  |
6. Provide manufactures approved channel continuously below all horizontal PEX or other plastic pipe where hung from structure.

- D. Adjust hangers and supports to bring piping to proper levels and elevations.
- E. Provide all necessary structural attachments such as anchors, beam clamps, hanger flanges and brackets in accordance with MSS SP-69. Attachments to beams wherever possible. Supports suspended from other piping, equipment, metal decking, etc., are not acceptable.
- F. Horizontal banks of piping may be supported on common steel channel member spaced not more than the shortest allowable span required on the individual pipe. Maintain piping at its relative lateral position using clamps or clips. Allow lines subject to thermal expansion to roll axially or slide. Size channel struts for piping weights.
- G. Installation of drilled-in concrete anchors shall comply with the manufacturer's instructions for working load, depth of embedment, and spacing between anchors and from the edge of the slab. Use only wedge style anchors.
- H. Seismic Restraints: Install restraints where recommended in SMACNA "Seismic Restraint Manual." Show analysis of supporting structure, anchorages, and restraints in accordance with OSSC Chapter 16 and reference ASCE standard. Seismic restraint system components shall be approved by the California Office of Statewide Health Planning and Development (OSHPD). Acceptable Manufacturers: Amber/Booth, Mason Industries, Tolco, or approved. Contractor shall submit calculations and shop drawings, sealed and signed by a Professional Engineer, showing seismic restraint design for all equipment, piping and ductwork required to be braced. **For remodeled areas seismic importance factor is 1.0.**

### 3.05 EQUIPMENT CONNECTIONS

- Provide complete plumbing connections for all items of equipment requiring such connections, including incidental piping, fittings, trim and labor necessary for a finished working installation.
- Verify the rough-in and finish requirements for all equipment provided under other Divisions of the work and requiring plumbing connections with equipment supplier and installer prior to rough-in. Minimum branch pipe size for fixtures shall be 1/2".

### 3.06 PROTECTION

- A. Protect all work and materials against loss or damage. Close all pipe openings with caps or plugs. At final completion, thoroughly clean and deliver all work and equipment in an unblemished new condition. Keep all motors and bearings in watertight and dustproof covers during entire course of installation.
- B. Protect floors, walls, framing and sheathing where pipe cutting and threading operations are conducted with plastic sheeting under plywood sheets. Extend plastic sheeting beyond the plywood. Clean-up metal cuttings, oil, etc., daily or as necessary to prevent debris from being tracked beyond the protected area. Damages, as determined by the Architect, due to the pipe cutting/threading operation shall be repaired by the responsible trade.

**3.07 CUTTING AND PATCHING**

- A. General: Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of mechanical work. Do all necessary cutting and patching of existing building and yard surfaces required for completion of the mechanical work. Patch to match finish and color of adjacent surfaces. Coordinate work in remodel and new areas to avoid cutting of new finished surfaces.

**3.08 PLUMBING WORK CLOSEOUT**

- A. General: Refer to the Division 1 sections for general closeout requirements. Calibrate all equipment requiring same. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of leaks, obstructions, or contamination.
- B. Record Drawings: Submit record set of drawings required in Division 1 as previously specified in this Section.
- C. Closeout Equipment/Systems Operations: Sequence operations properly so that work of project will not be damaged or endangered. Coordinate with seasonal requirements. Operate each item of equipment and each system in a test run of appropriate duration with the Architect present, and with the Owner's operating personnel present, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance. Clean and lubricate each system, and replace dirty filters, excessively worn parts and similar expendable items of the work.
- D. Operating Instructions: Conduct a walk-through instruction seminar for the Owner's personnel who are to be involved in the continued operation and maintenance of plumbing equipment and systems. Provide written instructions outlining and explaining the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar features of the systems.

**END OF SECTION**

**PLUMBING PIPING**

**PART 1 GENERAL**

**1.01 DESCRIPTION**

- A. Provide pipe, pipe fittings, piping specialties, pumps and related items required for complete piping system.
- B. Related Work: The requirements of Section 22 05 00, Common Plumbing Materials and Methods, also apply to this section.

**1.02 QUALITY ASSURANCE**

- A. General: ASTM, and ANSI Standards are indicated. In addition, special standards are referenced where neither ASTM nor ANSI Standards are applicable.
- B. Labeling: All piping shall be continuously and legibly labeled on each length as required by codes and standards and including as a minimum, country of origin, manufacturer's identification marking, wall thickness designation, and applicable standards and approvals. Fittings shall be labeled as required by the referenced standard. Tubular fixture traps shall be stamped with manufacturer's mark and material thickness.
- C. Potable Water Valves: Potable water piping materials not limited to faucets, mixing valves, or pressure reducing valves. Valves shall meet NSF Standard 61, Section 9, for drinking water faucets and shall be brass construction. Brass components which contact water within the faucet shall be from brass which contains no more than 3 percent lead by dry weight.
- D. Concealed Plastic Piping: No concealed plastic piping inside the building unless approved by Code or Governing Authorities.
- E. Definitions: Where piping fluid is not indicated in the following paragraphs, provide similar piping materials for similar fluids (i.e., "make-up water" = "domestic water"; "wet stand pipe" = "fire sprinkler pipe"; "drainage piping" = "sanitary/storm sewer piping").
- F. Plumbing System Disinfection shall be performed by an experienced, qualified, chemical treatment agency.

**1.03 STORAGE AND HANDLING**

- A. Provide factory-applied end caps on each length of pipe and tube. Maintain end caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

**1.04 SUBMITTALS**

- A. Submit catalog data for each product specified.

**PART 2 PRODUCTS**

**2.01 PIPING MATERIALS**

- A. Cast Iron DWV Pipe:
  - 1. Application: 1-1/2" and larger.

- a. Plumbing vent
  2. Pipe: Hubless cast iron soil pipe, CISPI 301-05/ASTM A 888-05. Produced by American manufacturer only. Foreign produced piping is not allowed.
  3. Fittings: Hubless cast iron fittings: CISPI 301-05/ASTM A 888-05.
  4. Couplings:
    - a. Standard Duty: No-hub couplings meeting CISPI 310 and incorporating ASTM C 564 gasket, type 301 SS corrugated shield and type 301 SS clamping bands. Two clamping bands on 1-1/2" thru 4" pipe and four bands on 6" thru 10" pipe.
    - b. Heavy Duty: No-hub couplings meeting ASTM C 1540, and FM 1680. ASTM C 564 neoprene gasket, type 304 SS corrugated shield and type 304 SS clamping bands. Four bands on 1-1/2" thru 4" pipe and 6 bands on 5" thru 10" pipe.
    - c. Couplings to Dissimilar Pipe in Concealed Locations: Fernco "ProFlex" with stainless steel collar or approved substitute.
  5. Manufacturers: Cast iron pipe and fittings – AB&I, Charlotte Pipe, Tyler Pipe, or approved. All pipe shall be labeled by the manufacturer.
- C. Plastic Pipe – Drain, Waste, Vent (DWV):
1. Application:
    - a. Plumbing vent if existing material is PVC or ABS
  2. Pipe:
    - a. Poly(vinyl chloride) (ASTM D1784) (PVC) solid core plastic drain, waste and vent pipe (ASTM D2665 and D1785) and fittings (ASTM D2665) (DWV).
  3. Fittings: Provide fittings of the type indicated, matching piping manufacture. Where not otherwise indicated, provide fittings produced and recommended for the service indicated by the piping manufacturer.

### PART 3 EXECUTION

#### 3.01 PIPE INSTALLATION

- A. General: Install pipe, tube and fittings in accordance with recognized industry practices and plumbing code standards. Install each run accurately aligned with a minimum of joints and couplings, but with adequate and accessible unions and flanges for disassembly, maintenance and/or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings.
- B. Piping Runs: Route piping close to and parallel with walls, overhead construction, columns and other structural and permanent-enclosure elements of the building. Install piping plumb and level except where pitched for drainage. If not otherwise indicated, run piping in the shortest route which does not obstruct usable space or block access for servicing the building or equipment and avoid diagonal runs. Wherever possible in finished and occupied spaces, conceal piping from view. Do not encase horizontal runs in solid (concrete or CMU) partitions.
- C. Ensure all copper piping is protected from contact with non-copper and plated supports. Provide strut cushion below clamp or 2 layers of UPC listed 10 mil tape.

#### 3.02 PIPING JOINTS

- A. General: Provide joints of the type indicated in each piping system, and where piping and joint as manufactured form a system, utilize only that manufacturer's material.
- B. Cast Iron "No-Hub": All joints in accordance with the Cast Iron Soil Pipe Institute (CISPI) Designation No. 310-97 "Installation Procedures for Hubless Cast Iron Soil Pipe and Fittings For Sanitary and Storm Drain, Waste and Vent Piping Applications." Horizontal runs of 5" and greater shall be braced as indicated in Figure 4 for "rodding" restraints. Application of couplings



as follows:

1. Standard Duty Couplings: All vent piping and all drainage and waste piping above grade.
  2. Heavy Duty Couplings: All underground waste installations and any storm drain installations 2 stories or more in height.
- C. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.
- D. Line Grades:
1. Drainage Lines: Run at maximum possible grade and in no case less than 1/4" per foot within building.
  2. Vents: Pitch for drainage 1/4" per 10'.
  3. Water: Pitch to low points and install hose bib drains. 3' minimum depth of ground cover for all lines outside building unless otherwise noted.

### 3.03 CLEANING

- A. General: Clean all dirt and construction dust and debris from all mechanical piping systems and leave in a new condition. Touch up paint where necessary.
- B. Disinfection of Domestic Water Piping System:
1. Prior to starting work, verify system is complete and clean.
  2. Open all drains and fixtures valves in the building starting with the valve nearest the water service line and permit the water to run clear for 10 minutes to eliminate grease, cuttings, flux, and foreign matter.
  3. Inject disinfectant at beginning of water system to be disinfected. Introduce free chlorine in liquid form, throughout system to obtain concentration required by local Public Health Department regulations or 50 to 80 mg/L residual.
  4. Bleed water from all potable water outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
  5. Maintain disinfectant in system for 24 hours.
  6. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
  7. Flush disinfectant from system until residual is equal to that of incoming water or 1.0 mg/L.
  8. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C601. If any sample fails the analysis, repeat the procedure.
  9. Include a copy of the bacteriological analysis in the Operating and Maintenance manuals.
  10. If allowed by local jurisdiction, testing is acceptable in lieu of treatment.

### 3.04 TEST

- A. General:
1. Minimum duration of two hours or longer, as directed for all tests. Furnish report of test observation signed by qualified inspector. Make all tests before applying insulation, backfilling, or otherwise concealing piping or connecting fixtures or equipment. Where part of the system must be tested to avoid concealment before the entire system is complete, test that portion separately, same as for entire system.
  2. Provide all necessary temporary equipment for testing, including pump and gauges. Remove control devices before testing and do not use piping system valves to isolate sections where test pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.
  3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

- B. Repair:
  - 1. Repair piping system sections which fail the required piping test by disassembly and re-installation, using new materials to the extent required to overcome leakage. Do not use chemical stop-leak compounds, solder, mastics, or other temporary repair methods.
  - 2. Drain test water from piping systems after testing and repair work has been completed.
- C. Plumbing Waste and Vent Piping: Hydrostatic test by filling to highest point, but not less than 10' water column on major horizontal portion.

3.05 SUPERVISION AND START-UP

- A. Adjust flush valves, pressure reducing valves, water heater thermostats, and similar equipment.

**END OF SECTION**

**HVAC MATERIALS AND METHODS****PART 1 GENERAL****1.01 DESCRIPTION**

- A. The provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the HVAC work specified in this Division.
- B. The requirements of this Section apply to the HVAC systems specified in these Specifications and in other Division 23 sections.
- C. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the Drawings and/or in these Specifications, including all labor, supervision, services, permits, fees, and incidentals necessary and required to provide a complete and operable facility with complete systems as shown, specified, and required by applicable codes.
- D. Advise subcontractor, suppliers, and vendors involved in the work specified in this Section of the applicable requirements.

**1.02 QUALITY ASSURANCE**

- A. All work and materials shall conform to all applicable local and state codes and all federal, state and other applicable laws and regulations. All clarifications and modifications which have been cleared with appropriate authorities are listed under the applicable sections. All electrical products shall bear the label of a recognized testing laboratory such as UL or CSA.
- B. Whenever the requirements of the Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.
- C. Codes and Standards: Comply with the provisions of the following referenced codes, standards and specifications:
  - 1. Federal Specifications (FS)
  - 2. American National Standards Institute (ANSI)
  - 3. National Electrical Manufacturer's Association (NEMA)
  - 4. National Fire Protection Association (NFPA)
  - 5. Underwriters Laboratories, Inc. (UL)
  - 6. Factory Mutual (FM)
  - 7. International Building Code (IBC) with State and Local Amendments
  - 8. International Mechanical Code (IMC) with State and Local Amendments
  - 9. Uniform Plumbing Code (UPC) with State and Local Amendments
  - 10. American Society for Testing and Materials (ASTM)
  - 11. Americans with Disabilities Act (ADA)
  - 12. International Fire Code (IFC) with State and Local Amendments
  - 13. Energy Policy Act (EPAct)
  - 14. Manufacturers Standardization Society (MSS)
  - 15. American Gas Association (AGA)
- D. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name. Where two or more units of the same class of equipment are furnished, use product of the same manufacturer; component parts of the entire system need not be products of same manufacturer. Furnish all materials and equipment, new and free from defect and of size, make, type and quality herein specified or

approved by the Architect. All materials shall be installed in a neat and professional manner.

- E. All apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.
- F. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both.
- G. Drawings: Do not scale drawings for roughing-in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings. Coordinate work with shop drawings of other specification divisions. See Article 3.1 for more information and requirements.
- H. Field Wiring: It is the intent of these specifications that all systems shall be complete and operable. Refer to all drawings and specifications, especially the electrical drawings, to determine voltage, phase, circuit ampacity and number of connections provided. Provide all necessary field wiring and devices from the point of connection indicated on the electrical drawings. All equipment shall be installed in compliance with the Electrical Code and the equipment's UL listing. Bring to the attention of the Architect in writing, all conflicts, incompatibilities, and/or discrepancies prior to bid or as soon as discovered.

#### 1.03 WORK OF OTHER CONTRACTS

- A. Work under this contract shall be conducted in a manner to allow for the future installations of such equipment or items listed in other sections of this Specification.

#### 1.04 WORK OF OTHER DIVISIONS

- A. Work under this Division shall be conducted in a manner to cooperate with the installation of such equipment or items as specified in other Divisions.
- B. Plumbing piping systems and fixtures and fire suppression piping systems are specified under other Divisions of these Specifications except for provisions or items specifically noted on the Drawings or specified herein.
- C. Consult all Drawings and Specifications in this project and become familiar with all equipment to be installed. Coordinate all aspects of the construction with the other trades on the job to ensure that all work and materials required to provide a complete and operational facility are included in the bid.
- D. All sections of Division 23 are interrelated and shall be considered in their entirety when interpreting any material, method, or direction listed in any section of Division 23. Individual sections are not written for specific Subcontractors or suppliers but for the General Contractor.

#### 1.05 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES (SUBMITTALS)

- A. Submit in accordance with Division 1 full technical and descriptive shop drawing data on proposed materials and equipment as detailed in each section.
- B. The Contractor shall verify that all equipment submitted can be delivered and installed within the time constraints of the construction period.
- C. Include the manufacturer, type, style, catalog number, complete specification, certified dimensions, and description of physical appearance for each item and option submitted. Reproduction of catalog data sheets shall be clean and legible to show all details, including gauge of metal used.

- D. Include only information on exact equipment to be installed, not general catalogs of the manufacturer. Where sheets show proposed equipment as well as other equipment, identify proposed equipment with rubber stamp arrow or similar concise method.
- E. Submit with each copy a transmittal letter verifying that all included equipment submittals have been carefully considered for quality, dimensions, function, and have been coordinated with the Drawings and Specifications. Guarantee that proposed materials will meet or exceed the quality and function of those specified.
- F. Include field wiring diagrams and connection diagrams for all control and/or low voltage systems, including floor plans.
- G. Submittal Review: The submittal review process is a means to provide quality control. The action noted to be taken (or where conflicts with the contract documents are not noted) shall not be interpreted by the Contractor as automatic "change orders." Approval of the data for substitution and shop drawings shall not eliminate the Contractor's responsibility for compliance with Drawings or Specifications, nor shall it eliminate the responsibility for freedom from errors of any sort in the data discovered prior to or after the review process. Deviations, discrepancies, and conflicts between the submittals and the Contract Documents shall be called to the Architect's attention in writing at the time of transmittal of the data.
- H. Submittals shall be in the form of PDF documents. Arrange submittals numerically with specification sections identified in tabs. All required sections shall be submitted at one time.  
**Partial submittals will be rejected without review.**
- I. For adhesives and sealants used on the interior of the building (inside the waterproofing system), include printed statement of volatile organic compound (VOC) content.

#### 1.06 PRODUCT SUBSTITUTION

- A. Materials other than those specified may be approved for this project providing a written request is submitted to the Architect prior to bid in accordance with Instructions to Bidders. Requests shall include complete specifications, dimensions, manufacturer and catalog number for each item for which approval is desired. If, in the opinion of the Architect, the material is not complete or if it is not an acceptable substitute, he may reject it. The Architect's evaluation will be based solely on the material submitted.

#### 1.07 CHANGE ORDERS

- A. All supplemental cost proposals by the Contractor shall be accompanied by a complete itemized breakdown of labor and materials without exception. At the Architect's request, the Contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor must be separated and allocated for each item of work.

#### 1.08 RECORD DOCUMENTS

- A. Project Record (As-Installed) Drawings:
  - 1. Maintain a set of record drawings on the job site as directed in Division 1.
  - 2. Keep Drawings clean, undamaged, and up to date.
  - 3. Record and accurately indicate the following:
    - a. Depths, sizes, and locations of all buried and concealed piping dimensioned from permanent building features.
    - b. Locations of all valves with assigned tag numbers.
    - c. Locations of all fire dampers and other airflow control devices.

- d. Changes, additions, and revisions due to change orders, obstructions, etc. Eradicate extraneous information.
      - e. Model numbers of installed equipment.
    - 4. Make Drawings available when requested by Architect for review.
    - 5. Submit as part of the required Project Closeout documents. Final submittal will be in the form of reproducible drawings.
    - 6. Quality of entire set of project record drawings to match the quality of the contract documents; quality to be judged by Architect. Computer-aided design drafting (CADD) shall be used to complete project record drawings. Use standards set in contract documents. Note field modifications, all addenda, and change order items on project record drawings. If deficiencies are found in either the quality or the accuracy of the drawings, they will be returned unapproved. Additional review of subsequent submissions shall be at the Contractor's expense.
  - B. Operating and Maintenance Manuals: Submit Operating and Maintenance Instructions, including manufacturer's service data, wiring diagrams, and parts lists and vendors for all serviceable items of equipment, valve charts, balancing data, final control diagrams showing final set points, duct and piping pressure test reports, equipment startup records, and any additional equipment added by change order. Provide any performance curves, data, and model numbers from submittals. Comply with provisions of Division one where applicable to the mechanical work. Submittal shall be in the form of a PDF file per specification section. Arrange submittals numerically with equipment type or classification identified in tabs. Manufactures O&M manuals shall be provided as a single PDF file that can be hyper-linked by Owner for reference. O&M manuals that are a series of PDF files will not be accepted.
- 1.09 WARRANTY
- A. Furnish, prior to application for final payment, three copies of written and signed guarantee effective a period of one year from date of completion and acceptance of entire project; agree to correct, repair and/or replace defective materials and/or equipment or the results of defective workmanship without additional expense to the Owner. Where no response satisfactory to the Owner has occurred within three working days from the written report of a warranty covered defect, the contractor shall agree to pay for the cost of repair of the reported defect by a contractor of the Owner's choice.
  - B. Where the manufacturer's guarantee exceeds one year, the longer guarantee shall govern and include the Contractor's labor.

## PART 2 PRODUCTS

### 2.01 GENERAL

- A. General: Provide all new materials and equipment, identical to apparatus or equipment in successful operation for a minimum of two years. Provide materials of comparable quality omitted here but necessary to complete the work. Maximum allowable variation from stated capacities, minus 5% to plus 10% as approved in each case.
- B. Compatibility: Provide products which are compatible with other portions of the work and provide products with the proper or correct power and fuel-burning characteristics, and similar adaptations for the project.
- C. Efficiency: Heating and cooling equipment shall comply with ASHRAE Standard 90.1-2019 and the State Energy Code. Where equipment efficiencies are indicated, the use of alternate or substitute manufacturer's equipment with lower efficiencies is not permitted.

- D. Storage and Handling:
  - 1. Delivery: Deliver to project site with manufacturer's labels intact and legible.
  - 2. Handling: Avoid damage.
  - 3. Storage: Inside protected from weather, dirt and construction dust. Where necessary to store outside, elevate well above grade and enclose with durable, waterproof wrapping.

## 2.02 STARTERS AND SWITCHES

- A. Manufacturers: Cerus Industrial Model numbers are listed. General Electric, ABB, Allen Bradley, Schneider Electric, Eaton, are approved if equal. Provide starters by same manufacturer throughout project.
- B. General: Provide each motor with starter or switch as approved and recommended by manufacturer of motor or equipment of which motor is a part. All starters shall include integral disconnect.
- C. System Description
  - 1. Single Phase Starter: Starters for 115VAC single phase motors less than 1 HP shall be capable of both manual and automatic operation. Refer to Section D for single phase starter requirements.
  - 2. Magnetic Starters: Starters for 3-phase motors shall be magnetic starters. Refer to Section E for magnetic starter requirements.
- D. Enclosed Full Voltage Non-Reversing (FVNR) Single Phase Starter
  - 1. Single Phase Motor Starter Control: The single phase motor starter shall consist of a manually operated quick-make toggle mechanism lockable in the "Off" position which shall also function as the motor disconnect. Additionally, the starter shall provide thermal overload protection, run status pilot light and fault pilot light. The starter must include the capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output and fault output. All control terminals shall be integrated in the starter. At a minimum, each single phase starter shall include an interposing run relay and current sensing status output relay. Single phase motor starter shall be in a surface mount enclosure.
  - 2. Approved manufacturer: Cerus Industrial, model BAS-1P or approved equal.
- E. Enclosed Full Voltage Non-Reversing (FVNR) Non-Combination Starter
  - 1. Magnetic Motor Starters shall be enclosed in a general purpose electrical enclosure with the appropriate environmental rating.
  - 2. Starters shall consist of a horsepower rated magnetic contactor with a minimum of 1NO and 1NC auxiliary contacts and solid state electronic overload relay. Overload relay shall protect all three phases with a wide range current setting and trip class to allow field adjustment for specific motor FLA. Overload relay shall provide phase failure, phase loss, locked rotor and stall protection.
  - 3. Provide a manual reset pushbutton on the starter cover to restore normal operation after a trip or fault condition.
  - 4. Each starter shall include an installed 50VA control power transformer (CPT) with protected secondary. The CPT must accept the available line voltage and the control voltage shall not exceed 120V.
  - 5. Installed accessories shall include Hand-Off-Auto operation switch with 22mm style operator interfaces. Include LED pilot light indicators for Hand, Off, Auto, Run and Overload conditions. All pilot devices shall be water tight and dust tight.
  - 6. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals including 24VAC, 120VAC, 24VDC and 48VDC to allow direct connection of the transistorized automation signal to the starter.

7. In applications where the motor is interlocked with a damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only close the motor circuit and start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.
  8. Manufacturer shall provide and install tags with engraved white lettering to designate equipment served.
- F. Enclosed Full Voltage Non-Reversing (FVNR) Combination Starter / Disconnect
1. Magnetic Motor Starters shall be enclosed in a general purpose electrical enclosure with the appropriate environmental rating.
  2. Starters shall consist of a horsepower rated magnetic contactor with a minimum of 1NO and 1NC auxiliary contacts and solid state electronic overload relay. Overload relay shall protect all three phases with a wide range current setting and trip class to allow field adjustment for specific motor FLA. Overload relay shall provide phase failure, phase loss, locked rotor and stall protection.
  3. Provide a manual reset pushbutton on the starter cover to restore normal operation after a trip or fault condition.
  4. Each starter shall include an installed 50VA control power transformer (CPT) with protected secondary. The CPT must accept the available line voltage and the control voltage shall not exceed 120V.
  5. Installed accessories shall include Hand-Off-Auto operation switch with 22mm style operator interfaces. Include LED pilot light indicators for Hand, Off, Auto, Run and Overload conditions. All pilot devices shall be water tight and dust tight.
  6. When remotely controlled by an automation system, the starter shall include remote run terminals which accept both a voltage input signal and a contact closure. The voltage run input shall accept both AC and DC signals including 24VAC, 120VAC, 24VDC and 48VDC to allow direct connection of the transistorized automation signal to the starter.
  7. In applications where the motor is interlocked with a damper or valve, the actuator control must reside within the starter enclosure. The starter must provide a voltage output to operate the actuator to open the damper or valve without closing the motor circuit. The starter will only close the motor circuit and start the motor after it has received a contact closure from a limit or end switch confirming the damper or valve position.
  8. Provide and install tags with engraved white lettering to designate equipment served.
  9. Enclosed combination starters shall include all of the magnetic starter requirements in addition to a disconnecting method. Acceptable disconnects include: motor circuit protectors or UL 489 circuit breakers. All disconnects shall include a lock-out mechanism when in the off position.
  10. The Motor Circuit protector shall be a UL listed 508 current limiting manual motor starter with magnetic trip elements only. The breaker shall carry a UL 508F rating (up to 100A frame size) which provides for coordinated short circuit rating for use with the motor contactor and provides a minimum interrupting rating of 30,000 AIC for the combination starter.
  11. Disconnect shall be UL 98 suitable for service entrance protection.
  12. UL 489 breaker shall include thermal and magnetic trip mechanisms.
  13. Provide over/under voltage and phase monitoring capability. Monitor shall be field adjustable for both over and under voltage levels and a delay time before returning to normal operation after a trip.
- G. Quality Assurance
1. Manufacturer shall provide a five year warranty on the complete starter assembly.
  2. The starter assembly shall be UL listed under UL 508A.

## 2.03 SOLID-STATE, VARIABLE-SPEED MOTOR CONTROLLERS



- A. General: Controllers listed and labeled as a complete unit and arranged to provide variable speed of a standard NEMA Design B 3-phase induction motor by adjusting output voltage and frequency of controller. Designed and rated by the manufacturer for the type of load (e.g., fans, blowers, and pumps) used and also approved by the manufacturer for the type of connection used between the motor and load (direct connection or power transmission connection).
- B. Input Line Reactors: 5% for reduction of harmonics.
- C. Output Line Reactors: Specially designed and constructed for IGBT controllers and designed to protect motor from voltage spikes over 150% of the bus voltage. Required where controller to motor cable length exceeds 50 feet. Provide dV/dT filters for 460 volt motors with cable lengths in excess of 300'.
- D. In lieu of providing line reactors, the drive manufacturers may submit a power system analysis demonstrating compliance with IEEE 519.
- E. Ratings:
  - 1. Output Ratings: 3-phase, 6 to 60 Hz, with voltage proportional to frequency throughout the voltage range.
  - 2. Starting Torque: 100 percent of rated torque, or as indicated.
  - 3. Speed Regulation: Plus or minus 1 percent.
  - 4. Ambient Temperature: 0° C to 40° C.
  - 5. Efficiency: 98 percent at normal power levels.
- F. Isolated Control Interface: Allow the controller to follow one of the following over an 11:1 speed range:
  - 1. Electrical Signal: 4 to 20 milliamperes at 24 V.
- G. Internal Adjustability: Provide the following internal adjustment capabilities:
  - 1. Minimum Speed: 5 to 25 percent of maximum RPM.
  - 2. Maximum Speed: 80 to 100 percent of maximum RPM.
  - 3. Acceleration: 2 to 22 seconds.
  - 4. Deceleration: 2 to 22 seconds.
  - 5. Current Limit: 50 to 110 percent of maximum rating.
- H. Self-Protection and Reliability Features:
  - 1. Input transient protection by means of surge suppressors.
  - 2. Snubber networks to protect against malfunction due to system voltage transients.
  - 3. Motor Overload Relay: Adjustable and capable of NEMA class 10 performance.
  - 4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
  - 5. Instantaneous Overcurrent Trip.
  - 6. Loss of Phase Protection.
  - 7. Reverse Phase Protection.
  - 8. Under- and Over-Voltage Trips.
  - 9. Overtemperature Trip.
  - 10. Short Circuit Protection.
- I. Automatic Reset/Restart: Attempt three restarts after controller fault or on return of power to the system following an interruption and before shutting down for manual reset or fault correction. Provide for restarting during deceleration without damage to the controller, motor, or load.
- J. Serial Communications: The VFD shall have an EIA-485 port as standard. The standard protocols shall be Modbus and BACnet MS/TP. The use of third party gateways and multiplexers is not acceptable. All protocols shall be certified by the governing authority (i.e. BTL Listing for BACnet).

- K. EMI / RFI filters: All VFDs shall include onboard EMI/RFI filters. The onboard filters shall allow the entire VFD assembly to be CE Marked and the VFD shall meet product standard EN61800-3 for the First Environment restricted. No Exceptions.
- L. Operation and Maintenance Features: Include:
  - 1. Status Lights: Door-mounted LED indicators to indicate power on, run, overvoltage, line fault, overcurrent, and external fault.
  - 2. Elapsed Time Meter.
  - 3. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer.
  - 4. Current-Voltage-Frequency Indicating Devices: Mount meters or digital readout device and selector switch flush in controller door and connect to indicate controller output.
  - 5. Provide with non-fused disconnect rated for drive capacity. Disconnect shall be UL 98 suitable for service entrance.
- M. For drives to be mounted outside install in a NEMA 3R enclosure with ventilation fan to control cabinet temperature below 135°F.
- N. Acceptable Manufacturers: Subject to compliance with requirements.
  - 1. ABB Power Distribution, Inc.

#### 2.04 HANGERS AND SUPPORTS

- A. General: Provide factory-fabricated horizontal piping hangers, clamps, hanger rod, inserts, supports, etc., of the indicated MSS type and size. The Manufacturers Standardization Society (MSS) of the Valve and Fittings Industry Practice SP-58 and SP-69 are referenced in this section.
- B. Manufacturers: B-Line, Carpenter & Paterson, Grinnell, Michigan, Superstrut, Tolco, Erico, or accepted substitute. Grinnell figure numbers in parentheses where applicable (or other manufacturers as noted).
- C. Corrosion Protection: Provide materials which are zinc plated or factory painted to prevent corrosion. Prevent electrolysis in the support of copper tubing by the use of copper hangers (copper coated alone is not sufficient), strut cushion, or at least two layers of UPC 10 mil tape.
- D. Seismic Requirements: Provide seismic restraints in accordance with OSSC Section 1613. Design restraint systems in accordance with "Seismic Restraint Manual: Guidelines for Mechanical Systems," Second Edition, 1998, SMACNA, or "A Practical Guide to Seismic Restraint" ASHRAE RP-812, 1999.
- E. Horizontal Piping Hangers and Supports:
  - 1. Adjustable Clevis Hanger: MSS Type 1 (Fig. 260).
  - 2. Adjustable Band Hanger: MSS Type 7 (Fig. 97), fabricated from steel.
  - 3. Adjustable Swivel-Band Hanger: MSS Type 10 (Fig. 70).
  - 4. Clamp: MSS Type 4 (Fig. 212, 216).
  - 5. Double-Bolt Clamp: MSS Type 3 (Fig. 295A, 295H), including pipe spacers.
  - 6. Adjustable Saddle-Support: MSS Type 36 (Fig. 258) and MSS Type 37 (Fig. 259), including saddle, pipe and reducer. Fabricate base-support from steel pipe and include cast-iron flange or welded-steel plate.
  - 7. Channel Support System: Galvanized, 12 gauge channel and bracket support systems, single or double channel as indicated on the Drawings or as required by piping and equipment weights. Grinnell "Power Strut" channel. Acceptable Manufacturers: Super Strut, Globestrut, Bee, Kindorf or Unistrut.
- F. Vertical Pipe Clamps:

1. Two-Bolt Riser Clamp: MSS Type 8 (Fig. 261).
  2. Four-Bolt Riser Clamp: MSS Type 42 include pipe spacers at inner bolt-holes.
- G. Hanger Attachment:
1. Hanger Rod: Rolled threads, zinc plated. Right hand threaded.
  2. Turnbuckles: MSS Type 13 (Fig. 230).
  3. Weldless Eye-Nut: MSS Type 17 (Fig. 290).
  4. Malleable Eye-Socket: MSS Type 16 (Fig. 110R).
  5. Clevises: MSS Type 14 (Fig. 299).
- H. Building Attachments:
1. Concrete Inserts: MSS Type 18 (Fig. 282), steel or Grinnell Power-Strut PS349 continuous channel. Acceptable Manufacturers: Michigan Hanger, Globestrut, Unistrut, Super Strut.
  2. Clamps: MSS Type 19 (Fig. 285, 281), Type 20, 21 (Fig. 225, 226, 131), Type 23 (Fig. 86, 87, 88), Type 25 (Fig. 227), Type 27 through 30 where applicable.

### PART 3 EXECUTION

#### 3.01 LAYOUT AND COORDINATION

- A. Site Examination: Before starting work, carefully examine site and all contract Drawings. Become thoroughly familiar with conditions governing work on this project. Verify all indicated elevations, building measurements, roughing-in dimensions and equipment locations before proceeding with any of the work.
- B. Utility Locations: The location of existing utilities, wires, conduits, pipes, ducts, or other service facilities are shown in a general way only on the Drawings and are taken from existing records. Ascertain whether any additional facilities other than those shown on the plans may be present and determine the exact location and elevations of all utilities prior to commencing installation.
- C. Coordination:
1. The Drawings are based on equipment of a certain manufacturer and may be identified as such. Where alternate manufacturers or approved substitutes are incorporated into the work, any required design changes are the responsibility of the contractor. Such changes may include changes in utility or system connection sizes, location, or orientation, service clearances, structural support or acoustic considerations.
  2. Prepare accurate AutoCAD shop drawings showing the actual physical dimensions required for the installation for duct work, piping and mechanical devices. Submit drawings prior to purchase/fabrication/installation of any of the elements involved in the coordination. Provide drawing files to other trades for coordination.
  3. Cooperate with other trades in furnishing material and information for sleeves, bucks, chases, mountings, backing, foundations and wiring required for installation of mechanical items.
  4. Coordinate all work with other trades and determine in advance where interfacing of the mechanical work and other work are required to be connected together. Provide all materials and equipment to make those connections. Submit shop drawings showing required connections where special conditions exist.
- D. Discrepancies: Report immediately any error, conflict or discrepancy in Plans, Specifications and/or existing conditions. Do not proceed with any questionable items of work until clarification of same has been made. Should rearrangement or re-routing of piping be necessary, provide for approval the simplest layout possible for that particular portion of the work.

#### 3.02 MECHANICAL EQUIPMENT WIRING

- A. Provide all mechanical equipment motors, automatic temperature, limit, float and similar control devices required, with wiring complete from power source indicated on Electrical Drawings.
- B. Provide properly rated motor overload and undervoltage protection and all manual or automatic motor operating devices for all mechanical equipment.
- C. Equipment and systems shown on the Drawings and/or specified, are based upon requirements of specific manufacturers which are intended as somewhat typical of several makes which may be approved. Provide all field wiring and/or devices necessary for a complete and operable system including controls for the actual selected equipment/system.
- D. Provide all starters for mechanical motors. Review Electrical Specifications and Drawings to determine starter sizes. Adjust fusing/time delay on all starters once installed.

### 3.03 GENERAL INSTALLATION

- A. Locating and Positioning Equipment: Observe all Codes, Regulations and good common practice in locating and installing mechanical equipment and material so that completed installation presents the least possible hazard. Maintain adequate clearances for repair and service to all equipment and comply with Code requirements.
- B. Arrangement: Arrange piping parallel with primary lines of the building construction, and with a minimum of 7' overhead clearance in all areas where possible. Unless indicated otherwise, conceal all piping. Locate operating and control equipment properly to provide easy access, and arrange entire mechanical work with adequate access for operation and maintenance. Give right-of-way to piping which must slope for drainage. Set all equipment level or as recommended by manufacturer. Under no conditions shall beams, girders, footings or columns be cut for mechanical items. Casting of pipes into concrete is prohibited unless so shown on Drawings.
- C. Adjusting: Adjust and calibrate all automatic mechanical equipment, temperature controls, float devices, etc. Adjust flow rates at each piece of equipment or fixture.
- D. Building Vapor Barrier: Wherever the building insulation vapor barrier is penetrated by piping, hangers, conduits, etc., provide clear self-adhesive tape recommended by the insulation manufacturer around the penetrations.

### 3.04 INSTALLATION OF HANGERS AND SUPPORTS

- A. General: Proceed with the installation of hangers, supports and anchors only after the required building structural work has been completed in areas where the work is to be installed. Correct inadequacies including (but not limited to) the proper placement of inserts, anchors and other building structural attachments.
  - 1. Install hangers, supports, clamps, and attachments to support piping and equipment properly from the building structure. Use no wire or perforated metal to support piping, and no supports from other piping or equipment. For exposed continuous pipe runs, install hangers and supports of the same type and style as installed for adjacent similar piping.
  - 2. Prevent electrolysis in the support of copper tubing use of at least 2 layers of UPC listed 10 mil tape at all bearing surfaces or strut clamp cushion. Copper plated hangers alone are not sufficient.
  - 3. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at panel points only.
- B. Provisions for Movement:
  - 1. Install hangers and supports to allow controlled movement of piping systems and to

permit freedom of movement between pipe anchors, and to facilitate the action of expansion joints, expansion loops, expansion bends and similar units. Install specified seismic restraints to restrict excessive movement.

2. Install hangers and supports so that equipment and piping live and dead loading and stresses from movement will not be transmitted to connected equipment.
3. Install hangers and supports to provide the indicated pipe slopes, and so that maximum pipe deflections allowed by ANSI B31 are not exceeded. Comply with the following installation requirements:
  - a. Clamps: Attach clamps, including spacers (if any), to piping outside the insulated piping support. Do not exceed pipe stresses allowed by ANSI B31.
  - b. Insulated Pipe Supports: Insulated pipe supports shall be supplied and installed on all insulated pipe and tubing.
  - c. Load Rating: All insulated pipe supports shall be load rated by the manufacturer based upon testing and analysis in conformance with ASME B31.1, MSS SP-58, MSS SP-69 and MSS SP-89.
  - d. Support Type: Manufacturer's recommendations, hanger style and load shall determine support type.
  - e. Insulated Piping Supports: Where insulated piping with continuous vapor barrier or where exposed to view in finished areas is specified, install hard maple wood insulation shields (Elcen Fig. 216) or steel pipe covering protection shields (MSS type 39) at each hanger.

C. Pipe Support:

1. Vertical Spacing: Support at base, at equivalent of every floor height (maximum 10' as required by Code) and just below roof line.
2. Screwed or Welded Steel or Copper Piping: Maximum hanger spacing shall be as follows:

	<u>Steel</u>	<u>Copper</u>
1-1/4" and smaller	7' span	6' span
1-1/2" pipe	9' span	6' span
2" pipe	10' span	10' span
2-1/2" & larger	12' span	10' span

3. Install additional hangers or supports at concentrated loads such as pumps, valves, etc. to maintain alignment and prevent sagging.
4. Support Rod: Hanger support rods sized as follows:

<u>Pipe and Tube Size</u>		<u>Rod Size</u>	
<u>Inches</u>	<u>mm</u>	<u>Inches</u>	<u>mm</u>
1/2" to 4"	12.7 to 101.6	3/8"	9.5
5" to 8"	127.0 to 203.2	1/2"	12.7
10" to 12"	254.0 to 304.8	5/8"	15.9

5. Provide manufactures approved channel continuously below all horizontal PEX or other plastic pipe where hung from structure.

- D. Adjust hangers and supports to bring piping to proper levels and elevations.
- E. Provide all necessary structural attachments such as anchors, beam clamps, hanger flanges and brackets in accordance with MSS SP-69. Attachments to beams wherever possible. Supports suspended from other piping, equipment, metal decking, etc., are not acceptable.
- F. Horizontal banks of piping may be supported on common steel channel member spaced not more than the shortest allowable span required on the individual pipe. Maintain piping at its relative lateral position using clamps or clips. Allow lines subject to thermal expansion to roll axially or slide. Size channel struts for piping weights.
- G. Installation of drilled-in concrete anchors shall comply with the manufacturer's instructions for

working load, depth of embedment, and spacing between anchors and from the edge of the slab. Use only wedge-style anchors.

- H. Seismic Restraints: Install restraints where recommended in SMACNA "Seismic Restraint Manual" and as required by code. Show analysis of supporting structure, anchorages, and restraints in accordance with OSSC Section 16 and reference ASCE standard. Seismic restraint system components shall be approved by the California Office of Statewide Health Planning and Development (OSHPD). Acceptable Manufacturers: Amber/Booth, Mason Industries, Tolco, or approved. Contractor shall submit calculations and shop drawings, sealed and signed by a Professional Engineer, showing seismic restraint design for all equipment, piping and ductwork required to be braced. **For remodeled areas seismic importance factor is 1.0.**

### 3.05 HVAC SYSTEM IDENTIFICATION

- A. Equipment: Provide engraved plastic-laminate signs at locations of major equipment such as heat exchangers, pumps, etc. Identify equipment in field same as on drawings. Permanently mount in an appropriate and effective location.

### 3.06 EQUIPMENT CONNECTIONS

- A. Provide complete connections for all items of equipment requiring such connections, including incidental piping, fittings, trim and labor necessary for a finished working installation.
- B. Verify the rough-in and finish requirements for all equipment provided under other Divisions of the work and requiring HVAC piping or duct connections with equipment supplier and installer prior to rough-in.

### 3.07 PROTECTION

- A. Protect all work and materials against loss or damage. Close all pipe openings with caps or plugs. At final completion, thoroughly clean and deliver all work and equipment in an unblemished new condition. Keep all motors and bearings in watertight and dustproof covers during entire course of installation.
- B. Protect floors, walls, framing and sheathing where pipe cutting and threading operations are conducted with plastic sheeting under plywood sheets. Extend plastic sheeting beyond the plywood. Clean-up metal cuttings, oil, etc., daily or as necessary to prevent debris from being tracked beyond the protected area. Damages, as determined by the Architect, due to the pipe cutting/threading operation shall be repaired by the responsible trade.

### 3.08 CUTTING AND PATCHING

- A. General: Comply with the requirements of Division 1 for the cutting and patching of other work to accommodate the installation of mechanical work. Do all necessary cutting and patching of existing building and yard surfaces required for completion of the mechanical work. Patch to match finish and color of adjacent surfaces. Coordinate work in remodel and new areas to avoid cutting of new finished surfaces.

### 3.09 HVAC WORK CLOSEOUT

- A. General: Refer to the Division 1 sections for general closeout requirements. Calibrate all equipment requiring same. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of leaks, obstructions, or contamination.

- B. Record Drawings: Submit record set of Drawings required in Division 1 as previously specified in this Section.
- C. Closeout Equipment/Systems Operations: Sequence operations properly so that work of project will not be damaged or endangered. Coordinate with seasonal requirements. Operate each item of equipment and each system in a test run of appropriate duration with the Architect present, and with the Owner's operating personnel present, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance. Clean and lubricate each system and replace dirty filters, excessively worn parts and similar expendable items of the work.
- D. Operating Instructions: Conduct a walk-through instruction seminar for the Owner's personnel who are to be involved in the continued operation and maintenance of the HVAC equipment and systems. Provide written instructions outlining and explaining the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar features of the systems.

**END OF SECTION**





**MECHANICAL SOUND AND VIBRATION CONTROL****PART 1 GENERAL****1.01 DESCRIPTION**

- A. The requirements of this section apply to the vibration isolation for mechanical equipment specified elsewhere.

**1.02 QUALITY ASSURANCE**

- A. Isolator Engineering: Selected and furnished by the equipment manufacturer. Select isolators for 98% efficiency unless indicated otherwise on the Drawings.
- B. Manufacturer: Provide field installed isolation required from a single manufacturer where possible.

**1.03 SUBMITTALS**

- A. Provide product data sheets on all vibration isolators and seismic restraints.
- B. Provide itemized list showing the items of equipment or piping to be isolated, isolator type and model number selected, isolator loading and deflection, and reference to specified drawings showing frame and construction.
- C. Provide manufacturer's drawings showing equipment frame construction for each item including dimensions, structural member sizes and support locations.

**PART 2 PRODUCTS****2.01 ACCEPTABLE MANUFACTURERS**

- A. Manufacturers: Amber/Booth, Mason Industries, Vibration Mountings and Controls, Kinetics Noise Control.
- B. Manufacturer Model Numbers: Amber/Booth figure numbers are listed unless indicated otherwise.

**2.02 VIBRATION ISOLATORS**

- A. Types of Isolators:
  - 1. Hanger with Spring and Rubber Stop: Combination neoprene element and spring hangers – Hangers shall consist of a steel frame containing a neoprene isolation element at the top and a coil steel spring seated in a neoprene cup on the bottom. Both the element and the cup shall be molded with a neoprene bushing that passes through the steel frame. The neoprene element shall be capable of an average deflection of 0.35". The steel springs shall be capable of a minimum static deflection of 0.75" with a minimum additional travel to solid of 1/2". Spring diameters and hanger box lower hole size shall be large enough to permit the hanger rod to swing through a 30 degree arc before contacting the box and short circuiting the spring. Hangers shall be factory precompressed 60% of the total deflection determined by the assigned load per hanger. Hangers shall be manufactured with provision for bolting or attaching to ceiling flat iron straps, rods or steel runners. Hangers shall be of a fail-safe design. Amber / Booth BSRA.
  - 2. Neoprene Pads: Neoprene pads shall be of waffle or ribbed design, 1/4" – 3/8" thick. They shall be installed as a single layer or in multiple layers with 16 gauge steel shims

cemented between so that the combination of stiffness and total neoprene thickness achieves the static deflection listed in the vibration isolation schedule in conjunction with a distributed load area that will maintain 10-50 psi. If the equipment support location does not completely cover the pads or does not consist of flat steel footing, an additional full coverage, load distribution plate of minimum 3/8 steel shall be placed between the pad and attached to the equipment support. There shall be no rigid structure between top and bottom of mount. Amber / Booth Type NR Ampad.

- B. Neoprene Mounts: Neoprene mounts shall be one piece, neoprene molded assemblies with a minimum loaded static deflection of 0.25". The mount shall incorporate both rubber-in-shear and compression load characteristics. All metal surfaces shall be neoprene covered. The mount shall have friction pads both top and bottom. Bolt holes shall also be provided for both surfaces. The top bolt hole shall be threaded. There shall be no rigid structure between top and bottom supports. Amber / Booth Type RV.
- C. Noise and Vibration Barrier Hanger: For ductwork and piping where indicated. Target Enterprises Inc. "ARH-1" or accepted substitute.
- D. Seismic and Start-Up Restraints: Select all isolators to withstand seismic loads equivalent two times the isolator load rating applied from any direction. Mason Industries type Z-1011 on all isolated equipment not utilizing isolators with integral restraints.
- E. Flexible Pipe Connectors - Type SS: All stainless steel hose and braid with carbon steel connections. Male thread ends on flexible connectors 2" and smaller, and flanged connections on 1-1/2" and larger connectors.
- F. Ductwork Flexible Connections:
  - 1. Typical connections shall be made of 30 ounce woven glass fiber, coated with neoprene, sewn together at the edges and joints.
  - 2. The flexible connections shall be approximately 6" long and held in place with 1" wide bands of 12 gauge galvanized steel bolted to duct and to outlets and inlets of the units and fans with 1/8" stove bolts, 5" o.c.
  - 3. It is the intent that these flexible connections shall withstand the operating air pressure, shall not permit air leakage and shall not transmit vibration.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. General: Install vibration isolators and flexible connectors as specified herein, as shown on the Drawings and as recommended by manufacturer.
- B. Ductwork Flexible Connections: Install flexible duct connections on all externally spring isolated air handling units including roof mounted units down through roof curbs (and/or to unit side duct connections). Fan connections, both at inlet and discharge, shall be made with flexible materials so as to prevent the transfer of vibration from fans to ductwork connected thereto.
- C. Flexible Pipe Connections:
  - 1. Provide flexible connections on all piping to spring isolated equipment, where indicated on Drawings and for all coils mounted in spring isolated air handling units or plenums. Coils in rigid units and plenums do not require flexible connectors. Provide a flexible connection in both the supply and return connections to the coil as near the coil as possible.
  - 2. Install connectors in a straight line as recommended by the manufacturer without offsets or twists and support pipe without any load on flexible connectors. Minimum live length shall be as follows:

<u>Pipe Size</u>	<u>Minimum Live Length</u>
1" through 1-1/2"	8"
2" through 2-1/2"	10"
3" through 4"	12"
Over 4"	18"

- D. Anchorage: Anchor all isolators to the floor, wall or ceiling structure and anchor points reinforced where necessary. Anchor bolts, cap screws, etc., shall not be continuous through the isolator such that vibrations are transmitted to the structure.
- E. Adjustment: Adjustable during and after installation, to ensure sufficient clearance between vibration isolation element and rigid restraining device. Do not install isolators until they have been loaded and adjusted to achieve the specified static deflection and clearances.
- F. Housekeeping Pads: Construct minimum 3" thick with chamfered edges using 3000 psi concrete. Provide #4 reinforcing bars 8" on center in each direction and within 4" of each edge, centered in pad thickness. Provide 1/2" dowel with 3" embedment into floor slab for each 2 square feet of pad area. Dowels and equipment anchor bolts shall be spaced a minimum of 6" from pad edges.

### 3.02 EQUIPMENT RESTRAINTS

- A. All equipment shall be anchored to resist displacement including sliding, swinging, and overturning due to seismic forces. Friction due to equipment weight shall not be considered as anchorage.
- B. Contractor shall submit shop Drawings showing seismic restraint design for all equipment weighing 400 lbs. or more. Design shall show analysis of supporting structure, anchorages, and restraints in accordance with OSSC Section 16.

**END OF SECTION**



**TESTING, ADJUSTING AND BALANCING****PART 1 GENERAL****1.01 DESCRIPTION**

- A. Work Included: After completion of the work of installation, test and regulate all components of the new heating, air conditioning and ventilating systems to verify air volumes and heating-cooling flow rates indicated on the Drawings.
- B. Balancing Organization:
  - 1. Balancing of the Heating and Air Conditioning Systems: Performed by a firm providing this service established in the State of Oregon.
  - 2. Balancing Organization: Approval by Architect. Air Balancing Specialties, Neudorfer Engineers, Northwest Engineering Services, or approved.
  - 3. Provide all necessary personnel, equipment, and services.
- C. Balancer shall perform work as a Contractor to the General Contractor directly, not through the Mechanical Contractor.

**1.02 QUALITY ASSURANCE**

- A. Balancing of the Heating and Air Conditioning Systems: Agency shall be a current member of NEBB or AABC specializing in the adjusting and balancing of systems specified with a minimum of 10 years documented experience.
- B. Testing, adjusting, and balancing shall be performed under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor.

**1.03 SUBMITTALS**

- A. See Section in Division 1, Administrative Requirements, for submittal procedures.
- B. Submit name of adjusting and balancing agency for approval within 30 days after award of Contract.
- C. Field Reports: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
  - 1. Submit under provisions of Section 23 05 00.
  - 2. Prior to commencing work, submit report forms or outlines indicating adjusting, balancing, and equipment data required.
  - 3. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
  - 4. Provide reports in soft cover, letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
  - 5. Include detailed procedures, agenda, sample report forms, and copy of AABC National Project Performance Guaranty or other certifying agency prior to commencing system balance.
  - 6. Test Reports: Indicate data on AABC MN-1 forms, forms prepared following ASHRAE 111, NEBB forms, or forms containing information indicated in Schedules.
  - 7. Include the following on the title page of each report:
    - a. Name of testing, adjusting, and balancing agency.
    - b. Address of testing, adjusting, and balancing agency.

- c. Telephone number of testing, adjusting, and balancing agency.
  - d. Project name.
  - e. Project location.
  - f. Project Architect and Owner.
  - g. Project Engineer.
  - h. Project Contractor.
  - i. Project altitude.
  - j. Report date.
- D. Project Record Documents: Record actual locations of flow measuring stations and balancing valves and rough setting.
- E. Provide a list of equipment, air supply, return and exhaust, heating water, and chilled water systems not in compliance with tolerances subsequently specified.

## PART 2 PRODUCTS

-- NOT USED --

## PART 3 EXECUTION

### 3.01 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
  - 1. Systems are started and operating in a safe and normal condition.
  - 2. Temperature control systems are installed complete and operable.
  - 3. Proper thermal overload protection is in place for electrical equipment.
  - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
  - 5. Duct systems are clean of debris.
  - 6. Fans are rotating correctly.
  - 7. Access doors are closed and duct end caps are in place.
  - 8. Air outlets are installed and connected.
  - 9. Duct system leakage is minimized.
- B. Submit field reports. Report defects and deficiencies noted during performance of services which prevent system balance.
- C. Beginning of work means acceptance of existing conditions.

### 3.02 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus 10 percent or minus 5 percent of design for supply systems and +/- 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent or minus 5 percent of design to space. Adjust outlets and inlets in space to within +/- 10 percent of design.

### 3.03 ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.

- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Owner.

#### 3.04 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust noise distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to the extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- L. Measure building static pressure and adjust supply, return, and exhaust air systems to provide required relationship between each to maintain approximately 0.02" (12.5 Pa) positive static pressure near the building entries.
- M. Space pressure Control, Relief Fan Speed Endpoints: Determine at what OSA damper position the power exhaust or relief fan is to begin operation, the power exhaust or relief fan speed increase over the range of OSA damper position and when relief fans are to stage up or down based on OSA damper position. Coordinate and provide this information to the Control Contractor for programming.
- N. CO2 controller set points – minimum CO2 setpoint (ppm), maximum CO2 setpoint (ppm)(setting

for min OSA at full occupancy).

- O. Outside air intake damper settings at minimum CO<sub>2</sub> and maximum CO<sub>2</sub> setpoint.

### 3.05 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
1. Air handling units
  2. Fans
  3. Air filters
  4. Air inlets and outlets
- B. Report:
1. Summary Comments:
    - a. Design versus final performance
    - b. Notable characteristics of system
    - c. Description of systems operation sequence
    - d. Summary of outdoor and exhaust flows to indicate amount of building pressurization.
    - e. Nomenclature used throughout report
    - f. Test conditions
  2. Instrument List:
    - a. Instrument
    - b. Manufacturer
    - c. Model number
    - d. Serial number
    - e. Range
    - f. Calibration date
- C. Electric Motors:
1. Manufacturer
  2. Model/frame
  3. HP/BHP
  4. Phase, voltage, amperage; nameplate, actual, no load
  5. RPM
  6. Service factor
  7. Starter size, rating, heater elements
  8. Sheave make/size/model
- D. V-Belt Drives:
1. Identification/location
  2. Required driven RPM
  3. Driven sheave, diameter, and RPM
  4. Belt, size, and quantity
  5. Motor sheave diameter and RPM
  6. Center to center distance, maximum, minimum, and tested
- E. Heating Sections:
1. Identification/number
  2. Location
  3. Service
  4. Manufacturer
  5. Air flow, design and tested
  6. Entering air temperature, design and tested
  7. Leaving air temperature, design and tested
  8. Air pressure drop, design and tested



- F. Air Moving Equipment:
  - 1. Location
  - 2. Manufacturer
  - 3. Model number
  - 4. Serial number
  - 5. Arrangement/Class/Discharge
  - 6. Air flow, specified and tested
  - 7. Return air flow, specified and tested
  - 8. Outside air flow, specified and tested
  - 9. Total static pressure (total external), specified and tested
  - 10. Inlet pressure
  - 11. Discharge pressure
  - 12. Sheave make/size/bore
  - 13. Number of Belts/Make/Size
  - 14. Fan RPM
- G. Return Air/Outside Air:
  - 1. Identification/location
  - 2. Supply air flow, design and tested
  - 3. Return air flow, design and tested
  - 4. Outside air flow, design and tested
  - 5. Return air temperature
  - 6. Outside air temperature
  - 7. Mixed air temperature, design and tested
- H. Exhaust Fans:
  - 1. Location
  - 2. Manufacturer
  - 3. Model number
  - 4. Serial number
  - 5. Air flow, specified and tested
  - 6. Total static pressure (total external), specified and tested
  - 7. Inlet pressure
  - 8. Discharge pressure
  - 9. Sheave Make/Size/Bore
  - 10. Number of Belts/Make/Size
  - 11. Fan RPM
- I. Duct Traverses:
  - 1. System zone/branch
  - 2. Duct size
  - 3. Area
  - 4. Design velocity
  - 5. Design air flow
  - 6. Test velocity
  - 7. Test air flow
  - 8. Duct static pressure
  - 9. Air temperature
  - 10. Air correction factor
- J. Air Distribution Tests:
  - 1. Air terminal number
  - 2. Room number/location
  - 3. Terminal type
  - 4. Terminal size

5. Area factor
6. Design velocity
7. Design air flow
8. Test (final) velocity
9. Test (final) air flow
10. Percent of design air flow

**3.06 DETAILED REQUIREMENTS**

- A. Adjusting and Balancing:
  1. Adjust and balance all portions of the mechanical systems to produce indicated results within limits of minus 5 or plus 10 percent or as subsequently directed by the Architect.
  2. Balancing data may be spot checked with instruments similar to that used by the balancing firm.
  3. If, in the judgment of the Architect, the discrepancies warrant additional adjustment, readjust and rebalance the systems at no additional project cost.

**END OF SECTION**

**HVAC INSULATION**

**PART 1 GENERAL**

**1.01 DESCRIPTION**

- A. The requirements of this section apply to the insulation of mechanical equipment specified elsewhere in these specifications.
- B. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

**1.02 QUALITY ASSURANCE**

- A. Insulation Thickness and Thermal Performance: Comply with provisions of the State of Oregon Energy Code.
- B. Composite (Insulation, Jacket or Facing and Adhesives) Fire and Smoke Hazard Ratings: Not to exceed a flame spread of 25 or smoke development of 50 and containing less than 0.1% by weight deca-PDE fire retardant.
- C. Component Ratings of Accessories (Adhesives, Mastics, Cements, Tapes, Finishing Cloth for Fittings): Same as "B" requirements above and permanently treated. No water soluble treatments.

**1.03 PRODUCT DELIVERY, STORAGE AND HANDLING**

- A. General: In addition to the requirements specified in Section 23 05 00, the following apply:
  - 1. Deliver insulation, coverings, cements, adhesives and coatings to the site in factory-fabricated containers with the manufacturer's stamp or label affixed showing fire hazard ratings of the products. Store insulation in original wrappings and protect from weather and construction traffic.
  - 2. Protect insulation against dirt, water, chemical and mechanical damage. Do not install damaged insulation. Remove such insulation from project site.

**1.04 SUBMITTALS**

- A. Submit catalog data and performance characteristics for each product specified.

**PART 2 PRODUCTS**

**2.01 ACCEPTABLE MANUFACTURERS**

- A. Insulating Manufacturers: Johns Manville, Knauf, Armstrong, Owens-Corning, Pittsburgh Corning, Pabco, Imcoa or Certain Teed. Johns Manville products are listed unless indicated otherwise.
- B. Adhesive Manufacturers: Foster, 3M, Insul-Coustic, Borden, Kingco or Armstrong.

**2.02 DUCT INSULATION**

- A. Interior Above Grade Ductwork: Glass fiber formaldehyde-free blanket with "FSK" facing, k value = 0.31 at 75 deg. F, 0.2 perms, and UL 25/50 surface burning rating. Johns Manville "Microlite."

**PART 3 EXECUTION**

**3.01 DUCTWORK INSULATION**

- A. Ductwork: Insulate the following:
  - 1. All supply ductwork.
  - 2. All supply and return ductwork in systems routed in unconditioned spaces or exposed to the outside conditions.
  - 3. All outside air intake ducts.
  - 4. All ductwork required to be insulated by code.
  - 5. All relief ducts.
- B. Insulation Thickness: Select board and blanket insulation of thickness required to provide the following installed R-value.
  - 1. All heating or cooling system supply and return ducts located on the exterior of the insulated building envelope and all outside air intake ducts.
    - a. R-8
  - 2. All heating and cooling system supply ducts located inside of building envelope or in unconditioned spaces, R-5.
  - 3. All heating and cooling system return ducts located in vented spaces, R-8.
- C. Fittings: Wire and duct adhesive as required. To prevent sagging on all rectangular or square ducts over 24" wide, install Gramweld or equal welding pins on the bottom. Maximum spacing 18" on center in both directions.
- D. Installation: Applied with butt joints, all seams sealed with vapor seal mastic or taped with 2" wide vapor-proof, pressure-sensitive tape. Seal all penetrations with vapor barrier adhesive.
- E. Internally Lined Ductwork: Where internally lined ductwork is indicated on the Drawings and/or specified, no exterior insulation is required. Select duct lining to provide the required R-value. Carefully lap the ends of the exterior insulation a minimum of 6" past the interior insulation unless otherwise shown. Seal the end of vapor barrier jacket to the duct with mastic where the vapor barrier is required. Duct lining is specified in Section 23 30 00.

**END OF SECTION**

**DDC CONTROLS****PART 1 GENERAL SYSTEM DESCRIPTION****1.01 GENERAL REQUIREMENTS**

- A. Drawings and general provisions of the Contract, including General and other Conditions and other Division 1 – General Requirements sections, apply to the work specified in this Section.

**1.02 BASIC SYSTEM**

- A. Building Automation System (BAS) system shall utilize DDC to control valve and damper actuators for all mechanical equipment as specified in the sequence of operation and in the drawings for all systems.
- B. The control system shall be fully integrated and installed as a complete package of controls and instruments in a manner that provides maximum benefit to the end user.
- C. The system shall include all computer software and hardware, control unit hardware and software, operator input/output devices, sensors, control devices, and miscellaneous devices required for complete operation and future modifications. Documentation for all software and hardware devices shall be provided.
- D. Provide engineering, installation, calibration, commissioning, acceptance testing assistance, software programming, and checkout for complete and fully operational DDC.
- E. Existing Johnson Control devices may be re-used if tested confirmed operational and compatible with the new system.

**1.03 SCOPE OF SERVICES (OVERVIEW OF SECTION 23 09 23)**

- A. Work under this section of the specification shall include, but not limited to, the following:
  - 1. Furnish and install a complete sensor, actuator, wiring and piping system for all air handling and related equipment as shown on the plans and specified in this section. Install all necessary sensors and actuators as required by the plans and specifications and equipment schedules.
  - 2. Label all sensors, control devices, and control units.
  - 3. Furnish and install conduit, wire, branch circuit protection, etc. as required to bring 120 VAC power to control panel locations and equipment (actuators, sensors, control devices, etc.) as shown on the drawings and described in the specifications.
  - 4. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.
  - 5. Coordination as required with other sections of the specification for the proper and complete installation of the wiring system, control devices, dampers, valve, actuators, etc.
  - 6. Furnish and install Direct Digital Control Equipment (DDC) as required by the point list, plans, and specifications including, control units, software, database development, check-out, and debugging. Provide points necessary for a complete and operable system.
  - 7. Install the sequence of operations specified in the drawings and in this section.
  - 8. Software testing requirements shall include testing in the field of all logic sequences including actual simulation of different processes and events and observing program response to the process or event. All deviations from the requirements of the sequence as specified on the drawings or this specification shall be corrected immediately at no additional cost to the Owner.
  - 9. Provide documentation of software system testing before acceptance testing.
  - 10. Provide staff for acceptance testing procedures. Modify hardware and software

- errors/problems at no additional cost to the Owner.
- 11. Provide a series of training classes for Owner staff.
- 12. Setup trending data before and after system acceptance.
- 13. Attend a series of meetings with the Engineer and Owner to agree on system setup and operating parameters.
- 14. Provide detailed documentation of system configuration including control units and all control devices.
- 15. Provide all software (with hardware connections) and software license for district computer as required.
- 16. Read this section in its entirety for specific details.
- 17. If the Control Contractor cannot comply with any of these specifications, then the Control Contractor must explain in writing the reasons for non-compliance and provide an alternative approach that satisfies these requirements.
- 18. Provide all equipment and personnel to complete system commission per previous section and as listed further in specification.

#### 1.04 QUALITY ASSURANCE AND SYSTEM OVERVIEW

- A. The BAS system shall be designed, installed, commissioned, and serviced by qualified Contractor.
  - 1. The Contractor shall be pre-qualified per Beaverton School District Control Contractor review process.
  - 2. Control Contractor shall operate a local branch facility within 75 miles of the job site.
  - 3. Emergency service shall be available 24/7.
- B. Acceptable Control System Contractors and Manufacturers: Control systems shall be BTL listed across the line of product controllers (BACnet advanced application controller B-AAC, BACnet Building Controller (B-BC) controllers and BACnet application specific controllers) B-ASC as defined by BACnet International testing standards.
- C. All products proposed for this contract shall have been in continuous and successful use for at least two (2) year (not including beta testing).
- D. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specially for this project.
- E. The control system shall be forward compatible with future versions of the manufacturer's hardware, firmware, and software. Future versions of the manufacturer's hardware, firmware, and software shall be backward compatible with the installed control system. Forward and backward compatibility shall be guaranteed for at least five (5) years from the time of system acceptance. Any hardware, firmware, or software modifications or replacements required within that period because of incompatibility with new hardware, firmware, or software installed in the same facility shall be at no cost to the Owner.  
Note: Equipment (controllers and software) should be provided by single manufacturer. All other products (e.g., sensors, valves, dampers, and actuators) need not be manufactured by the control manufacturer.
- F. System shall be web based.
- G. Commissioning of the new mechanical devices and control system shall be completed. Coordinate with Owners Commissioning Contractor.

#### 1.05 CONTROL CONTRACTOR/MANUFACTURER QUALIFICATIONS

- A. The Control Contractor shall have WEB based programming tools required to program and modify the BAS controllers.

- B. Proprietary programming tools are not allowed
- C. All programming tools shall be supplied to the Owner for future use.
- D. See Basic System Requirements (1.02) for additional requirements.
- E. The Controls Contractor shall be regularly engaged in the engineering, programming, installation, and service of Control Systems by the selected manufacturer and shall have a minimum of five years' experience with the complete, turn-key installation of Controls by the same manufacturer of similar size and technical complexity. If portions of the installation will be performed by a Subcontractor, the Controls Contractor will submit to BSD, two sample installations performed by Subcontractor which are similar to the current project. The Controls Contractor shall have a local branch facility within a 75-mile radius of the job site. Emergency service shall be available on a 24-hour, 7-day-a-week basis. Acceptable Controls Contractors:
  - 1. Johnson Controls, Inc., 4011 S.E. International Way #605, Milwaukie, OR 97222.
  - 2. Northwest Control Contractors, 8750 SE McLoughlin Blvd, Milwaukie, OR 97222
  - 3. Or selected Johnson Controls Inc. Authorized Building Controls Specialist (ABCS), and their designated agents.
  - 4. Selection of Controls Contractors is subject to approval by BSD.  
Controls Contractors not currently approved by the District shall provide a list of five comparable projects that have Controls with the features as specified for this project. These projects must be on-line and functional.
- F. No installer or programmer substitutions will be made without written approval from the Owner.
- G. All materials, products, and equipment used for this contract shall be standard components that have been in full production with continuous and successful use for at least two years.
- H. The Controls architecture shall consist of the products of a manufacturer regularly engaged in the production of Controls, and shall be the manufacturer's latest proven standard design. Controllers and DDC (Direct Digital Control) system components shall be current production products.
- I. All other equipment shall be the products of the CONTROLS manufacturer or of an approved manufacturer regularly engaged in production of specialized Controls materials or equipment.
- J. The Controls Manufacturer will provide a written guarantee to the Owner that the system and technology being provided will be supported for a minimum of ten years following the completion and acceptance of the project.
- K. Johnson Control System shall be the current version used by Beaverton School District. Graphics shall match the quality, type, and operability of the current graphics used by Beaverton School District. All devices, controls, graphics, and programming shall be compatible with current Beaverton School District standards.

#### 1.06 RELATED SECTIONS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Mechanical Special Conditions, Electrical Special Conditions and Division - 1 Specification.
- B. Coordination with Other Trades:
  - 1. This section specifies cooperation of the Control Contractor (the combination of installer and programmer hence forth) with other trades and including balancing firm to assure proper arrangement of control items. Control valves, dampers, wiring, thermostat wells, and other control devices that are to be built into the field assembled ductwork, piping, or wiring systems shall be furnished by the Control Contractor and installed under other sections of the specification as directed by the Control Contractor and indicated in other

- portions of the specifications and drawings.
2. The Control Contractor shall insure that the DDC system communicates successfully with other equipment (e.g., air handling units, packaged rooftop units, heat pumps, motors, actuators, etc.). Note: the equipment supplier is responsible for the proper performance of their equipment (assuming the proper signals are sent/received from the BAS). The Control Contractor is responsible for all system sensors, including those which are factory installed.
  3. Electrical Wiring: All wiring required for work under this section of the specification shall be provided under this section of the specification unless otherwise specified.
  4. Electrical wiring - power for control panels, control devices, and sensors
    - a. Power for control units, control devices and sensors shall be coordinated with the air handling manufacturer for the project and/or the Owner.
    - b. Contact locations in starter control circuits. All contacts controlling motor starters, including overload contacts, shall be located on the hot side of the coil (ungrounded control power leg). Coordinate this requirement with the air handling manufacturer for the project.
    - c. Extend power to damper actuators.
      - 1) Actuators will be powered at 24 VAC.
      - 2) At each auxiliary panel location, furnish and install a 24 VAC transformer with 20 VA of capacity for each actuator installed and served from the panel.
      - 3) Furnish and install a fused terminal in the +24 VAC lead and a disconnecting terminal in the neutral lead of the power cable to each actuator.
  5. Testing, Adjusting and Balancing: If necessary, The Controls Contractor shall operate the BAS to assist the TAB Contractor.

#### 1.07 QUALITY CONTROL – CODES AND STANDARDS

- A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications. As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids for the following codes:
  1. National Electric Code (NEC)
  2. Uniform Building Code (UBC), Oregon Structural Specialty Code
  3. Uniform Mechanical Code (UMC), Oregon Mechanical Specialty Code
  4. Underwriters Laboratories (UL)
  5. National Electric Manufacturers' Association (NEMA)
  6. National Fire Prevention Association (NFPA)
  7. American Society Of Heating, Refrigeration, And Air Conditioning Engineers (ASHRAE)
  8. Instrument Society Of America (ISA)
  9. National Institute of Standards and Technology (NIST).
- B. Meet all of the local authorities and State Fire Marshal code requirements for normal operating and smoke mode functions.

#### 1.08 SUBMITTALS

- A. Shop drawing submittals are required for the following, in accordance with Section 23 05 00. The Contractor shall not start the project until the Shop Drawings have been submitted and approved. Shop drawings shall include:
  1. All submittals should be provided on paper (with legible font type and size).
  2. All drawings should be labeled TC (temperature control) rather than being referenced within the mechanical or electrical divisions. Sheets shall be consecutively numbered
  3. One drawing per air handler or system (e.g., boiler plant). Drawing should include point



descriptors (DI, DO, AI, AO), addressing, and point names. Each point names should be unique (within a system and between systems). For example, the point named for the mixed air temperature for AH#1, AH #2, and AH #3 should not be MAT but could be named AH #1 MAT, AH #2 MAT, and AH #3 MAT. The point names could be logical and consistent between systems and AHs. The abbreviation or short hand notation (e.g., MAT) should be clearly defined in writing by the Control Contractor. See Section 5 for Naming Standard.

4. Floor plans depicting all BAS control devices (control units, control devices, gateways, LAN interface devices, actuators, sensors, motor control centers, etc.) in relation to mechanical rooms, HVAC equipment, and building footprint.
5. DDC System Engineer diagram indicating schematic location of all Control Units, workstations, LAN Interface devices, gateways, etc. Indicate address and type for each Control Unit. Indicate protocol, baud rate, and type of LAN (per Control Unit).
6. For each drawing, include a schematic flow diagram of each air and water system showing fans, coils, dampers, valves, pumps, heat exchange equipment, control devices, etc. Label each control device with setting or adjustable range of control. Label each input and output with the appropriate range.
7. Electrical wiring diagrams shall include both ladder logic type diagrams for motor start, control, and safety circuits and detailed digital interface panel control point termination diagrams with all wire numbers and terminal block numbers identified. Indicate all required electrical wiring. Provide panel termination drawings on separate drawings. Ladder diagrams shall appear on system schematic. Clearly differentiate between portions of wiring that are existing, factory-installed and portions to be field-installed.
8. Show all electric connections of the controls system to equipment furnished by others complete to terminal points identified with manufacturer's terminal recommendations.
9. Control Contractor shall provide one complete drawing that shows the equipment (fan unit, boiler, chiller, etc.) manufacturers wiring diagram with the Control Contractors wiring diagram superimposed on it.
10. Provide sequence of operation based on sequence in these documents, as discussed with Engineer and Owner and as modified based on site conditions and normal programming protocol. Provide details such as levels controlled to and point designations. Simply copying the sequence from these documents is not sufficient.
11. Provide complete panel drawings that are
  - a. Clearly labeled.
  - b. Drawn to scale
  - c. Show the internal and external component arrangement so that the operators can identify the components by their position if the labels come off
  - d. Wiring access routes should also be identified so that Class 1 wiring is separated from Class 2 and 3 and so high voltage wiring is segregated from low voltage wiring and tubing.
12. Cataloged cut sheets of all equipment used. This includes, but is not limited to, the following: DDC panels, peripherals, sensors, actuators, dampers, control air system components, and so forth.
  - a. Range and scale information for all transmitters and sensors. This sheet shall clearly indicate one device and any applicable options. Where more than one device to be used is on a single sheet, submit two sheets, individually marked.
  - b. Manufacturer's installation, operation and maintenance data for all equipment.
13. Training course outlines for each four-hour session.
14. Hardware data sheets for all operator workstations, local access panels, and portable operator terminals.
15. Software manuals for all applications programs to be provided as a part of the operator workstations, portable operator terminals, programming devices, and so forth for evaluation for compliance with the performance requirements of this Specification.
16. Initial project team Quality Assurance compliance report.
17. Bill of materials for each system with part numbers.
18. Provide all necessary BACnet-compliant hardware and software to meet the system's

functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system, including unitary controllers.

19. Damper schedule should include:
  - a. Action (normally open or closed)
  - b. Direct or reverse actuation
  - c. Manufacturer make and model
  - d. Design pressure drop at full flow
  - e. Leakage rate
  - f. Operating range
  - g. Flow rate
  - h. Actuator requirements
  - i. Actuator spring range
  - j. Special construction features (U.L. listed smoke damper, etc.)
20. Shop drawings submitted are required within 21 days of contract award.

**B. Record Documents:**

1. Provide a complete set of control drawings with as-installed equipment and operating sequences on paper and in electronic format (AutoCAD). "As-built" (i.e., as-installed and debugged and after system acceptance) documentation shall include the following as minimum:
  - a. All data specified in the shop drawings section in its final "as-built" form.
  - b. Schematic outline of the overall control system for quick reference
  - c. Adequate record of the work as installed, including exact location of control panels and the wiring route (using TC documents, section 1.8-3).
  - d. Blue prints shall include sequence of operation.
  - e. System hardware specification data which provides a functional description of all hardware components.
  - f. System engineering information which provides all of the information for the system set-up, definition and application.
  - g. System database information that provides the point names and application data programmed into the system.
  - h. All of the information, data, procedures and drawings shall be supplied in the form of manuals.
2. Provide as-installed (after system acceptance) control logic diagrams showing all points (real and virtual).
3. DDC systems that use line-based programming must reference line code number with control logic diagrams and/or with sequence of operation text. Control Contractor shall discuss final format with Owner.
4. Provide licensed electronic copies of all software for each workstation and laptop. This includes, but is not limited to: project graphic images, project database, trouble-shooting and debugging programs, project-specific application programming code and all other software required to operate and modify the programming code (including software at system level, primary control units, secondary control units, and all communication software). Any hardware devices (cables, protection devices) required to operate the software/hardware shall also be provided.
5. The Control Contractor shall document deviations from the shop drawing submittals. Documentation should include what equipment was changed and the reason for the change.
6. Provide copy of final test reports.
7. Provide within 21 days of substantial completion.
8. Documents shall be provided as a PDF file. See O & M for number of hard copies.

**C. Operating and Maintenance Materials:**

1. Submit three sets of each manual within three weeks (21 calendar days) of Substantial Completion.

- a. Include the following documentation in the Hardware Manual:
    - 1) General description and cut sheets for all components.
    - 2) Detailed wiring and installation illustrations and complete calibration procedures for each field and panel device.
    - 3) Complete trouble-shooting procedures and guidelines.
    - 4) Complete operating instructions for all systems.
    - 5) Maintenance Instructions: Document all maintenance and repair/replacement procedures.
  - b. Include the following documentation in the DDC Software Manual:
    - 1) Sequence of Operations
    - 2) Program Listing of Software Source Code OR Flow Chart Diagrams of Programming Objects.
    - 3) Printed listing of controller and operator workstation database files.
    - 4) Software Point Name Abbreviation List. Include Name, Description, Controller Where Located, Point Type and Point ID.
    - 5) I/O Point List. Include Point Name, Controller Location, Point Number, Control Device, Range and Span.
    - 6) Printouts of the following; Reports, Group Listings and Alarm Messages.
    - 7) Index of all DDC point names with documentation, manual page number references.
  - c. Provide all English language manufacturers manuals covering the installed system. This shall include, as a minimum:
    - 1) System Engineering Manual
    - 2) System Installation Manual
    - 3) Programming Manual
    - 4) Engineering and Troubleshooting Bulletins
    - 5) Operator Workstation Software Manual
    - 6) All other pertinent manuals published by the control system manufacturer.
2. All manuals shall be provided in an editable PDF file with tabs and an index for each device or system. Copyrighted factory manuals may be in a PDF file.

#### 1.09 WARRANTY

- A. Material:
  1. The Control System shall be free from defects in material and workmanship under normal use and service. If within thirty six (36) months from the date of substantial completion any of the equipment herein described is defective in operation, workmanship or materials, it will be replaced, repaired or adjusted at the option of the Controls Contractor free of charge.
- B. Installation:
  1. The Control System shall be free from defects for a period of one year from acceptance. The Controls Contractor shall, free of charge, correct any defects in workmanship within one week of notification in writing by the Owner.
- C. System Compatibility
  1. The Controls Manufacturer will provide a written guarantee to the Owner that the system and technology being provided will be supported for a minimum of ten years.

#### 1.10 DELIVERY AND STORAGE

- A. Provide factory-shipping cartons for each piece of equipment and control device not factory installed. Provide factory applied plastic end caps on each length of pipe and tube. Maintain cartons and end caps through shipping, storage, and handling as required to prevent equipment and

pipe-end damage, and to eliminate dirt and moisture from equipment and inside of pipe and tubes. Store equipment and materials inside and protected from weather.

#### 1.11 DEMOLITION

- A. Remove all control devices no longer used.

#### 1.12 DISCREPANCIES

- A. Any items not included in the specification but referred to in the Appendix and/or Drawings in reference to this project and any other incidentals not referred to but required as a basic element to the overall performance and/or successful completion of the work shall be installed as part of this contract.

### PART 2 PRODUCTS

#### 2.01 BASIC MATERIALS, CONTROL DEVICES, SENSORS

- A. Installation of some of the equipment in this section may be the responsibility of other Contractors
- B. All sensors and equipment related to or connected to the DDC system shall be installed according to manufacturer's recommendations.

#### 2.02 WIRING, CONDUIT, AND HANGERS

- A. To supply, install and connect all conduits, boxes and wires between all the different components related in this section including all line voltage to the equipment.
- B. Provide all necessary field wiring and devices from the point of connection indicated on the drawings. Bring to the attention of the Engineer in writing, all conflicts, incompatibilities, and/or discrepancies prior to bid or as soon as discovered.
- C. Field Wiring: It is the intent of these specifications that all systems shall be complete and operable. Refer to all drawings and specifications to determine voltage, phase, circuit ampacity and number of connections provided.
- D. All wiring and fiber optic cable in the central plant, tunnels, and plenums to be supported by B-line Bridle rings or equal. All wiring and fiber optic cable in the hallways, rooms, and other public areas shall be in conduit unless noted otherwise in section H.
- E. All wires in Bridle Rings or conduit shall follow building lines (i.e., wires in plenum space shall run within several inches of the wall and shall NOT run in the middle of the space). Those areas of the building with RA plenum ceilings where wire is routed above that wire shall be plenum rated or routed in conduit.
- F. Wire:
  - 1. Wire and cable of the sizes and types shown on the plans and/or hereinafter specified shall be furnished and installed by the Control Contractor. All wire and cable shall be new soft drawn copper and shall conform to all the latest requirements of the National Electrical Code, IPCEA, and shall meet the specifications of the ASTM.
  - 2. All control wiring to be copper stranded TEW-105, with appropriate gauge in accordance with the Codes. The minimum gauge used to be 16 AWG.
  - 3. Input/Output Wiring: Wiring serving inputs and outputs from the BAS shall be cables consisting of single or multiple twisted individually shielded pairs. Each pair shall have an independent shield with drain wire. Cables installed without conduit shall be plenum

- rated and comply with NEC article 725. Where automation input/output wiring is run in cable tray furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 340 and/or 725. Conductors shall be minimum #18 wire gauge.
4. Power Conductors: All feeder and branch circuit wire shall be 600 V insulated of THHN type unless shown or specified to be otherwise. No wire less than No. 12 gauge shall be used except for control circuits or low voltage wiring. Wire sizes No. 14 to No. 10 shall be solid except where otherwise indicated. Wire sizes No. 8 and larger shall be stranded. All wire sizes shown are American Wire Gauge sizes. Where power conductors are run in cable tray, furnish and install conductors or multi-conductor cable rated for use in cable trays per NEC articles 340 and/or 725.
  5. All the conductors used for signals from the Controllers and field sensors must be shielded two wire, 18 AWG. with a drain wire. Conductor model 8760 from Belden is to be used or approved alternative by Engineer.
  6. All power wiring to be copper stranded RW 90 type, with appropriate gauge in accordance with the Codes. The following color code must be applied: line voltage to be black and/or white, ground to be green.
  7. Acceptable Manufacturers: Cable and wire shall be a standard type as manufactured by General Electric Company, National Electric Company, U. S. Rubber Company, Simplex, General Cable Company, Carol, Anaconda, Rome, Southwire, Belden, Alpha, Houston Wire and Cable, or ITT Royal.
- G. Wiring Installation:
1. All wires shall be continuous from outlet to outlet and there shall be no unnecessary slack in the conductors.
  2. All wire terminations will be identified using rail terminal strips (see 5.11)
  3. All drain wires must be grounded at the source end. The other end must be protected with a dielectric material (tape).
  4. All control wiring (24 V and more) must be in a separate conduit from the shielded conductors.
  5. Pull-Box and Junction Box:
    - a. Pull boxes and junction boxes shall be installed where indicated on the drawings or where required to facilitate wire installation. Locate in conjunction with other trades so as to install without conflict with other materials or equipment.
    - b. A pull-box will be located at every 50'.
    - c. All switch, pull, junction boxes, etc., shall be hot dipped galvanized or sherardized, concrete tight, with interlocking ring or multiple point locking devices. Connectors shall be three piece. Indentation fittings are not acceptable.
    - d. In suspended ceilings, all boxes must be installed on the structure.
    - e. Boxes shall be attached by fasteners designed for the purpose and shall provide adequate mechanical strength for future maintenance.
    - f. Junction and pull boxes not dimensioned shall be minimum 4 inch square.
  6. Care shall be used to avoid proximity to heat ducts and/or steam lines. Where crossings are unavoidable, conduit shall clear covering of line by at least six inches.
  7. Motor Interlock Wiring: Interlock circuit wiring shall be No. 14 solid or stranded wire. Stranded wire only shall be used where wiring is used for flexible wiring harnesses. Stranded control wire shall be provided with crimp type spade terminators. Interlock circuit wiring shall be color coded or numbered using an identical number on both ends of the conductor. Wire numbers shall be installed before conductors are pulled. Where motor interlock conductors are run in cable tray, furnish and install conductors or multiconductor cable rated for use in cable trays per NEC articles 340 and/or 725.
  8. All splices, taps, and terminations shall be made at outlet, junction, or pull boxes. Wire to No.6 gauge shall be spliced using Scotchlok wire nuts. No Bakelite wirenuts shall be used. Wire No. 6 and larger shall be spliced using solderness connectors as manufactured by Penn Union Company. Splices No. 6 and larger shall be insulated by taping with plastic vinyl tape as manufactured by Minnesota Mining and Manufacturing Company. Splices shall not be permitted in automation input and output wiring with out specific

written authorization from the Engineer. If such a splice is approved, the location of the splice shall be clearly documented on the "As Built" drawings. Splices in automation wiring, if necessary, shall be made using Thomas&Betts STA-KON connectors installed per the manufacturer's directions to maintain NEMA specified voltage drops and wire retention forces.

9. Grounding:

- a. The Contractor shall extend existing equipment grounding systems. The Contractor shall use only approved grounding clamps and connectors as manufactured by Penn-Union, Burndy or O-Z Mfg. Company.
- b. The conduit system of the 480/277 and 208Y/120 volt systems shall be continuous and shall be used as the static grounding conductor, except for circuits installed in flexible conduit. Install a green grounding conductor inside all flexible conduits and extend to the nearest outlet or junction box. Install a green grounding conductor inside all non-metallic conduits or raceways.

H. Conduit:

1. Conduit Material:

- a. All wiring to be in E.M.T. type conduits unless in plenum or otherwise noted below.
  - 1) Above accessible ceilings open cable with bridle ring support is allowed.
  - 2) Routed in corridors or other finished spaces on top of exposed sheet metal ducts supported with open wire way devices attached to the center top of the duct is allowed. Wire shall not be visible under casual observation of the installation.
  - 3) 12 ft. or more above the floor in mechanical rooms where supported per specifications.
- b. All conduits to be a minimum of 1/2".
- c. All flexible conduits will not exceed 6' in length and are to be used only in areas where vibrations and/or expansion joints are present.
- d. Flexible conduit to be used for connecting any element to its conduit. The length of this flexible conduit will not exceed 24".
- e. Jacketed flexible steel conduit (Sealtite) shall be used where flexible conduit connections are required outdoors and at connections to all motorized equipment and motors outdoors.
- f. In damp areas, the conduit and related equipment must be suitable for the application.
- g. Electrometallic tubing shall be installed for all exposed work and for all concealed work in applications where conduit is required. For exposed locations in finished spaces (halls, classrooms, offices, gym's etc.) conduit shall be painted. See Architectural Drawings for location where painting is required.
- h. Conduit shall be by Allied, Triangle, Republic, Youngstown, Carlon, Rob Roy, or approved equal.
- i. For exposed installations where the conduit cannot be run in ceiling spaces, wall cavities or attics, EMT is required. EMT shall be painted to match wall. See Painting Specification.

2. Conduit Installation:

- a. All wiring in mechanical rooms at heights below 12 feet must be run in conduit. Otherwise, wiring in all other open areas must have conduit (at all heights). Existing conduit runs where compliant with these specifications may be re-used.
- b. All conduits to be installed in a concealed manner where possible and shall be installed parallel to the lines of the building.
- c. All exposed conduits shall be installed parallel or at right angles to the building walls or floors.
- d. Conduit bends shall be made with standard hickies of proper size; radius of bends to be at least 6 times the diameter of the conduit. Runs between outlets

shall not contain more than the equivalent of three quarter bends. Conduit runs shall be continuous from outlet to outlet, outlet to cabinet, etc.

- e. Conduits shall be installed with pitch toward outlet box wherever possible. All heavy wall conduits shall have two locknuts and a bushing at each termination outlet box, junction box, etc., except where terminated in a threaded hub. Fittings on electrometallic tubing shall be compression type.
- f. A bushing shall be used where conduit enters a panel box. Bushing for No. 4 AWG or larger shall be insulated type with provisions for grounding as type "BL" made by O-Z Electric Company, or approved equal.
- g. Expansion fittings shall be provided at all conduits across the building expansion joints. Fittings shall be Type "AX" or "TX" as made by O-Z Electric Company, or approved equal. Provide copper bonding jumper at each expansion fitting.
- h. All ½" conduit to be supported every 6', the supports will be located at the connector end of the conduit.
- i. Exposed conduit shall be securely fastened in place on maximum 5 ft. intervals for ¾" through 2-1/2 inch nominal sizes. Supports may be one hole malleable straps or other approved devices. No perforated metal straps will be permitted.

I. Wireway:

- 1. Furnish and install at all control panel locations a NEMA 1 lay-in wireway system to bring cable into and out of the panel as detailed on the drawings and specified in this section. Furnish 3-way wireways at each panel location: one for Class 1 wiring, 1 for Class 2 and Class 3 wiring. Panels at units to be NEMA 3R or better.
- 2. Wireway systems at locations where cables are to be run without conduit or in a cable tray shall consist of a connection to the control panel with a vertical extension to 8'-0" or the pipe rack or cable tray level, whichever is higher. The vertical section shall terminate in a 90° fitting with a closure plate. The closure plate shall be provided with a conduit nipple with locknuts and bushings as a wire entry point into the square duct. The conduit nipple shall be one size smaller than the wireway it is associated with.
- 3. Wireway systems at locations where cables are to be run in conduit shall consist of a horizontal section of wireway with a length equal to the control panel width and located above the control panel and connected to the control panel with three conduit nipples, locknuts, and bushings; one for tubing, one for Class 1 wiring and one for Class 2 and 3 wiring. Conduits for cable runs shall terminate on the wireway.
- 4. The intent of the wireway configurations outlined above is to provide a method for adding input and output wiring to the control panel without having to drill directly into the electronics enclosure after the system is on-line and running and to provide sufficient area to land field conduits while maintaining appropriate circuit segregation for wire entry into the controller enclosure. The installation of wireway shall be made with this consideration in mind.

J. Hangers and Anchors:

- 1. Where control system tubing is run on trapezes and/or hangers used by and or installed by other trades, supports for the trapezes shall be coordinated by all trades using the trapeze to assure that the anchor system is not overloaded and is sufficient for the load imposed including a margin of safety and seismic considerations. Under no circumstances shall a trapeze or hanger system installed by the electrical trades be used to support work by any other trade, nor shall the electrical trades use the trapezes installed by any of the other trades for the support of electrical equipment, all as required by the National Electric Code. Similarly, under no circumstances shall a trapeze or hanger system installed by the sprinkler trades be used to support work by any other trade, nor shall the sprinkler trades use the trapezes installed by any of the other trades for the support of sprinkler systems or equipment, all as required by NFPA 13, Standard For The Installation Of Sprinkler Systems.
- 2. Anchors to be loaded in tension for use in existing concrete structure and anchors loaded

in tension and not cast in place shall be epoxy resin set anchors installed per the manufacturers recommendations for technique, size, loading, embedment, etc. Where anchors are loaded in shear at these locations, suitably sized and installed wedge type anchors may be used.

3. In all cases, anchor loading shall be based on hanger spacing, weight of the pipe to be supported when full and insulated, weight of any additional loads imposed upon the anchor, wind loading, seismic loading, quality of the material that the anchor is being installed in, etc. The Control Contractor shall verify in the field that the anchors used and the materials that they are being installed in are suitable for the load imposed and shall bring any problems to the attention of the Engineer in writing immediately and not proceed without direction from the Engineer.
4. Wedge type anchors shall be Hilti Kwik Bolt II. Adhesive anchors shall be Hilti HVA.

## 2.03 UNIT CONTROL PANELS (INSTALLATION AND FABRICATION)

- A. Enclosed cabinet type with hinged door for mounting all relays, switches, thermometers, and miscellaneous controls not requiring direct mounting on equipment such as sensing elements, valves and damper motors. Provide cabinet for each control unit adjacent to each system.
- B. Each panel shall have power conditioners on electrical supply, Crucial Power Product MI Series.
- C. Control panels shall be fabricated to match the approved shop drawings submitted by the Control Contractor. Fabrication shall be in a neat and workmanlike manner and shall facilitate repair, maintenance, and adjustment of the equipment contained therein.
- D. Control panels shall be fabricated and laid out to incorporate the following features:
  1. Identification of all internally and cover mounted devices. Cover mounted labels shall be engraved labels as specified in this section (5.10). Labels shall be mounted adjacent to the device they are associated with so that replacement of the device does not eliminate the label. Provide laminated control diagram at each panel.
  2. Electrical wiring shall enter the panel from the top, bottom, and/or side of the left side of the panel or as required by the panel supplier to meet NEC requirements.
  3. All wires entering or leaving the panel shall pass through a rail terminal strip. Where the wires are part of a current loop transmission circuit, the terminals shall be the disconnecting link type. Terminals shall be identified with a number that corresponds to the terminal number on the job wiring diagram. Rail terminal strip specifications include:
    - a. General: Terminal rail assemblies shall be fabricated from components selected from the product line of one manufacturer. Sizes (heights, widths, and profiles) of each terminal shall be selected to be compatible with the other terminals on the rail. Terminal units located at the end of a rail or adjacent to terminals with a different profile (for example, where disconnecting terminals are located next to resistor terminals) shall be provided with end caps to completely close off the terminal unit interior components from the local environment. End stops shall be provided for on all rails to secure the terminals located on the rail in place.
  4. All internal wiring and tubing shall be run inside plastic wiring/tubing duct as manufactured by Tyton. Wire duct shall be sized to hold the required number of wires and tubes without crimping the tubes and with sufficient space to allow wiring and tubing to be traced during troubleshooting operation.
  5. Wires that pass from the panel interior to cover mounted devices shall be provided with a flex loop that is anchored on both sides of the hinge. Wiring running to cover mounted devices shall be bundled using cable ties.
  6. Provide strain relief type cord and cable connectors for all cables that leave the panel as individual cables not in conduit.
  7. All control panels shall be provided with removable sub panels to allow the panel enclosures to be installed at the job site during rough in while the panels are fabricated off-site for later installation.



8. Provide one under cabinet type fluorescent light with switch mounted internally in the control panel. Panels with external light hoods will also be acceptable if the light will illuminate the panel interior with the door open.
  9. Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic or electrical control components. This receptacle may be served from the control panel 120 VAC power source.
  10. Each control panel shall be provided with a control power disconnect switch located and wired so as to disconnect all control power in the panel. The leaving side of this switch shall be wired to the panel and field components through a fuse or fuses sized and applied to protect both the components of the system as well as the wire and as required for code compliance.
  11. Power to the following equipment will be have a fuse rated for applicable current and voltage. Fuses will be on rail terminal strips. Equipment includes:
    - a. Each control unit
    - b. Control devices
    - c. Panel light
    - d. Receptacle loads (e.g., modems, laptops)
  12. All control panels containing electrical equipment shall be NEMA rated for the location in which they are installed. Cover mounted components, tubing penetration, and conduit penetrations shall be made in a manner consistent with the NEMA rating.
  13. All wiring leaving the panel shall be separated by classification; i.e., Class 1 circuits shall not be run with Class 2 circuits, etc. Segregation shall be maintained inside the panel to the fullest extent possible. Where low voltage wires carrying low level ac and dc signals cross wires containing power and high level ac signals, the wires shall cross at a 90° angle.
- E. Control panels shall be shop fabricated and tested prior to installation in the field. The panels shall be inspected and approved by the Engineer at the assembly location prior to installation in the field. The Engineer shall be given the opportunity to witness the testing of the panels.
- F. Panel Location:
1. Each control panel is to be located for convenient servicing.
  2. Mount panels adjacent to associated equipment on vibration isolation.

## 2.04 CONTROL DAMPER ACTUATORS AND VALVES

- A. Damper Actuator Requirements:
1. All damper actuators shall be Belimo electric actuators.
  2. Torque rating shall be based on the damper manufacturers operating torque requirements at the design flows and pressure drops or shall be based on the manufacturer's required shut-off torque to achieve the design leakage rate, whichever is greater. This higher torque rating shall be doubled. An actuator with this doubled torque rating shall be installed.
  3. All damper sections which operate in sequence with each other shall have identical actuators and identical linkage arrangements to assure similar performance between all sections.
  4. Modulated actuator operation shall be industry standard 0-10V.
  5. Two or three position operation is not acceptable for economizers, VAV dampers, multizone dampers, or any other application specifying modulated operation. OSA Dampers to be normally closed, mixed air dampers to be normally open.
  6. Spring returns on damper operators are required for OSA application.
  7. Actuator quantities for dampers shall be based on the following criteria.
    - a. Actuators must be outside unit enclosure.
    - b. Actuators shall be installed to maximize the linearity between actuator stroke and actuated device travel (25% actuator stroke produces approximately 25% of

the desired angular rotation required; 50% stroke produces 50% angular rotation). In addition, actuators should be installed to maximize force available for useful work over the entire stroke.

- B. Control Valves and Actuators:
  - 1. Provide adequate size and number of modulating or two-position action.
  - 2. Provide positive positioning devices where shown or where sequencing cannot be accomplished by using standard spring ranges.
  - 3. Belimo only.

## 2.05 SENSORS

- A. Shall be manufactured by Johnson Controls, Mamac, Kele, Setra, Veris, or Penn only.
- B. All sensing inputs shall be provided industry standard signals.
- C. Temperatures, humidities, differential pressure signals, and all other signal inputs shall be industry standard variable voltage or amperage.
- D. All signal inputs shall be compatible with the controllers used and with the requirement for readout of variables as specified.
- E. If sensors are not linear, then software will linearize sensor output.
- F. Controls and sensors for VAV boxes to be provided to VAV manufacturer for installation at the factory.
- G. Minimum sensor accuracy (as compared to a test standard) and range are listed in Table. Accuracy is not the same as resolution (the ability of the DDC to measure incremental change). Resolution is specified in "Part 3. DDC Hardware."
  - 1. All accuracy values should be combined effect numbers taking into account thermal drift, interchangeability, hysteresis, etc.

Sensor Type	Range	Min. Accuracy
Duct/Air Handling		
Unit Temperature	40 – 130°F	± 0.5 Degree F
Room Temperature	50 – 85°F	± 1 Degree F
Outside Air Temperature	- 20 to 120°F	± 0.5 Degree F
Chilled Water Temperature	32 – 80°F	± 0.1 to ± 0.5 Degree F
Hot Water Temperature	80 – 220°F	± 0.1 to ± 0.5 Degree F
Water flow	Sized for application	± 5% of reading
Humidity	0 to 100% RH	± 3% RH
Duct Static Pressure	0 to 3" w.c.	± 1% full scale per 50°F
Space Static Pressure	- 0.25" to 0.25" w.c.	± 1% full scale per 50°F
High Limit Static	0-5" w.c.	± 1% full scale per 50°F
Steam Pressure	Sized for application	± 1% full scale
Current Sensor	Sized for application	± 1% full scale
Power (kWh)	Sized for application	± 2.5% full scale (at 0.5 PF) ± 2% full scale (at 1.0 PF)
Air flow	700 to 4,000 fpm	± 2% full scale
CO <sub>2</sub> sensors	0 to 2,000 PPM	± 3% full scale
Freeze Stat	34°F to 68°F	± 1°F

Sensors shall not drift more than 1% of full scale per year

## 2.06 TEMPERATURE SENSORS/THERMOSTATS

- A. All sensors shall be completely electronic. The temperature sensor shall be of the resistance type, and shall be either two-wire 1000 ohm nickel RTD, or two-wire 1000 ohm platinum RTD.
- B. Duct/ Air Handling Unit type temperature sensor (mixed, discharge/supply, and return air):
  - 1. The probe of the duct sensor shall be 12" in length, and be made of Stainless Steel. Applications where the smallest dimension of the duct is less than 24", the probe shall be sized to reach the center of the duct.
  - 2. Large systems above 9 square feet may require an averaging probe if sufficient mixing of the air stream is not possible.
  - 3. Mount the sensor far enough down stream to allow mixing of the air stream, this is most important on Hot and Cold Deck applications where the coil is placed after the fan.
  - 4. Sensors for mounting on insulated ducts or casings are to be equipped with brackets for mounting clear of the isolation.
  - 5. Do not locate sensors in dead air spaces or in positions with obstructed air flow.
  - 6. Provide separate duct flange for each sensing element.
  - 7. Temperature sensing elements shall be thermally isolated from brackets and supports.
  - 8. Securely seal ducts where elements or connections penetrate duct.
  - 9. Mount sensor enclosures to allow for easy removal and servicing without disturbance or removal of duct insulation.
- C. Immersion Type Temperature Sensor:
  - 1. The probe of the sensor shall be constructed of stainless steel and pressure rating consistent with system pressure and velocity.
  - 2. The well shall be constructed of stainless steel and sized to reach into the center of the pipe. Pipes with small diameters shall have the well mounted at a 90 degree elbow to allow sufficient contact with the fluid.
  - 3. Locate wells to sense continuous flow conditions.
  - 4. Do not install wells using extension couplings.
  - 5. Wells shall not restrict flow area to less than 70 percent of line-size-pipe normal flow area. Increase piping size as required to avoid restriction.
  - 6. Provide thermal transmission material within the well.
  - 7. Provide wells with sealing nuts to contain the thermal transmission material and allow for easy removal.
- D. Room Type Temperature Sensor:
  - 1. All thermostat locations shall be submitted for approval before installation.
  - 2. Provide all sensors without CO<sub>2</sub> function with blank wall plate, vandal-proof covers that are flush with wall. Mamac TE-205-P Series are equal.
  - 3. Coordinate sensor location with light switches, and mount 60" above the floor. Verify location before installation, so that no direct sunlight or influences from heat and cooling sources will be imposed on the sensor.
  - 4. At classrooms or other systems required to include CO<sub>2</sub> monitoring a combination sensor is allowed. JCI CD-WOO-XO-2 Series only.
  - 5. Metal guards shall be provided as shown on Drawings.
  - 6. Insulation shall be installed between the temperature sensor and open conduit to eliminate false temperature readings due to cold drafts.
- E. Outside Air Sensors
  - 1. Outside air sensors shall be designed to withstand the environmental conditions to which they will be exposed. They shall also be provided with a solar shield.
  - 2. Sensor's exposed to wind velocity pressures shall be shielded by a perforated plate that surrounds the sensor element.
  - 3. Temperature transmitters shall be of NEMA 3R construction and rated for ambient temperatures.

## F. Averaging Sensors

1. For ductwork greater in any dimension than 48 inches and/or where air temperature stratification exists, an averaging sensor with multiple sensing points shall be used.
2. For plenum applications, such as mixed air temperature measurements, a string of sensors mounted across the plenum shall be used to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12-foot long segment.
3. Capillary supports at the sides of the duct shall be provided to support the sensing string.

## 2.07 TRANSFORMERS

- A. Transformers selected and sized for appropriate VA capacity and installed and fused according to applicable Codes.

2.08 CO<sub>2</sub> SENSORS

- A. Self-calibrating sensors are acceptable but, sensor must easily allow field calibration with test gas. Sensors must retain accuracy for between 3 - 5 years without requiring calibration. Sensors that require annual calibration are not acceptable. Provide CO<sub>2</sub> sensor calibration tool with system. Sensors must be calibrated at system start-up. Calibration tool is to be turned over to Owner along with instructions for use at close-out.
1. CO<sub>2</sub> sensor output shall be 4 – 20 mA or 2 – 10 VDC proportional over the specified range. Minimum sensor accuracy and range:
  2. The transmitter shall be capable of operating from an unregulated 18 – 30 VDC power supply.
  3. Acceptable Manufacturers: Veris Industries, Johnson Controls.

## 2.09 POWER MONITORING DEVICES

## A. Current Measurement (Amps)

1. Current measurement shall be by a combination current transformer and a current transducer. The current transformer shall be sized to reduce the full amperage of the monitored circuit to a maximum 5 Amp signal, which will be converted to a 4-20 mA DDC compatible signal for use by the Controls.
2. Current Transformer – A split core current transformer shall be provided to monitor motor amps.
  - a. Operating frequency – 50 - 400 Hz.
  - b. Insulation – 0.6 Kv class 10Kv BIL.
  - c. UL recognized.
  - d. Five amp secondary.
  - e. Select current ratio as appropriate for application.
  - f. Acceptable manufacturers: Veris Industries
3. Current Transducer – A current to voltage or current to mA transducer shall be provided. The current transducer shall include:
  - a. 6X input over amp rating for AC inrushes
  - b. Manufactured to UL 1244.
  - c. Accuracy: +.5%, Ripple +1%.
  - d. Minimum load resistance 30kOhm.
  - e. Input 0-20 Amps.
  - f. Output 4-20 mA.
  - g. Transducer shall be powered by a 24VDC regulated power supply (24 VDC +5%).
  - h. Acceptable manufacturers: Veris Industries
4. Provide devices specifically designed for EC motor operation confirmation for fan systems operated by an EC Motor.

## 2.10 SURGE PROTECTION

- A. All equipment shall be protected from power surges and voltage transients. If failure occurs from surges and transients during the warranty period, then the contractor shall repair surge protection equipment and other equipment damaged by the failure at no cost to the Owner.
- B. Isolation shall be provided at all peer-to-peer network terminations, as well as all field point terminations to suppress induced voltage transients, and shall be consistent with IEEE standards 587-1980.

## 2.11 FACTORY MOUNTED DEVICES

- A. Sensors as required shall be provided by Control Contractor to the manufacturer for installation. All materials and labor beyond this is the responsibility of the Control Contractor.

## 2.12 TIMER SWITCH

- A. Spring wound timer switch with range of 0-4 hours. Intermatic FF Series or equal.

**PART 3 DIRECT DIGITAL CONTROLS – HARDWARE**

## 3.01 SYSTEM ARCHITECTURE

- A. Extend existing JCI BACnet system to this building. Provide new controllers as required. Modify programming as required.

## 3.02 PRIMARY CONTROL UNITS

- A. Primary control units are stand-alone units able to control HVAC equipment per the specified sequence of operation.
  - 1. Each controller shall be capable of performing all specified control functions independently. The primary control unit shall directly control all units, fans, and control devices. All control software shall be implemented in the primary control unit. The sequence of operation precisely identifies all points of monitoring and control.
  - 2. Shall monitor specific analog and digital inputs, process the data received, and produce analog or digital outputs to control the systems specified.
  - 3. Systems utilizing controllers that operate in a default mode only as a stand-alone will not be acceptable.
- B. Minimum specifications include:
  - 1. Microprocessor-based controllers, fully equipped with power supply, input and output terminals, internal (electronic) timeclock, and self-charging battery backup.
  - 2. Modular multi-tasking microprocessor based direct digital controller with minimum of 1MB of EEPROM and RAM memory.
  - 3. Minimum 10 bit Analog-to-Digital (A/D) converter.
  - 4. Minimum 12 bit Digital-to-Analog (D/A) converter.
  - 5. Sufficient memory for storing 288 trend values for every point (real and virtual).
  - 6. Controllers shall have unused physical points available for future add-ons. The number of spare points shall equal 20% of all physical points (20% AI, 20% AO, 20% BI, 20% BO) or at least two spare points of each type.
  - 7. Shall include all control strategies listed in "Part 4: DDC Software."
  - 8. Each control loop shall be fully definable in terms of inputs and outputs that are a part of the control strategy.
  - 9. Each control unit shall be equipped with a communication interface connection,

- minimum of 16 universal analog or digital inputs and outputs, and shall communicate via the LAN to the building level controller.
10. On board power supply for all sensors.
  11. On board sockets for plug-in resistors.
  12. Each control units shall be capable of proper operation in an ambient environment of between 32°F and 110°F and from 10% to 90% RH.
  13. Control units provided for outside installation shall be capable of proper operation in an ambient environment of 0°F to 120°F, and 5 to 95% RH. If such hardware is not available, locate hardware in an accessible indoor location or as approved by the Engineer.
  14. Power Failure Protection:
    - a. All control panels shall be provided with automatic protection from power failure for at least 168 hours.
    - b. This protection shall, at a minimum, include continuous real-time clock operation, automatic system restart upon power return, and integrity of all volatile point data.
    - c. Panel outputs shall, at a minimum, be configured to remain in the last commanded state and return to the required state upon restoration of power.
  15. Diagnostics: Controller shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all panel components. The network controller shall provide both local and remote annunciation of any detected component failures, low battery conditions, or repeated failures to establish communication.
  16. Power Failure: In the event of the loss of normal power, there shall be an orderly shutdown of all controllers to prevent the loss of database or operating system software. Nonvolatile memory shall be incorporated for all critical controller configuration data, and battery backup shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.
    - a. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.
    - b. Upon restoration of normal power and after a minimum off-time delay, the controller shall automatically resume full operation without manual intervention through a normal soft-start sequence.
    - c. Should a controller memory be lost for any reason, the operator workstation shall automatically reload the program without any intervention by the system operators.
  17. Certification: All controllers shall be listed by Underwriters Laboratories (UL).
    - a. All controllers shall be listed by Underwriters Laboratories (UL).
- C. Primary control units shall be installed on:
1. Air handling units greater than 2,000 CFM
  2. Air handling units with VFDs
  3. Any application not listed in secondary and application control units.
- D. Devices shall be JCI only.

#### **PART 4 DIRECT DIGITAL CONTROLS – SOFTWARE**

##### **4.01 SYSTEM SOFTWARE**

- A. Extend the existing software from the rest of the building to this new system. Web browsing shall be enabled and viewable for this system.

#### **PART 5 SYSTEM SETUP**

##### **5.01 RESPONSIBILITIES OF INSTALLER AND PROGRAMMER**

- A. Match / extend the existing JCI control system to allow viewing and operation of the new HVAC system.
- B. Graphics with dynamic animation shall match the current district standards regardless of the graphics at the rest of the school.
- C. Passwords and Alarms for new system access shall be as per BSD standards and BSD direction.
- D. Point naming convention shall match the current BSD standards regardless of the naming convention used at the rest of the school.
- E. Trending and Reports shall be per BSD. Any trending requested by the Commissioning Agent shall be removed after the project has been accepted unless specifically requested to remain by BSD.
- F. The schedule shall be dependent on the school schedule but shall be able to operate independently of the rest of the school if overridden.

#### 5.02 ON-SCREEN SENSOR RESOLUTION

Sensor Type	Resolution (displayed on screen)
Temperature	0.1°F
Pressure	0.01 inches w.c.
Actuators (damper and valve)	1% of full range
Humidity	0.5% RH
Air Flow	10 CFM
CO <sub>2</sub> sensors	20 PPM
Current Sensor	0.1 kW

#### 5.03 OVERRIDES

- A. The DDC system should recognize the override and report to the screen and the printer.
- B. Software shall have adjustable time limits for each override.

#### 5.04 SAFETY CIRCUITS

- A. All safety circuits shall be hard wired circuits with independent manual reset type switches.

#### 5.05 LABELING AND IDENTIFICATION

- A. All devices relating to the work or systems included herein, including controllers, valves, motors, relays, etc., shall be identified with a unique identification number or name on the submitted engineering drawings. This identification number or name, along with the service of the device (discharge air controller, mixed air controller, etc.), shall be permanently affixed to the respective device.
- B. All field devices will be supplied with a nameplate indicating its name, number, address, and all other pertinent information.
- C. If the field device is too small for the nameplate to be "adhered" to or on another piece of equipment near it (e.g., nameplate on air handling unit at wire penetration for mixed air

temperature sensor), then attach the nameplate via nylon ties.

- D. Tagging shall be computer generated. For input/output wiring, cabling, or tubing, the panel side of the terminals shall be labeled with the automation panel circuit board and terminal numbers associated with the point. The field side shall be labeled with the point number. Cable, wiring and tubing not specifically associated with an input or output shall be labeled with a number and function.
- E. All wiring, tubing, and cabling both inside and outside of control panels shall be labeled at both ends using Thomas and Betts EDP printable wire and cable markers using style WSL self-laminating vinyl. Input and output cables and wiring shall be labeled with the point number and the point description, such as:
  - CPDPS005
  - Primary Heating Water
  - Pump #1 On/Off Status
- F. Cable and wiring not specifically associated with an input or output shall be labeled with a number and a function description such as:
  - 120 VAC
  - Panel #
- G. Raceway Identification. All the covers to junction and pull boxes of the control system raceways shall be painted blue, or have identification labels stating "Control System Wiring" affixed to the covers. Labels shall be typed, not hand written.
- H. Wire Identification. All low and line voltage control wiring shall be identified by a number, as referenced to the associated control diagram, at each end of the conductor or cable. Identification number shall be typed and permanently secured to the conductor or cable. Wiring to all control devices shall be labeled at each end of the conductor with the point name and description.
- I. Beaverton School District - Standard Naming Conventions: HVAC standard system Owner reference is **BSD** (Beaverton School District). Due to the size and complexity of the mechanical systems, controls network definitions may be expanded to represent the educational levels of the facilities. **BSD-ES** will be used for any elementary level facilities. **BSD-MS** will be used for facilities housing 6<sup>th</sup>, 7<sup>th</sup>, and 8<sup>th</sup> grade level facilities that do not serve the lower grades. **BSD-HS** will be the reference used for all facilities serving 9<sup>th</sup> grade students and beyond. This group will also include any additional ancillary facilities (e.g., Transportation.).
  - 1. Equipment Labels
    - a. Control systems or groups shall be named with industry standard labels. Acronyms will be consistent and must match the current BSD control system naming conventions. All control system components will reference the building, equipment association, and unit ID in their descriptor. For example, an air handler labeled "BY-ACU-3" represents Bethany air-conditioning unit number 3. A list of currently used, eight-character building descriptors is available from BSD.
    - b. The following is a sample of currently used acronyms in BSD control systems. All new construction must follow a similar industry standard format. The intention of this standard format is that all systems and related equipment are easily identifiable in order to aid in efficient operation and service of the building. All controls systems on retrofit or capital growth and improvement projects must be formatted to match the existing facility systems as reflected on the prints. Numbering of equipment shall logically and sequentially follow the numbering used on existing equipment. The naming conventions used for each Project shall be consistent throughout all documentation, including prints, schedules, and controls.
    - c. System groups/Systems:



- 1) Air Handling Equipment
  - a) AC: Air conditioning unit
  - b) ACU: Air conditioning unit
  - c) AHU: Air handling unit, typically indoor penthouse unit
  - d) FC: Fan coil unit, split systems
  - e) HVU (HV): Heating/ventilating unit, without cooling, with return air
  - f) RTU: Rooftop unit
  - g) MAU (MU): Make-up air unit, 100% outside air with no return
  - h) MZU: Multi-zone air handlers
- 2) VAV System Components
  - a) NORTH (SOUTH): Building area designator
  - b) MAIN (LOWER): Building area designator
  - c) VAV: Variable air volume boxes
  - d) VT: VVT/variable volume by temperature boxes
- 3) UNITVENT (U-VENT, UV): Classroom or individual zone unit ventilators
- 4) ZONE: Zone or channel on time-clock replacements.
- 5) BOILER: Boiler room equipment, central plant
  - a) BLR (BR): Boilers, pumps
- 6) PT: Portables
- 7) MISC: Miscellaneous group for small systems
  - a) EDH: Electric duct heaters
  - b) OVPNL: Override panel
  - c) OST: Optimal start group/program
  - d) MISC: Exhaust fans, domestic water pumps, demand meters, Em. Shutdown, lighting relays, security input, (portables), global points, fire input points
  - e) (ZONE: (Time-clock retrofit zones)

## 5.06 INSTALLATION DETAILS

- A. Low Differential Air Pressure Applications (Under 5" w.c.) Differential pressure transmitters used for flow measurement shall be sized to the flow sensing device and shall be supplied with Tee fittings and shut-off valves in the high and low sensing pick-up lines to allow the Balancing Contractor and Owner permanent easy-to-use connection. Provide a minimum of a NEMA 1 housing for the transmitter. Locate transmitters in accessible local control panels wherever possible. Except on VAV box applications.
- B. Medium to High Differential Water Pressure Applications (5" to Over 21" w.c.): Mount stand-alone pressure transmitters in a bypass valve assembly panel. The panel shall be constructed to NEMA 1 standards. The transmitter shall be installed in the panel with hi and low connections piped and valved. Air bleed units, bypass valves and compression fittings shall be provided.
- C. Building Differential Air Pressure Applications (-1" to +1" w.c.): Mount pressure transmitter in the local control panel. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind. The interior tip shall be inconspicuous and located within a central corridor shown on the drawings.
- D. Outside Air Sensors: Outside air sensors shall be mounted on the North wall to minimize solar radiant heat impact or located in a continuous intake flow adequate to monitor outside air temperatures accurately. Sensors exposed to solar radiation must be installed with solar shields. Sensor's which are exposed to wind velocity pressures shall be shielded by a perforated plate surrounding the sensor element.

- E. Duct Temperature Sensors: Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned to be easily accessible for repair or replacement. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate. For ductwork greater in any dimension than 48 inches and/or air temperature stratification exists such as a mixed air plenum, utilize an averaging sensor with multiple sensing points. The sensor shall be mounted to suitable supports using factory approved element holders. For large plenum applications such as mixed air temperature measurements, utilize a string of sensors mounted across the plenum to account for stratification and/or air turbulence. The averaging string shall have a minimum of 4 sensing points per 12 feet long segment.
- F. Low Temperature Limit Switches: Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

## PART 6 SYSTEM COMMISSIONING AND TRAINING

**Air and water balancing shall be completed (and discrepancies resolved) before Control Contractor's final system check and before the acceptance test to be conducted in the presence of the Engineer/Commissioning Agent.**

### 6.01 CONTROL TECHNICIAN MEETING REQUIREMENTS

- A. During all pre-installation meetings with Owner/Engineers and separate meetings pertaining to the commissioning process, the control technician attending the meetings must be the same technicians that are/will install and program the DDC system.
- B. The Control Contractor's installer and programmer must attend all the commissioning meetings. These meetings occur throughout the design and construction process.
- C. First Meeting - discuss point naming and sequence of operation with Engineer and Owner
  1. Prior to software and database installation and checkout but subsequent to software and database development, the Control Contractor shall meet with the Owner and the Engineer and review the database and program code in detail on a point by point, sequence by sequence basis. The Control Contractor (using blueprints and this specification) shall provide the project point list and sequence of operation to initiate discussion.
  2. Any necessary modifications required to make the database and sequence match the intent and requirements of the contract documents shall be identified at this meeting including point names, descriptors, alarm setpoint, numeric setpoint requirements, access requirements, sequence adjustments, etc.
  3. Successful completion of this review process will result in software and database approval for installation and start-up. Any software or database that is installed prior to this approval process shall be corrected to match the results of the approval process at no additional cost to the Owner.
  4. The results of this meeting shall be documented in meeting minutes taken and issued by the Control Contractor. Documentation can be in the form of marked up data base forms and sequences of operation.
- D. Second Meeting - graphic screen development shall be coordinated with the Owner through a series of meetings that will allow the functions described above (sequence of operation, alarms, etc.) and any other Owner's requirements to be incorporated into the graphic screens.

### 6.02 PRE-COMMISSIONING TESTING, ADJUSTING, AND CALIBRATION REQUIREMENTS

- A. Prior to acceptance, the following steps will be used by the Control Contractor to produce a testing and pre-commissioning report by system to be submitted for approval by the Engineer/Commissioning Agent or Owner.
- B. Work and/or systems installed under this section shall be fully functioning prior to Demonstration, Acceptance Period and Contract Close Out. Control Contractor shall start, test, adjust, and calibrate all work and/or systems under this contract, as described below:
1. Verify proper electrical voltages and amperages, and verify all circuits are free from grounds or faults.
  2. Verify integrity/safety of all electrical connections.
  3. Verify proper interface with fire alarm system.
  4. Coordinate with TAB Subcontractor to obtain control settings that are determined from balancing procedures. Record the following control settings as obtained from TAB Contractor (and note any TAB deficiencies):
    - a. Minimum outside air damper settings for air handling units and CFM values.
  5. Test, calibrate, and set all digital and analog sensing, and actuating devices.
    - a. Calibrate each instrumentation device by making a comparison between the DDC display and the reading at the device, using a standard traceable to the National Bureau of Standards, which shall be at least twice as accurate as the device to be calibrated (e.g., if field device is  $\pm 0.5\%$  accurate, test equipment shall be  $\pm 0.25\%$  accurate over same range). Record the measured value and displayed value for each device in the Pre-Commissioning Report.
    - b. All analog input points are to be tested by comparing the reading obtained through the workstation and through an independent reading device (meter).
    - c. Check each analogue output by making a comparison between the control command at the DDC controller and the status of the controlled device. Check each output point by making a comparison of the state of the sensing device and the Host computer display. Record the results for each device in the Pre-Commissioning Report.
      - 1) All analog output points are to be tested using a command from the workstation modulating the output in 10% increments and recording the associated voltage/amps sent to the controlled device.
  6. Check each digital input/output point by making a comparison between the control command at the DDC controller and the status of the controlled device. Check each digital point by making a comparison of the state of the sensing/control device and the Host computer display. Record the results for each device in the Pre-Commissioning Report.
    - a. ON/OFF commands from the workstation should be performed in order to verify its true operation.
  7. Check and set zero and span adjustments for all actuating devices. Manually activate damper and valve operators to verify free travel and fail condition. Check valve or damper to insure that it shuts off tight when the appropriate signal is applied to the operator. Adjust the operator spring compression as required. If positioner or volume booster is installed on the operator, calibrate per manufacturer's procedure to achieve spring range indicated. Check split range positioner to verify proper operation. Record settings for each device in the Pre-Commissioning Report.
  8. Verify proper sequences of operation. Record results and submit with Pre-Commissioning Report. Verify proper sequence and operation of all specified functions by adjusting input variable to determine if sequence of operation is operating as specified.
  9. Tune all control loops to obtain the fastest stable response without hunting, offset or overshoot. Record tuning parameters and response test results for each control loop in the Pre-Commissioning Report. Except from a startup, maximum allowable variance from set point for controlled variables shall be as follows:
    - a. Air temperature:  $\pm 0.5$  degrees F
    - b. Water temperature:  $\pm 1$  degrees F
    - c. Duct pressure:  $\pm 0.05$  inches wc

- C. Pre-Commissioning Testing, Adjusting, and Calibration shall be completed prior to Substantial Completion.
- D. Provide Pre-Commissioning Test Report for approval by the Engineer/Commissioning Agent or Owner before system demonstration.

#### 6.03 DEMONSTRATION

- A. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Control Contractor has completed the installation, started up the system, and performed its own tests (outlined in 6.1 and to be submitted in writing).
- B. The tests described in this section are to be performed in addition to the tests that the Control Contractor performs as a necessary part of the installation, startup, and debugging process. The Commissioning Agent/ Engineer will be present to observe and review these tests. The Commissioning Agent/Engineer shall be notified at least 10 days in advance of the start of the testing procedures.
- C. Demonstration shall not be scheduled until all hardware and software submittals, and the Pre-Commissioning Test Report are approved by the Commissioning Agent/Engineer.
- D. Verifying compliance of equipment operation and sequence of operation with this specification through all modes of operation.
  - 1. If more than 10 percent of the demonstrated equipment operation and sequence of operation fails to operate per the submittals, the demonstration test will be rescheduled after the Control Contractor takes corrective action.
  - 2. If the Control Contractor fails to demonstrate proper equipment operation and sequence of operation in the second round of tests, the Commissioning Agent/Engineer's costs for witnessing all further demonstration may be assigned to the Control Contractor by the Owner as a deduct to their contracted price. Note: The Control Contractor will not be responsible for costs related to poor design or to other factors beyond their control, though it is expected to call any design concerns and other factors beyond their control that might cause system failure to the attention of the Commissioning Agent/ Engineer and the Owner.
- E. Programming changes for correction of improperly programmed sequences will not be considered legitimate reasons for change orders.
- F. Demonstration/Commissioning Software:
  - 1. Provide fully licensed copy of the required BAS workstation graphic software to be used by the Commissioning Agent/Engineer on a remote computer (not included in contract) for accessing the BAS network via modem. This software copy shall be used only for the purpose of commissioning this project. The Owner agrees that the commissioning BAS software license shall become null and void upon termination of the Contract Warranty Period. The software shall be returned to the Control Contractor within one year after system acceptance.
  - 2. Software shall be fully configured to view project specific database and shall include trend logs, specified graphic screens, alarms, and reports.
  - 3. Provide assistance by telephone upon request if required to assist Commissioning Agent/Engineer in setting up software on Commissioning Agent/Engineer's remote computer.
  - 4. Submit one complete set of programming and operating manuals for all graphics software packages concurrently with the commissioning software. This set will be returned to the Control Contractor within one year after system acceptance.

- G. The Control Contractor shall provide at least two persons equipped with two-way communication, and shall demonstrate actual field operation of each controlled and sensing point for all modes of operation including day, night, occupied, unoccupied, fire/smoke alarm, seasonal changeover, and power failure modes. The purpose is to demonstrate the calibration, response, and action of every point and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Control Contractor.
- H. As each control input and output is checked, a log shall be completed showing the date, technician's and Commissioning Agent/Engineer's initials, and any corrective action taken or needed.
- I. The system shall be demonstrated following the same procedures used in Pre-Commissioning (Section 6.1)
- J. Demonstrate that all points specified and shown can be interrogated and/or commanded (as applicable) from all workstations.
- K. At a minimum, demonstrate correct calibration of input/output devices using the same methods specified for the pre-commissioning tests. A maximum of [10] percent of I/O points shall be selected at random by Commissioning Agent/Engineer for demonstration. Upon failure of any device to meet the specified accuracy, an additional [10] percent of I/O points shall be selected at random by Commissioning Agent/Engineer for demonstration. This process shall be repeated until 100 percent of randomly selected I/O points have been demonstrated to meet specified accuracy.
- L. The Contractor shall demonstrate that the panels' response to LAN communication failures meet the requirements of these Specifications.
- M. Demonstrate that required trend graphs and trend logs are set up per the requirements. Provide a sample of the data archive. Indicate the file names and locations.
- N. Demonstrate successful communication of point values between the BAS and other HVAC equipment (e.g., chiller).
- O. Demonstrate complete operation of Operator Interface such as graphic screens, trend logs, alarms, etc.
- P. Additionally, the following items shall be demonstrated:
  - 1. DDC Loop Response. The Control Contractor shall supply trend data output in a graphical form showing the step response of each DDC loop. The test shall show the loop's response to a change in set point that represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 1 second to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values (e.g., VFD frequency or Amperage). Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Control Contractor.
  - 2. Optimum Start/Stop. The Control Contractor shall supply a trend data output showing the capability of the algorithm. The 5 minute trends shall include the operating status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
  - 3. Operational logs for each system that indicate all set points, operating points, valve positions, mode, and equipment status shall be submitted to the Commissioning Agent/Engineer. These logs shall cover three 48-hour periods and have a sample frequency of not more than 10 minutes. The logs shall be provided in both printed and disk formats.

4. The DDC and HVAC systems will be shut down for 15 minutes and then re-started. Within 15 minutes, the DDC system shall start and obtain stable control of the HVAC systems without safety trips, alarms, or excessive deviations in temperature and pressure (as defined by the Engineer).

- Q. System acceptance shall occur within 120 days of substantial completion. Any delay beyond this period of time shall initiate liquidated damages unless waived by Owner. Failure or delays on Engineers / Owners part shall not be included in 120 day count.

#### 6.04 ACCEPTANCE

- A. All tests described in this specification shall have been performed to the satisfaction of both the Commissioning Agent/Engineer and Owner prior to the acceptance of the control system as meeting the requirements of this document.
- B. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved.
- C. The warranty period starts when the Commissioning Agent/Engineer accepts the system and provides this acceptance in written from the Owner and the Control Contractor.
- D. Any tests that cannot be performed due to circumstances beyond the control of the Control Contractor may be exempt from the Completion requirements if stated as such in writing by the Commissioning Agent/Engineer. The Owner shall then perform such tests no later than 3 months after the building is occupied. The costs for these additional tests will be incurred by the Control Contractor.

#### 6.05 SPARE PARTS

- A. The Control Contractor shall provide two spare fuses of the correct size and capacity for each fuseholder located in all the installed control systems and the Control Contractor's related equipment.
- B. The Control Contractor shall provide two spare pilot lights for each control unit that contains one or more pilot lights.

#### 6.06 TRAINING

- A. Training must be on fully operational system, or the training must be repeated when the system is fully operational at no additional cost to the Owner. The Controls Contractor shall provide the following training services:
  1. One day of on-site orientation by a field engineer who is fully knowledgeable of the specific installation details of the project as part of the system start-up requirements. This orientation shall, at a minimum, consist of a review of the project as-built drawings, the control system software layout and naming conventions, and a walk through of the facility to identify panel and device locations. This training will include Project Managers, Maintenance, and Custodial personnel.
  2. Operator Training: Operator training shall include the detailed review of the control installation drawings, points list, and equipment list. The instructor shall then walk through the building identifying the location of the control devices installed. For each type of systems, the instructor shall demonstrate how the system accomplishes the sequence of operation. This training will include Project Managers, and Maintenance staff.
  3. From the workstation, the instructor shall demonstrate the software features of the system. As a minimum, the instructor shall demonstrate and explain logging on, setting passwords, setting up a schedule, trend, point history, alarm, and archiving the database.

**END OF SECTION**





**SEQUENCE OF OPERATIONS FOR HVAC CONTROLS****PART 1 GENERAL****1.01 SUMMARY**

- A. This section describes the sequence of operations for HVAC control systems specified elsewhere in these specifications.
- B. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.
- C. All work under this section is related to Highland Park Middle School.

**PART 2 PRODUCTS****2.01 NO PRODUCTS LISTED FOR THIS SECTION****PART 3 EXECUTION****3.01 SEQUENCE OF OPERATIONS**

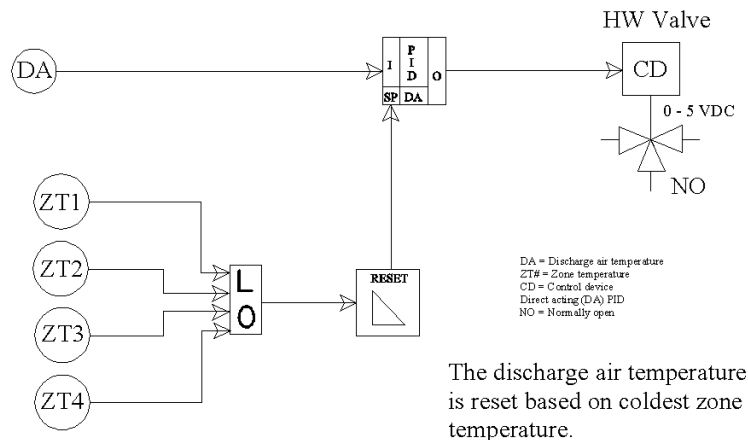
- A. Provide a complete and operational temperature control and building automation system based on the following points and sequence of operation, complete as to sequences and standard control practices. The determined point list is the minimum amount of points that are to be provided. Provide any additional points required to meet the sequence of operation.
- B. Object List:
  - 1. The following points as defined for each piece of equipment are designated as follows:
    - a. Binary Out (BO) - Defined as any two-state output (start/stop) (enable/disable), etc.
    - b. Binary In (BI) - Defined as any two-state input (alarm, status), etc.
    - c. Analog In (AI) - Defined as any variable input (temperature) (position), etc.
    - d. Analog Out (AO) - Defined as any electrical variable output. 0–20mA, 4–20mA, 0–10VDC are the only acceptable analog outputs. The driver for analog outputs must come from both hardware and software resident in the controllers. Transducers will not be acceptable under any circumstance.
- C. Occupancy and Performance Time Periods:
  - 1. Occupied Period is signaled automatically by adjustable settings at DDC server, Building Controller, Application Controller and also, at each zone when zone bypass timer is activated.
  - 2. Warm-up period occurs one hour before occupied start time or as calculated by Building Controller based on system performance history and outside air temperature.
  - 3. Unoccupied period occurs whenever Occupied, Warm-up, and Cool-down are not in effect.

**PART 4 SEQUENCE OF OPERATION****4.01 LEVEL OF DETAIL**

- A. Major changes in provided sequence of operation must be approved of in writing by the Owner and the Engineer.
- B. The Control Contractor shall provide two types of documentation for each system (e.g., boiler

plant, VAV system, etc.). The two types of documentation include:

1. Control Logic
  - a. Control logic shall be a series of statements providing, for each system, the following items:
    - 1) Identification of control process.
    - 2) Narrative of control loop or logic algorithm.
    - 3) Control parameters such as setpoints and differentials (e.g., throttling range, gains) reset schedules, and adjustable parameters for all points.
    - 4) Identification of all constraints, limits, or interlocks that apply to control loop.
    - 5) Identification of all DO, DI, AO, AI points that apply to system.
    - 6) Identification of all communication needs (data points from outside control unit).
2. Logic Diagrams
  - a. For each control logic system, a logic diagram shall show the actual interaction of the points (real and virtual) and the logic algorithm.
  - b. The diagram should identify
    - 1) System being controlled (attach abbreviated control logic text).
    - 2) All DO, DI, AO, AI points.
    - 3) Virtual points.
    - 4) All functions (logic, math, and control) within control loop.
    - 5) Legend for graphical icons or symbols.



#### 4.02 STANDARDIZATION

- A. All control loops will be standardized throughout the programming code.

#### 4.03 PROGRAMMING GUIDELINES

- A. All adjustable setpoints shall be developed as software points stored at memory locations so that setpoints can be changed by recommending the data stored at the memory location rather than by entering the program and changing parameters and lines in program code.
- B. Where reset schedules are specified or required the schedules shall be set up so that the operator enters the following points into memory locations.
  1. Two points for the independent variable on the reset schedule.
  2. Two points for the dependent variable on the reset schedule.

The computer system shall then use these values as input parameters to the appropriate program or

programs and calculate the reset schedule based on these values.

- C. Where several analog outputs are to be controlled in sequence by one control loop, software shall be arranged so that the sequence is guaranteed regardless of the spring range of the actuators and to prevent simultaneous heating and cooling.
- D. Programs controlling several pieces of equipment as one system shall reside in one control unit. Where programs use data points that reside in other control units the programs shall employ logic (either in software, firmware, hardware, or a combination of all three) to detect loss of communications with the remote control units containing the required data. When such a failure is detected, the program logic shall revert to a safe operating mode that will allow the controlled systems to remain in operation until normal system communication resumes. A pilot light on the control unit shall be illuminated when such a failure mode exists. In addition, an alarm shall be sent to the HOST computers (alarm level 4). The software shall track this type of alarm and report if communication failure is higher than expected (this condition shall generate an alarm level 3, with descriptive text, at the HOST computer). All safe operating modes shall be approved by the Engineer prior to implementation.
- E. Control sequences that use outdoor air conditions to trigger certain specific operating modes shall use data generated by one outdoor air temperature sensor and one outdoor humidity sensor. In other words, the data from one pair of sensors shall be shared by the entire system.
- F. All safety circuits shall be hard wired circuits using standard snap acting electric or pneumatic switches as required by the function, and shall be totally independent of the DDC system controllers. This includes interlocks that return dampers and valves to some normal, fail-safe position when the system they are associated with shuts down. It is the intent of this paragraph that the systems have the capability to be operated manually complete with safeties and fail safe interlocks even if the DDC system is off line.
- G. Provide hours of operation accumulation and lead/lag sequencing of equipment based on hours of operation for all equipment with proof of operation inputs.
- H. Global point name changing:
  - 1. The system shall provide an easy means to allow the operator to change a point name such that the point will automatically be referenced everywhere in the system by the new name.
  - 2. If a point name is removed from the database, any program code where the name appears must show an appropriate error signal for undefined point when the program is viewed, edited, or printed.
- I. Synchronization of real-time clocks between all control panels shall be provided.

#### 4.04 GENERAL SEQUENCE OF OPERATION GUIDELINES

- A. Control of all central fan systems, boilers, DX units, heaters, and pumping stations shall be based on run requests, heating requests or cooling requests from zone controls.
- B. Reset of supply air temperature and hot water temperature shall be based on zone temperature conditions via the zone's percentage of heating or cooling load.
- C. Unless otherwise indicated, all control loops will use PID loops. The coefficient for the derivative component is zero (0) unless otherwise indicated.
- D. All HVAC system controls shall be designed such that simultaneous heating and cooling, reheating, and recooling are minimized. This applies as well to non-mechanical treatment of mixed air (e.g. outside air, heat recovery, etc.) which must then be mechanically reheated or

recooled.

- E. Alarms: Except as directed otherwise by the Owner, all alarms will be registered at the building operator's terminal as well as at the Maintenance Building remote operator's station. Alarms are to be registered with a message explaining the nature of the alarm and which building/location the alarm is in.
- F. Whenever a setpoint is referred to as "adjustable" in these standards, the setpoint is to be easily and directly adjustable at the operator's terminal and Maintenance Building remote operator's station, and is not to require any code modification. This may require assigning virtual points to all adjustable setpoints. Frequently adjusted points, including space temperature setpoints, shall be adjustable from the graphics screen (e.g., floor plan screen).
- G. There are many interlocks and limits within each control loop or algorithm that may not be obvious or stated in this specification. The Control Contractor is responsible for identifying and programming these interlocks and limits into the software. The CO<sub>2</sub> Demand Ventilation Control algorithm is a good example of the complexity of the control loop with interlocks and limits.
- H. The Control Contractor will replace any and all equipment (actuators, chillers, etc) that fail due to programming errors. Such errors include, but are not limited to: moving actuators a couple fractions of a degree every second or so in response to some infinitesimal change in a measured variable or repeatedly turning equipment on/off within a short time period. The Control Contractor will avoid these problems by incorporating time delays, dead bands, and other programming techniques into the sequence of operation.
- I. Programmable time-of-day (start/stop) control shall be implemented for all HVAC equipment, except for:
  - 1. Equipment that is interlocked with other equipment under direct start/stop control (e.g. exhaust fans interlocked with an air handling unit).
  - 2. Equipment that must run continuously for reasons of safety.
  - 3. As otherwise noted in these standards.
- J. Auto-tuning algorithms will not be used to initially tune control loops.

#### 4.05 SEQUENCE OF OPERATION GUIDELINES

- A. This specification is intended to refine or elaborate on the sequence of operations provided by the Engineer. Note: there are many issues that may make any of these standard sequences inapplicable to a specific situation: thus, the Control Contractor should obtain written approval by the Engineer to implement the sequence of operations contained in this specification.
- B. The Control Contractor shall adhere to all applicable specifications, unless they submit written exceptions to the Owner and Engineer and such exceptions are approved in writing. Written exceptions shall state the specification's sequence of operations, the Control Contractor's proposed sequence of operations, and the reasons why the proposed sequence specifications are preferable to the sequences in this specification or those provided by the Engineer.
- C. It is the Control Contractor's responsibility to improve upon these specified sequences of operations if necessary. All improvements will be provided in writing to the Engineer for his/her written approval.
- D. The Control Contractor is responsible for accurately controlling and communicating with all packaged fan units or air handling units.

#### 4.06 SEQUENCE OF OPERATION – SCHEDULING

- A. The system will have the three (3) schedules that will be utilized based on the type of event selected by the building operator. The operator will be able to select the desired schedule to be actively used and select the equipment group to be associated with each schedule (equipment selection is user adjustable).
- B. Occupancy Override: The building operator shall be able to initiate occupancy (occupied operation) from the building operator's workstation (overriding any non-occupied sequences) for each individual air handling system. Override will last for eight (8) hours (adjustable) and then revert back to the current operating mode. Operator will be able to release override at any time during the override period.

4.07 SEQUENCE OF OPERATION – SINGLE ZONE WITH CONSTANT AIRFLOW WITH HEAT AND NO COOLING

- A. Fan Enable / Optimal Start Control or Warm-Up Mode:
  - 1. The intent of this sequence is that the air handling system be started early enough so that the maximum negative deviation of space temperature from the occupied heating set point (for all within the system) is less than 0.5 °F no more than 20 minutes prior to or 10 minutes after scheduled occupancy. Spaces should not be heated up above occupied heating space temperature set points.
  - 2. Air handling systems may be started under the optimal start mode no more than 3 hours (adjustable) prior to scheduled occupancy.
  - 3. This optimal start sequence will be locked out when the 3 hour rolling average outdoor air temperature is greater than setpoint (initial setpoint, 55°F, adjustable). If locked out, the AHU will start 10 minutes (adjustable, maximum of 30 minutes) before occupied time period.
  - 4. Air handling systems will be started as a function of:
    - a. Outdoor air temperature
    - b. Space temperature
    - c. Time until start of scheduled occupancy
    - d. Historical time period required to reach setpoint as a function of a, b, and c above.
  - 5. Discharge air temperature setpoint will be set to the maximum optimal start temperature setpoint (110°F, adjustable) during this mode.
  - 6. When the system is in heating optimal start mode, the mixed air dampers will be in full recirculation mode (i.e., outside air dampers are fully closed and the supply air volume will be limited to the return volume).
  - 7. Exhaust fans are off and exhaust dampers are closed.
- B. Night Low Limit Mode:
  - 1. Night low limit mode is initiated during unoccupied times (mode), when any terminal unit space temperature(s) falls below the unoccupied heating setpoint.
  - 2. The night low flag will start boiler sequence.
  - 3. The fan will delay starting until there is sufficient heat to run the unit without tripping a safety to lockout.
  - 4. The unit will operate until the Unoccupied heating SP is reached plus a 3° deadband is reached. The fan will have a 10 minute (adj) off delay.
- C. Night Purge Mode:
  - 1. This sequence is initiated before occupancy during the cooling season.
  - 2. Night purge will be enabled when the following conditions are true:
    - a. The space temperature is above 80° F (adjustable).
    - b. Outside air temperature is greater than setpoint (initial setpoint, 45°F, adjustable).
    - c. Outside air relative humidity is less than 50%.
    - d. Outside air temperature is at least 10°F (adjustable) less than the average space

- temperature
    - e. Occupancy period occurs within 3 hours (adjustable).
  - 3. Night purge will be disabled when average space temperature is within 3°F (adjustable) of the outside air temperature or the average space temperature has reach the occupied heating set point.
- D. Economizer Damper Control:
  - 1. Occupied Mode: Economizer dampers (Outside Air, Return Air and Relief Air) modulate to maintain supply air temperature set point and air quality setpoint.
  - 2. Unoccupied, Night Low Limit, Optimal Start and Low Limit Freeze Conditions: Dampers to modulate to full recirculation (0% Outside Air).
  - 3. Night High Limit and Night Purge: Dampers to modulate to full ventilation (100% Outside Air).
  - 4. The outside air damper will be at minimum position during occupied mode unless another sequence (economizer cooling, CO2 control, or any safeties) require a different position.
  - 5. The economizer cooling function will be enabled when the OSA is 3°F (adj) less than return air temp and disabled when OSA equals RAT. If there is no return air temperature sensor available, space temp will be used for comparison.
  - 6. Demand Ventilation Control (DVC): During occupied mode the outside air dampers shall modulate to maintain supply air CO2 levels at level listed on drawings (adjustable). DVC shall occur when levels begin to exceed the CO2 set point.
  - 7. Economizer Minimum Position (Air Quality Control): Economizer minimum-minimum (min-min) position value is based on 25% of the minimum ventilation requirement unless otherwise noted. The economizer minimum-maximum (min-max) position is based on the full minimum ventilation requirement. During DVC sequences, outside air damper position (outside airflow) is limited to the min-max setting. Balancer to determine actual damper positions at the min-min and min-max airflow setpoints. Control system shall use damper position setpoints for control purposes.
  - 8. The gym unit power exhaust fan shall modulate based on the OSA damper with an off-set to maintain the space slightly positive relative to outside conditions as determined by initial air balance.
  - 9. The gym pressure relief fans shall modulate and stage based on the OSA damper of the heating and ventilation unit. Switch lead weekly. Off-set to maintain the space slightly positive relative to outside conditions as determined by initial air balance.
  - 10. The airside economizer control shall include fault detection and diagnostics as required by ASHRAE 90.1-2016. See ASHRAE requirements for full description of sensor, monitoring and alarm requirements which are available normally due to the DDC system. Specific requirements not normally provided are listed below and required.
    - a. The system shall display the status of:
      - 1) Free cooling available
      - 2) Economizer enabled
      - 3) Cooling enabled
      - 4) Heating Enabled
      - 5) Mixed air low limit cycle active
    - b. The system shall be capable of detecting and reporting the following faults
      - 1) Air temperature sensor failure or fault
      - 2) Economizing when unit should not be economizing
      - 3) Not economizing when the unit should be economizing
      - 4) Damper not modulating
      - 5) Excess outside air

## 4.08 MISCELLANEOUS

- A. Destratification Fans: Operate when the temperature sensor near the top of the room is at more than 2 deg. F. (adj.) from the space mounted sensor at 48" AFF. Operation of the fans shall be

enabled when the heating and ventilation system is in operation. Provide wall mount timer switch with label to allow turning off the fans during noise sensitive performances in the space. Modulate based on variation from setpoint. Less than 2 deg. F. (adj.) is 0 VDC. 10 deg. F. (adj.) is 10 VDC.

**END OF SECTION**





**FACILITY FUEL SYSTEMS****PART 1 GENERAL****1.01 DESCRIPTION**

- A. The requirements of this section apply to the fuel storage, handling, and distribution systems for the facility.
- B. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

**1.02 CODES AND STANDARDS**

- A. General
- B. NFPA 30, 31
- C. UL-142

**1.03 SUBMITTALS**

- A. Required for all items.

**PART 2 PRODUCTS****2.01 PIPING MATERIALS**

- A. Black Steel Pipe:
  - 1. Applications: Above ground only.
    - a. Natural Gas, indoors.
  - 2. Pipe: Schedule 40, standard black steel pipe ASTM A-120 or A-53.
  - 3. Threaded Fittings: For above ground installations only. Banded class 150 malleable iron fittings, ANSI B16.3 to 150 psi.
  - 4. Welding Fittings: Standard weight, seamless steel, beveled end fittings, ANSI B16.9.
  - 5. MegaPress Fittings: ½-inch through 2-inch shall conform to ASME B31.1, ASME B31.3, or ASME B31.9. Fittings shall have zinc and nickel coating, an HNBR sealing element, 420 stainless steel grip ring, separator ring, and an un-pressed fitting leak identification feature. Sealing elements shall be verified for the intended use. Viega MegaPress or Engineer approved equal.
- B. Galvanized Steel Pipe:
  - 1. Applications: Above ground only.
    - a. Natural gas, outdoors.
  - 2. Pipe: Schedule 40, standard galvanized steel pipe, ASTM A-53 or A-106.
  - 3. Fittings: Banded class 150 galvanized malleable iron threaded fittings, ANSI B16.3.

**2.02 PIPING ACCESSORIES**

- A. Fuel Gas Valves: UL listed or AGA approved valves.
  - 1. 10 psig or Less:
    - a. Ball: NIBCO bronze body T/S 585-70-UL, brass body FP-600.
- B. Strainers: Threaded bronze or iron body for 175 working pressure, Y pattern with 1/32" stainless steel perforated screen.

- C. Gas Pressure Regulators: Size based on pressures indicated on the drawings and for 1.5 times connected load. Style and model as approved by Avista Gas Co. Regulators for systems operating above 2 PSI shall be rated for operation at 60 PSI minimum inlet pressure. The size of the orifice shall be clearly marked on the valve. Sensus, Emerson, Itron, or approved substitute.

### **PART 3 EXECUTION**

#### **3.01 EQUIPMENT INSTALLATION**

- A. Locating and Positioning Equipment: Observe all Codes and Regulations and good common practice in locating and installing mechanical equipment and material so that complete installation presents the least possible hazard. Maintain adequate clearances for repair and service to all equipment. Installation of any equipment with less than minimum clearances shall not be accepted.
- B. Anchorage: Anchor and/or brace mechanical equipment, piping and ductwork to resist displacement due to seismic action; include snubbers on equipment mounted on spring isolators.

#### **3.02 PIPE INSTALLATION**

- A. General: Install pipe, tube and fittings in accordance with recognized industry practiced for each indicated service without piping failure. Install each run with a minimum of joints and couplings, but with adequate and accessible unions and flanges for disassembly, maintenance and/or replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections.
- B. Ferrous Threaded Piping: Thread pipe in accordance with ANSI 82.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave no more than 3 threads exposed.
- C. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.
- D. Unions and Flanges: At all equipment to permit dismantling and elsewhere as consistent with good installation practice.
- E. Expansion: Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment.

#### **3.03 GAS SERVICE**

- A. Run all gas distribution piping and make final connections to all gas using equipment. Install regulators to deliver proper inlet pressures and vent regulators to outside where required.

#### **3.04 CLEANING**

- A. General: Clean all dirt and construction dust and debris from all mechanical piping systems and leave in a new condition. Touch up paint where necessary.
- B. Fuel Piping: Blow clear of debris with nitrogen or oil free air.

#### **3.05 TEST**

- A. General: Minimum duration of two hours or longer, as directed for all tests. Furnish report of test observation signed by qualified inspector. Make all tests before applying insulation, backfilling, or otherwise concealing piping or connecting fixtures or equipment. Where part of the system must be tested to avoid concealment before the entire system is complete, test that portion separately, same as for entire system.
- B. Natural Gas Piping: One half hour minimum air at 60 psig for 2 psig gas, and 15 minutes at 10 psig for 7" water gauge natural gas or as approved and certified by serving utility.

**3.06 MECHANICAL PAINTING**

- A. Uninsulated Piping: Paint black steel piping in moist equipment rooms, crawl spaces, inside of secondary containment piping, or exposed to weather two (2) coats black rust-inhibiting paint.

**END OF SECTION**



**AIR DISTRIBUTION****PART 1 GENERAL****1.01 DESCRIPTION**

- A. Provide Air Distribution Materials as specified herein and as shown on the Drawings.
- B. Material characteristics and size shall be as indicated on the Drawings.
- C. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

**1.02 QUALITY ASSURANCE**

- A. Air Distribution Equipment Rating: In accordance with AMCA certified rating procedures and bearing the AMCA label.
- B. See Commissioning specification for additional requirements.

**1.03 SUBMITTALS**

- A. Submit catalog data, construction details and performance characteristics for all manufactured materials.
- B. Submit operating and maintenance data.
- C. For adhesives and sealants used on the interior of the building (inside the waterproofing system), include printed statement of volatile organic compound (VOC) content.

**PART 2 PRODUCTS****2.01 SHEET METAL**

- A. Quality Assurance: Galvanized steel sheet metal except where otherwise indicated. Metal gauges, joints and reinforcement in accordance with Mechanical Code, ASHRAE and SMACNA standards. Ductwork shall be fabricated to the following pressure classifications:
  - 1. Return and exhaust ducts: 2" negative.
  - 2. Supply ducts from fan discharge to VAV box inlet: 4" positive. VAV box discharge to diffuser: 1" positive.
  - 3. Underfloor ductwork shall be per 2.1K unless associated with low return ducts and plenums with less than 10' of length below grade. Short runs of RA ductwork below grade may be constructed of 300 Series stainless steel with fully welded seams. Ducts to be lined per code for below grade ducts. Metal gauge shall be at least 20 gauge.
- B. Acoustical Duct Lining: Line ducts with 1" thick lining (unless noted otherwise) for installation inside the building insulation envelope, and 1-1/2" for installation outside the building insulation envelope. Density shall be 3 lb / ft<sup>3</sup> minimum. Owens Corning, QuietR, or equal Schueller, or Certain Teed. Meeting NFPA 90A and B requirements for maximum flame spread and smoke developed. Duct liner adhesive shall conform to ASTM C916. Mechanically attach lining to sheet metal duct with fasteners conforming to SMACNA Standard MF-1-1971, Schuller Grip Nails or Gramweld welding pins. Apply fire-retardant type adhesive similar to Schuller No. 44 adhesive, Benjamin Foster 81-99, Insul-Coustic 22 or 3M equivalent on all leading edges, joints and seams.
- C. Duct Sealing Tapes: Provide one of the following UL listed ductwork sealing tape systems.

1. Two-part sealing system with woven fiber, mineral gypsum impregnated tape and non-flammable adhesive. Hardcast "DT" tape and "FTA-20" adhesive, United "Uni-Cast" system, or accepted substitute.
  2. For joints and seams exposed to the weather in lieu of soldering, United "Uni-Cast" system or approved.
  3. Sealing systems with VOC content are not allowed.
  4. Sealants and Primers – General: Provide only products having lower volatile organic compound (VOC) content than required by South Coast Air Quality Management District Rule No. 1168.
- D. Optional Duct Joints for Sheet Metal Ducts: "Ductmate System" by Ductmate Industries, Inc., Ward Duct Connectors, Inc., Mez Industries, or acceptable substitute. Spiramir self-sealing round duct connector system meeting Class 3 leakage standards with EPDM o-ring seal.
- E. Exposed to View Spiral Seam Duct and Fittings: Round and flat oval spiral seam duct shall be manufactured of galvanized steel sheet metal with spiral lock seam. Matching fittings shall be manufactured of galvanized steel with continuous welded seams. Gauge shall be per SMACNA Duct Construction Standard third addition table for appropriate pressure, and reinforcement or at least 26 gauge.
- F. Concealed Round Duct: Round and flat oval spiral seam duct shall be manufactured of galvanized sheet metal with spiral lock seam. Construction, gauges, and reinforcement in accordance with SMACNA standards. Fittings shall be manufactured of galvanized steel with spot welded or riveted and sealed seams or continuously welded seams. Snap lock longitudinal seam duct shall fully comply with SMACNA standards for duct gauge and seam type for appropriate pressure class. Adjustable elbows are prohibited.
- G. Flexible Ductwork-Low Pressure: Insulated low pressure flexible duct, factory fabricated assembly consisting of a zinc-coated spring steel helix seamless inner liner, wrapped with a nominal 1" thick insulation for installation inside the building insulation envelope, and 1-1/2" for installation outside the building insulation envelope, 1 pound/cubic foot density fiberglass insulation. The assembly shall be sheathed in a vapor barrier jacket, factory vapor resistance sealed at both ends of each section. The composite assembly, including insulation and vapor barrier, shall meet the Class 1 requirements of NFPA Bulletin No. 90-A and be labeled by Underwriters Laboratories, Inc., with a flame spread rating of 25 or less and a smoke developed rating of 50 or under. The duct shall have factory sealed double air seal (interior and exterior) to assure an airtight installation. Genflex, ATCO, Wiremold, Thermaflex, Glassflex, Clevepak, Schuller, or accepted substitute.

## 2.02 ACCESSORIES

- A. Manual Volume Dampers: Construct of material two gauges heavier than duct in which installed; single plate up to 12" wide; multiple over 12" wide. Hem both edges 1/2" and flange sides 1/2". Use Young, Duro-Dyne, MAT, or accepted substitute damper accessories. Young numbers are shown.
1. No. 605 bearing set with No. 403 regulator for dampers up to 24" long.
  2. For dampers over 24" long use No. 660 3/8" rod, No. 656 end bearing and No. 403 regulator.
  3. Where damper regulators are not readily accessible, use No. 660 or No. 661 rod extensions and No. 301 and No. 315 concealed damper regulators or MAT cable operated dampers as required.

Location of all volume dampers is not necessarily shown on Drawings; minimum required is one in each supply, return or exhaust main, and one in each branch.

- B. Louvered Gravity Exhaust Head / Outside Air Intake Housing: Extruded aluminum (0.0081)

louvered tiered style with curb connection, flashing, 1/2" mesh bird screen. Cap color as selected by Architect. Provide with storm proof blades with aluminum construction and Kynar finish. Color as selected by Architect from standard color palette. See drawings for required performance and custom height/number of louver tiers. Greenheck WIH/WRH as basis of design. Equal Ruskin, Cook, or Carnes approved.

- C. Locking Connection Straps: 1/2" wide positive locking steel straps or nylon self-locking straps. Panduit or accepted substitute.
- D. Connection Fittings: Connections to non-metallic ducts manufactured sheet metal "spin-in" fittings. Genflex, Wiremold, Thermaflex, Glassflex, Clevepak, Schuller, or accepted substitute.
- E. Access Doors In Sheet Metal Work:
  - 1. Hollow core double construction of same or heavier gauge material as duct in which installed. Use no door smaller than 12" by 12" for simple manual access or smaller than 18" by 24" where personnel must pass through infrequently. Use 24" by 60" minimum for filters and more frequent maintenance. Use Ventlok or accepted substitute hinges and latches on all doors.
    - a. 100 Series hinges and latches on low pressure system doors up to 18" maximum dimension.
    - b. 200 Series on larger low pressure system doors and 333 Series on high pressure systems.
  - 2. Construct doors up to 18" maximum dimension with 1" overlap, furr and gasket with 3/4" by 1/8" sponge rubber. Fit larger doors against 1-1/2" by 1/8" or angle frame and gasket with 3/4" by 1/8" sponge rubber or felt.
- F. Anti-Backdraft Dampers: Connected, gasket-edged aluminum blades set in 14 gauge or heavier steel frame; brass, nylon or Teflon bearings; equip with spring helper with tension adjustment feature or with adjustable counterweight and adjust to open when not more than 0.10" wg pressure is applied. Ruskin CBS-4, Greenheck, Pacific Air Products, Air Balance, Controlair or accepted substitute.
- G. Opposed Blade Volume Damper: Install opposed blade volume damper in each zone supply duct on discharge of multi-zone units and where indicated on Drawings. Young No. 817 or accepted substitute.
- H. Flexible Connections: Neoprene impregnated fiberglass connection. Ventglass, Duro-Dyne, or accepted substitute.
- I. Control Dampers: Construct of aluminum frame and blades with continuous full length axle shafts and/or operating "jackshafts" as required to provide coordinate tracking of all blades. Interlocking multi-blade type, except where either dimension is less than 10", a single blade may be used. Opposed blade type on all modulating dampers and parallel blades on all two position dampers. Provide with metal jamb seal and neoprene blade seals. Damper assembly rated for maximum air leakage of 4 CFM per square foot at 1" wg pressure or less and with interconnecting blade linkages in the side channels of the frame.

## 2.03 GRILLES, REGISTERS AND DIFFUSERS

- A. Description: Provide grilles, registers and diffusers as shown on the Drawings.
- B. Finishes:
  - 1. Steel: Flat white enamel prime coat, factory applied on ceiling diffusers. Others are to have a baked enamel finish, color as selected by Architect.
  - 2. Aluminum: Anodized clear finish unless indicated otherwise.

- C. Manufacturers: Carnes, Krueger, Titus, Price, Nailor, and Tuttle & Bailey are accepted substitutes where only Titus model numbers are listed. Where other manufacturer's products are listed and/or "accepted substitute" is indicated, only the products or an accepted substitute for that item shall be provided.
- D. Ceiling Return and/or Exhaust Register: Perforated snap-in or concealed hinged face plate. Use in spaces containing ceiling diffusers and/or T-bar ceilings. Provide with damper except where dampered plenums are indicated. Titus PAR.
- E. Sidewall Supply Grille or Register: Double deflection grille with face bars parallel to long dimension on ceiling type and horizontal on wall type; bars to be individually adjustable, spaced on 0.66" to 0.75" centers; key operated opposed blade volume damper. Titus 300RL.
- F. Drum Type Outlet: Extruded aluminum adjustable "drum" type outlet with adjustable vertical blades and opposed blade volume damper behind. Select based upon duct size, throws, and sound levels indicated. Titus DL.
- G. Plaster Frames: Provide plaster frames for all diffusers, grilles or registers installed in plaster walls or ceiling. Where register face is aluminum, the plaster frame shall be aluminum. Frame to match manufacturer of register or be of compatible size of listed manufacturer. Titus TRM/TRM-S.
- H. Heavy Duty Return or Exhaust Register: All welded construction with 14 gauge frame 1/8" x 1/2" steel horizontal face bars set at 0° degrees. Face bars to be at 1/2" on centers and reinforced every 6" to 8". KEES GHD Series or equal.

### PART 3 EXECUTION

#### 3.01 EQUIPMENT INSTALLATION

- A. Air Handling Equipment Installation and Arrangement: Install and arrange as shown on Drawings. Comply with the manufacturer's recommendations for installation, connection, and start-up.
- B. Equipment Access Panels: Locate free of all obstructions such as ceiling bars, electrical conduit, lights, ductwork, etc.
- C. Filters: Install specified filters or accepted substitute temporary construction filters in supply units and systems prior to start-up or use for drying and/or temporary heat. Replace prior to acceptance of project.

#### 3.02 INSTALLATION OF GRILLES, REGISTERS AND DIFFUSERS

- A. Size and air handling characteristics shall be as shown on the Drawings.
- B. Locate, arrange, and install grilles, registers and diffusers as shown on the Drawings. Locate registers in tee-bar ceilings with diffusers centered on the tile unless indicated otherwise.

#### 3.03 DUCTWORK INSTALLATION

- A. Support: Install ductwork with 1" wide strap cradle hangers not more than 8' on centers or as required by code. Support terminal units independent of adjacent ductwork. Attach to available building construction according to good practices for materials involved. Manufactured hanger system acceptable in lieu of fabricated hangers at Contractor's option. Ductmate "Clutcher" system or approved. Support flexduct where shown to be used for lengths beyond 4' per above



requirements. Comply with SMACNA Duct Construction Standard Figure 3-9 and 3-10.

- B. Fan and Air Handling Unit Flexible Connections: Install neoprene impregnated fiberglass connections in ductwork at all rotating equipment. Ventglass, Duro-Dyne or accepted substitute.
- C. Elbows and Fittings: Construct elbows with throat radius equal to duct width in plane of turn or make them square and provide double wall, air foil turning vanes.
- D. Fittings: Make transitions and take-offs as shown on Drawings. Provide volume dampers and splitter dampers as indicated on Drawings and as specified. Saddle tees are not allowed.
- E. Acoustical Duct Lining:
  - 1. Acoustically line all fan unit intake and discharge plenums, all ductwork indicated as lined on the Drawings, all sheet metal ductwork specified per Section 23 07 00 as insulated, where exposed to view or subject to damage in areas such as mechanical rooms, and, at the Contractor's option, all insulated ductwork specified in Section 23 07 00 except outside air intake ducts. The duct size noted on the Drawings is the clear opening of the duct with insulation. Insulation shall not reduce duct size listed.
  - 2. All duct designated to receive duct liner shall be completely covered with a fire-resistant, fiber-bonding coating, or covering (composite, polymer, vinyl or neoprene) that reduces airflow resistance and controls fiber release. The duct lining shall be adhered to the sheet metal with 100% coverage of a fire retardant adhesive. The coated surface of the duct liner shall face the airstream. When width of duct exceeds 12" and also when height exceeds 24", use corrosion resistant mechanical fasteners 12" on center maximum lateral spacing and 18" on center maximum longitudinal spacing. Start fastening within 3" of upstream transverse edge of the liner and within 3" of the longitudinal joint. Mechanical fasteners shall be either impact-driven or weld-secured and shall not pierce the duct walls. Fasteners and washers of the specified type and length shall be used assuring no greater than 10% compression of the liner thickness. Installation shall be made so that no fastener pins protrude into the airstream. No gaps or loose edges shall occur in the insulation. Top pieces shall be supported by the side pieces. Provide insulated build out frames for attaching dampers at running vanes where required.
  - 3. All transverse and longitudinal abutting edges of duct lining shall be sealed and lapped 3" with a heavy coat of approved adhesive, in accordance with the manufacturer's recommendations. All upstream transverse edges shall be installed with sheet metal nosings. All raw exposed edges of lining shall be 'buttered' with approved adhesive.
- F. Manual Volume Dampers: Location of all volume dampers are not necessarily shown on the Drawings. Provide a minimum of one volume damper in each supply, return or exhaust branch. Do not install dampers closer than 3 duct diameters to the diffuser.
- G. Duct Insulation: Specified in Section 23 07 00.
- H. Sleeves: Provide galvanized sheet metal plaster ring around ductwork penetrating exposed finished walls. Sleeve and flash all duct penetrations through exterior walls in an air tight and weatherproof manner.
- I. Plenums: Construct sheet metal plenums and partitions of not lighter than 18 gauge galvanized steel and reinforce with 1-1/2" by 1/2" by 1/8" angles as required to prevent drumming or breathing.
- J. Access: Install necessary access opening and covers for cleaning, wiring or servicing motors, filters, fans, both entering and leaving air sides of coils, fire and/or smoke dampers and to other equipment located within or blocked by sheet metal work.
- K. Sealing: Caulk, seal, grout and/or tape ductwork and plenums to make airtight at seams, joints,

edges, corners and at penetrations. Solder all seams, joints, etc., on all ductwork exposed to the weather. Install specified tape in accordance with manufacturer's requirements using degreaser on surfaces to be taped and wiped to eliminate moisture.

**3.04 NEW DUCTWORK CLEANING**

- A. Store all ductwork materials on pallets or above grade, protected from weather, dirt/mud and other construction dust.
- B. Remove all accumulated dust, dirt, etc. from each duct section as it is being installed.
- C. Prior to installation of diffusers, grilles and registers, install temporary system filters and cover all diffuser, grille and register openings with temporary 25% efficiency filter materials and start the fan systems. Operate fans a minimum of 8 hours. Remove all temporary filters at the end of that period and install specified filters prior to balancing.
- D. Clean all diffusers, grilles and registers just prior to project final completion.
- E. Cover all ductwork terminations during construction to prevent accumulation of dust and debris.

**END OF SECTION**

**HVAC FANS**

**PART 1 GENERAL**

**1.01 DESCRIPTION**

- A. Provide Fans as specified herein and shown on the Drawings.
- B. Equipment capacity and size as indicated in the equipment lists on the Drawings.
- C. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

**1.02 QUALITY ASSURANCE**

- A. Air Handling Equipment: Rated in accordance with AMCA certified rating procedures and AMCA labeled.
- B. See Commissioning specification for additional requirements.

**1.03 SUBMITTALS**

- A. Submit catalog data, construction details and performance characteristics for each fan.
- B. Submit operating and maintenance data.

**PART 2 PRODUCTS**

**2.01 EXHAUST FANS**

- A. Destratification Fans: EC motor by Ebm-papst with certification conforming to UL-507 and No. 1113 ETL-USA. Provide with control device to accept a 0-10 VDC operation signal. Airius Fans Air Pear 25-EC series. See Drawings for size.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install and arrange equipment as shown on the Drawings and as recommended by the equipment manufacturer.

**3.02 AIR HANDLING INSTALLATION**

- A. Installation and Arrangement: Air handling equipment shall be installed and arranged as shown on the Drawings. Comply with the manufacturer's recommendations for installation connection and start-up.
- B. Train Owner's maintenance personnel to adjust, operate and maintain the entire unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

**3.03 CONTROLS**

- A. Wiring: All wiring shall be in accordance with the National Electrical Code and local electrical codes.

**END OF SECTION**

**HVAC AIR CLEANING DEVICES**

**PART 1 GENERAL**

**1.01 DESCRIPTION**

- A. Provide Air Cleaning Devices as specified herein and as shown on the Drawings.
- B. Materials characteristics and size shall be as indicated on the Drawings.
- C. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

**1.02 QUALITY ASSURANCE**

- A. Air Equipment Rating: In accordance with ASHRAE 52.2-2007.

**1.03 SUBMITTALS**

- A. Submit catalog data, construction details and performance characteristics for all manufactured materials.
- B. Submit operating and maintenance data.

**PART 2 PRODUCTS**

**2.01 AIR FILTERS**

- A. Disposable Media, MERV 8 Rated:
  - 1. Disposable, preformed 100% synthetic non-woven media, pleated 2" thick cartridge type with carrier board frames with diagonal and horizontal supports. Average ASHRAE test efficiency of MERV 8 per ASHRAE 52.2-2007 App J with initial pressure drop across the clean filter bank not exceeding 0.2" W.C. when operating at 500 FPM. The filter media shall have an Underwriters Laboratories UL 900 Class 2 listing.
  - 2. Provide specified filters for temporary heat and testing during construction and replace filters with new clean, specified filters prior to acceptance of project by Owner (two complete sets of media are required).
  - 3. Flanders or equal Farr.
- B. Disposable Media, MERV 13 Rated:
  - 1. Disposable, preformed 100% synthetic non-woven media, pleated 4" thick cartridge type with carrier board frames with diagonal and horizontal supports. Average ASHRAE test efficiency of MERV 13 per ASHRAE 52.2-2007 App J with initial pressure drop across the clean filter bank not exceeding 0.4" W.C. when operating at 500 FPM. The filter media shall have an Underwriters Laboratories UL 900 Class 2 listing.
  - 2. Flanders or equal Farr.

**PART 3 EXECUTION**

**3.01 EQUIPMENT INSTALLATION**

- A. Air Handling Equipment Installation and Arrangement: Install and arrange as shown on Drawings. Comply with the manufacturer's recommendations for installation, connection, and start-up.

- B. Equipment Access Panels: Locate free of all obstructions such as ceiling bars, electrical conduit, lights, ductwork, etc.
- C. Filters: Install specified filters or accepted substitute temporary construction filters in supply units and systems prior to start-up or use for drying and/or temporary heat. Provide 1 additional set of filters and replace those installed during Balancing and Commissioning process.
- D. Install and arrange equipment as shown on the Drawings and as recommended by the equipment manufacturer.

**END OF SECTION**

**ROOF TOP HVAC UNITS**

**PART 1 GENERAL**

1.01 DESCRIPTION

- A. Provide Heating, Cooling, and Ventilating Equipment as specified herein and shown on the Drawings.
- B. Equipment capacity and size shall be as indicated on the Drawings.
- C. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

1.02 QUALITY ASSURANCE

- A. Air Handling Equipment: Rated in accordance with AMCA certified rating procedures and AMCA labeled.
- B. Gas-fired Equipment: Design certified by American Gas Association.
- C. Field Wiring: Comply with requirements of Section 23 05 00.

1.03 SUBMITTALS

- A. Submit catalog data, construction details and performance characteristics for each HVAC unit.

**PART 2 PRODUCTS**

2.01 ROOFTOP HVAC UNIT

- A. Unit Performance:
  - 1. Units shall be safety certified in accordance with UL Standard UL1995, and ANSI Standard Z21.47.
  - 2. Unit shall be safety certified by an accredited testing laboratory.
  - 3. Unit nameplate shall carry the label of the certification agency.
  - 4. Unit shall be shipped completely assembled by the manufacturer including all standard items and optional items.
  - 5. Unit shall be 100% run tested by the manufacturer with a copy of the run test report shipped with the unit.
- B. Unit Construction:
  - 1. Unit shall be completely factory assembled, piped, wired and shipped in one piece.
  - 2. Unit shall be specifically designed for outdoor rooftop application with a fully weatherproof cabinet.
  - 3. Unit design shall be dedicated bottom supply / return air style system for mounting on a roof curb.
  - 4. Cabinet shall be constructed entirely of G90 galvanized metal with the exterior constructed of 18 gauge or heavier material and interior construction of 22 gauge or heavier solid liner.
  - 5. The unit roof shall be cross-broken and / or sloped to assure drainage.
  - 6. Access to compressor(s), controls, filters, blower, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors with a quarter turn latch (door fastening screws are not acceptable). Provide with door hold backs to prevent over extension.

7. Air side service access doors shall be fully gasketed with rain break overhangs.
  8. Air side access doors will have an internal metal liner to protect the door insulation.
  9. Unit exterior shall be painted with polyurethane paint over a primer and a G90 type galvanized steel.
  10. Paint finish shall be capable of withstanding at least 2000 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.
  11. All wiring shall be color-coded.
  12. The interior airside of the cabinet shall be entirely insulated on all exterior panels with 1" thick, 1.5-pound density, neoprene coated, fiberglass insulation or foam filled panels.
  13. To guarantee no leakage of conditioned air from the cabinet all of the cabinet under positive pressure, downstream from the supply air blower, shall have a separate internal cabinet contained within, and separate from, the exterior cabinet by an air gap. The internal cabinet shall be guaranteed to hold a static pressure of up to 12 inches water column.
  14. All openings through the base pan of the unit shall have upturned flanges of at least 1/2" in height around the opening through the base pan.
  15. Unit shall have decals and tags to indicate unit lifting - rigging, service areas and caution areas.
  16. Wiring diagrams shall be in color and marked to match the color and markings of the wires and shall be both "point-to-point" and "ladder" diagrams.
  17. Diagrams shall also be laminated in plastic and permanently fixed to the control compartment door.
  18. Installation and maintenance manuals shall be supplied with each unit, located in a metal pocket in the control access compartment.
  19. VFD equipped units shall have drives installed internally unless noted otherwise. The VFD may be installed in an environmentally controlled cabinet attached to the rooftop unit in a manner approved by the rooftop unit manufacturer.
- C. Blowers:
1. Blower(s) shall be entirely self-contained on a slide deck for service and removal from the cabinet.
  2. All supply air blowers shall be direct drive. Return air blowers shall be axial flow direct drive.
  3. Adjustable V-belt drive shall be provided with a minimum rating of 140% of the motor nameplate brake horsepower when the adjustable pulley is at the minimum RPM.
  4. Blowers, drives and motors shall be dynamically balanced to comply with 0.10 in/second for supply air fans and 0.15 in/second for return air fans. Provide certification or field test in presence of engineer.
- D. Outside Air: Shall be 0-100% with a motor operated outside air damper constructed of extruded aluminum, hollow core, air foil blade with rubber edge seals and aluminum end seals. Damper blades shall be gear driven and designed to have no more than 4 CFM of leakage per square foot of damper area when subjected to 1" WG air pressure differential across the damper. Damper motor shall be spring return to ensure closing of outdoor air damper during periods of unit shut down or power failure.
- E. Return Fan or Power Exhaust Section:
1. The control shall be via DDC system to modulate VFD or EC motor to maintain building pressure.
  2. Unit shall have exhaust fan with factory mounted VFD or EC motor.
- F. Gas Heating Section:
1. Unit shall be provided with a gas-heating furnace consisting of (stainless steel) heat exchanger with multiple concavities, an induced draft blower and an electric pressure switch to lockout the gas valve until the combustion chamber is purged and combustion



- air flow is established. Heat exchanger tubes with separate internal turbulators are not acceptable.
2. Unit shall be provided with a gas ignition system consisting of an electronic igniter to a pilot system, which will be continuous when the heater is operating, but will shut off the pilot when heating is not required.
  3. Unit shall have gas supply piping entrances in the unit base for through the curb gas piping and in the outside cabinet wall for across the roof gas piping.
  4. Unit shall be equipped with a 304 Stainless Steel tubular heat exchanger with a 25-year non pro-rated warranty.
  5. The completely factory mounted gas heating assembly shall be capable of operating at any firing rate between 100% and 30% of rated capacity. The discharge air set point shall be adjusted at the electronic controller within the rooftop unit control compartment.
- G. Power Option:
1. Unit equipment shall be provided with a single point disconnect switch.
  2. Unit shall be provided with phase and brownout protection to shut down all motors in the unit if the phases are more than 10% out of balance on voltage, or the voltage is more than 10% under design voltage.
  3. Provide with factory installed service outlet. Outlet to be wired from dedicated power source.
- H. Filters:
1. Unless otherwise noted, unit to be furnished with 2" pre-filter section and 4" filter section. See 23 40 00 for filters.
  2. Provide one complete extra set of filters for replacement once building flush out or construction is complete.
- I. Roof Curbs: Provide with seismically rated solid non-plenum 14" tall curb per drawings approved by manufacturer of units.
- J. Factory Controls:
1. Provide a complete integrated microprocessor based Direct Digital Control (DDC) system to control all unit functions including temperature control, scheduling, monitoring, unit safety protection, including compressor minimum run and minimum off times, and diagnostics. This system shall consist of all required temperature sensors, pressure sensors, controller and keypad/display operator interface. All MCBs and sensors shall be factory mounted, wired and tested. Controller shall allow network communication via BACnet MS/TP protocol.
  2. The stand-alone DDC controllers shall not be dependent on communications with any on-site or remote PC or master control panel for proper unit operation. The microprocessor shall maintain existing set points and operate standalone if the unit loses either direct connect or network communications. The microprocessor memory shall be protected from voltage fluctuations as well as any extended power failures. All factory and user set schedules and control points shall be maintained in nonvolatile memory. No settings shall be lost, even during extended power shutdowns.
  3. The DDC control system shall permit starting and stopping of the unit locally or remotely. The control system shall be capable of providing a remote alarm indication. The unit control system shall provide for outside air damper actuation, emergency shutdown, remote heat enable/disable, remote cool enable/ disable, heat indication, cool indication, and fan operation.
  4. All digital inputs and outputs shall be protected against damage from transients or incorrect voltages. All field wiring shall be terminated at a separate, clearly marked terminal strip.
  5. The DDC controller shall have a built-in time schedule. The schedule shall be programmable from the unit keypad interface. The schedule shall be maintained in nonvolatile memory to insure that it is not lost during a power failure. There shall be one

- start/stop per day and a separate holiday schedule. The controller shall accept up to sixteen holidays each with up to a 5-day duration. Each unit shall also have the ability to accept a time schedule via BAS network communications.
6. The keypad interface shall allow convenient navigation and access to all control functions. The unit keypad/display character format shall be 4 lines x 20 characters. All control settings shall be password protected against unauthorized changes. For ease of service, the display format shall be English language readout. Coded formats with look-up tables will not be accepted. The user interaction with the display shall provide the following information as a minimum:
- a. Return air temperature
  - b. Discharge air temperature
  - c. Outdoor air temperature
  - d. Space air temp
  - e. Dirty filter indication
  - f. Airflow verification
  - g. Control temperature (Changeover)
  - h. Unit status
  - i. All time schedules
  - j. Active alarms w/time and date
  - k. Previous alarms with time and date
  - l. Optimal start
  - m. Supply fan and return air/exhaust air fan speed
  - n. System operating hours
    - 1) Fan
    - 2) Exhaust fan
    - 3) Heating
    - 4) Economizer
    - 5) Tenant override
7. The user interaction with the keypad shall provide the following:
- a. Controls mode
    - 1) Off manual
    - 2) Auto
    - 3) Heat only
    - 4) Fan only
  - b. Occupancy mode
    - 1) Auto
    - 2) Occupied
    - 3) Unoccupied
    - 4) Tenant override
    - 5) Unit operation changeover control
    - 6) Return air temperature
    - 7) Space temperature
    - 8) Network signal
  - c. Supply reset options
    - 1) Return air temperature
    - 2) Outdoor air temperature
    - 3) Space temperature
    - 4) Airflow (VAV)
    - 5) Network signal
    - 6) External (0-10 vdc)
    - 7) External (0-20mA)
    - 8) Temperature alarm limits
    - 9) High supply air temperature
    - 10) Low supply air temperature
    - 11) High return air temperature
  - d. Night setback and setup space temperature

- e. Building static pressure
- f. Economizer changeover shall be Drybulb temperature operated.
- g. Current time and date
- h. Tenant override time
- i. Occupied/unoccupied time schedule
- j. One event schedule
- k. Holiday dates and duration
- l. Adjustable set points
- m. Service mode
  - 1) Timers normal (all time delays normal)
  - 2) Timers fast (all time delays 20 sec)
- 8. If the unit is to be programmed with a night setback or setup function, an optional space sensor shall be provided. Space sensors shall be available to support field selectable features. Sensor options shall include:
  - a. Zone sensor with tenant override switch
  - b. Zone sensor with tenant override switch plus heating and cooling set point adjustment. (Space Comfort Control systems only)
- 9. See 23 09 93 for sequence of operation and 23 09 23 for device specification for more information and device requirements.

K. Approved Manufactures: Daikin or Aeon.

### PART 3 EXECUTION

#### 3.01 INSTALLATION

- A. Install and arrange equipment as shown on the Drawings and as recommended by the equipment manufacturer.
- B. Piping: Refer to applicable sections for piping, ductwork, insulation, painting, etc.

#### 3.02 HVAC EQUIPMENT INSTALLATION

- A. All roof mounted mechanical equipment shall be supported and seismically anchored on leveled, flashed and counterflashed vibration isolated curbs anchored to resist seismic forces and suitable for the roof construction. Minimum curb height shall be 12" above the roof unless indicated otherwise on the Drawings. Flashing into the roof is specified in another Section.
- B. Make all piping, electrical and duct penetrations for each piece of equipment within the curb unless shown otherwise on the Drawings. Piping and electrical conduit routed above and across the roof shall be supported on flashed and counterflashed curbs with pipe guides anchored to the curbs in "pitch pockets." Submit shop drawings on other arrangements for approval.
- C. Installation and Arrangement: Air handling equipment shall be installed and arranged as shown on the Drawings. Comply with the manufacturer's recommendations for installation, connection, and start-up. Complete manufacturer's IOM.start-up document.
- D. Lubrication: All moving and rotating parts shall be lubricated in accordance with the manufacturer's recommendations prior to start-up.
- E. Filters: Specified filters or approved temporary construction filters shall be installed in supply units prior to start-up or used for drying and/or temporary heat. See specifications related to ensuring ducts remain clean during construction for more information.
- F. A factory representative shall meet with Control Contractor to review sequence of operations and

assist Control Contractor in generating a sequence of operation. Instances #'s from the factory controller shall be part of the sequence. See Section 23 0923 for more information and requirements.

- G. Manufacturer's Field Service: Engage a factory authorized service representative to inspect field assembled components and equipment installation, to include electrical and piping connections. Report results to A/E in writing. Inspection must include a complete startup checklist to include (as a minimum) the following: Completed Start-Up Checklists as found in manufacturer's IOM.
- H. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary, and install clean filters. Verify water source for compliance with manufacturer's requirements for flow and temperature. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.
- I. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the entire HVAC Air unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training. Provide one 4 hour on site training for each type of system (VAV/CAV) on how to operate factory controls to change set points, clear alarms, and all other operating parameters. Review the entire sequence of operation and show parameters affecting the sequence and how to alter them.

### 3.03 CONTROLS

- A. Wiring: All wiring shall be in accordance with the National Electrical Code and local electrical codes.
- B. Meet with control contractor to assist in integration of unit controls to BAS.

**END OF SECTION**

**COMMON WORK RESULTS FOR ELECTRICAL****PART 1 GENERAL****1.01 DESCRIPTION**

- A. The provisions of the General Requirements, Supplementary Requirements, and Division 1 apply to the electrical work specified in this Section.
- B. The requirements of this Section apply to the electrical systems specified in these Specifications and in other Division 26 sections.
- C. Provide all items, articles, materials, equipment, operations and/or methods listed, mentioned, shown and/or scheduled on the Drawings and/or in these Specifications, including all labor, supervision, services, permits, fees, and incidentals necessary and required to provide a complete and operable facility with complete systems as shown, specified, and required by applicable codes.
- D. The work shall include, but not be limited to, the following systems:
  - 1. Electrical service complete per serving utility company requirements.
  - 2. Electric service and distribution equipment.
  - 3. Complete lighting and power systems, including panelboards, branch circuits, devices, lighting fixtures, etc.
  - 4. Fire alarm central control panel, initiating and annunciating devices, raceway and cabling system, etc.
  - 5. Connection of electrical equipment furnished under other Divisions of this Specification.
  - 6. Wiring to and connection of electrical equipment or appliances furnished outside of these Specifications and Contract but described on the Electrical Drawings.
  - 7. Special systems as specified herein.
  - 8. Grounding.
- E. Advise subcontractor, suppliers, and vendors involved in the work specified in this Section of the applicable requirements.
- F. Temporary electrical service, Division 1.

**1.02 QUALITY ASSURANCE**

- A. All work and materials shall conform to all applicable local and state codes and all federal, state and other applicable laws and regulations. All clarifications and modifications which have been cleared with appropriate authorities are listed under the applicable sections. All electrical products shall bear the UL label.
- B. Whenever the requirements of the Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.
- C. Codes and Standards: Comply with the provisions of the following referenced codes, standards and specifications:
  - 1. Institute of Electrical and Electronic Engineers (IEEE)
  - 2. Federal Specifications (FS)
  - 3. American National Standards Institute (ANSI)
  - 4. National Electrical Manufacturer's Association (NEMA)
  - 5. National Fire Protection Association (NFPA)
  - 6. Underwriters Laboratories, Inc. (UL)
  - 7. Factory Mutual (FM)
  - 8. International Building Code (IBC) with State and Local Amendments

9. National Electrical Code (NEC) with State and Local Amendments
  10. American Society for Testing and Materials (ASTM)
  11. Americans with Disabilities Act (ADA)
  12. International Fire Code (IFC) with State and Local Amendments
  13. National Electrical Contractors Association (NECA)
- D. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name. Where two or more units of the same class of equipment are furnished, use product of the same manufacturer; component parts of the entire system need not be products of same manufacturer. Furnish all materials and equipment, new and free from defect and of size, make, type and quality herein specified or approved by the Architect. All materials shall be installed in a neat and professional manner.
- E. All apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.
- F. All disconnect switches, panelboards, switchboards, motor control centers, and equipment of like nature shall be of the same manufacturer.
- G. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both. If Drawings and Specifications contradict each other, the Contractor shall obtain written clarification prior to the bid. If time constraints are such that this is not possible, then the more stringent of the conflicting requirements shall be included in the bid. The Specifications are not automatically more authoritative than the drawings.
- 1.03 WORK OF OTHER CONTRACTS
- A. Work under this contract shall be conducted in a manner to allow for the future installations of such equipment or items, and include the wiring and/or devices shown on the Drawings or listed in other sections of this Specification. Also see "Equipment Connections."
- 1.04 WORK OF OTHER DIVISIONS
- A. Work under this Division shall be conducted in a manner to cooperate with the installation of such equipment or items as specified in other Divisions.
- B. Control devices and control wiring relating to the heating and air conditioning systems are specified under other Sections of these Specifications except for provisions or items specifically noted on the Drawings or specified herein.
- C. Consult all Drawings and Specifications in this project and become familiar with all equipment to be installed. Coordinate all aspects of the construction with the other trades on the job to ensure that all work and materials required to provide a complete and operational facility are included in the bid.
- D. All sections of Division 26 are interrelated and shall be considered in their entirety when interpreting any material, method, or direction listed in any section of Division 26. Individual sections are not written for specific Subcontractors or Suppliers but for the General Contractor.
- 1.05 SHOP DRAWINGS, PRODUCT DATA, AND SAMPLES
- A. Submit in accordance with Division 1 full technical and descriptive shop drawing data on proposed materials and equipment as detailed in each section.

- B. The Contractor shall verify that all equipment submitted can be delivered and installed within the time constraints of the construction period.
- C. Include the manufacturer, type, style, catalog number, complete specification, certified dimensions, and description of physical appearance for each item and option submitted. Reproduction of catalog data sheets shall be clean and legible to show all details, including gauge of metal used.
- D. Include only information on exact equipment to be installed, not general catalogs of the manufacturer. Where sheets show proposed equipment as well as other equipment, identify proposed equipment with rubber stamp arrow or similar concise method.
- E. Submit with each copy a transmittal letter verifying that all included equipment submittals have been carefully considered for quality, dimensions, function, and have been coordinated with the Drawings and Specifications. Guarantee that proposed materials will meet or exceed the quality and function of those specified.
- F. Include wire run and connection diagrams for all signal and/or low voltage systems, including floor plans.
- G. Submittal Review: The submittal review process is a means to determine quality control. The action noted to be taken (or where conflicts with the contract documents are not noted) shall not be interpreted by the Contractor as automatic "change orders." Approval of the data for substitution and shop drawings shall not eliminate the contractor's responsibility for compliance with Drawings or Specifications, nor shall it eliminate the responsibility for freedom from errors of any sort in the data discovered prior to or after the review process. Deviations, discrepancies, and conflicts between the submittals and the Contract Documents shall be called to the Architect's attention in writing at the time of transmittal of the data.
- H. Unless otherwise directed by Division 1, submittal data shall be in a 3-ring plastic binder with a clear plastic sleeve and a project identification sheet inserted. Arrange submittals numerically with specification sections identified on divider tabs. All required sections shall be submitted at one time. If approved by Owner and Architect all submittals may be transmitted electronically in PDF format.

#### 1.06 PRODUCT SUBSTITUTION

- A. Material other than those specified may be approved for this project providing a written request is submitted to the Architect prior to bid in accordance with Instructions to Bidders. Requests shall include complete specifications, dimensions, manufacturer and catalog number for each item for which approval is desired. If, in the opinion of the Architect, the material is not complete or if it is not an acceptable substitute, he may reject it. The Architect's evaluation will be based solely on the material submitted.

#### 1.07 CHANGE ORDERS

- A. All supplemental cost proposals by the Contractor shall be accompanied by a complete itemized breakdown of labor and materials without exception. At the Architect's request, the Contractor's estimating sheets for the supplemental cost proposals shall be made available to the Architect. Labor must be separated and allocated for each item of work.

#### 1.08 RECORD DOCUMENTS

- A. Maintain a set of record drawings as directed in Division 1.

- B. Keep Drawings clean, undamaged, and up to date.
- C. Record and accurately indicate the following:
  - 1. Depths, sizes, and locations of all buried and concealed conduits/cables.
  - 2. Changes, additions, and revisions due to change orders, addenda, obstructions, etc.  
Eradicate extraneous information.
- D. Make Drawings available when requested by Architect for review.
- E. Submit as part of the required Project Closeout documents as indicated in Division 1.
- F. Use standards set in contract documents. Computer-aided design drafting (CADD) shall be used to complete project record drawings. Note field modifications, all addenda and change order items on project record drawings. If deficiencies are found in either the quality or the accuracy of the drawings, they will be returned unapproved. Additional review of subsequent submissions shall be at the Contractor's expense.

**1.09 OPERATING AND MAINTENANCE DATA**

- A. Upon completion of Contract and after no further action is noted as being required on catalog data submitted for review, submit multiple sets of Operating and Maintenance Manuals for inclusion in Owner's Maintenance Brochure as specified in Division 1. Operation and maintenance manuals shall include descriptive and technical data, maintenance and operation procedures, wiring diagrams, spare parts lists, service representatives, supplier for replacement parts, etc. Bind each set of Operating and Maintenance Manuals in 3-ring, vinyl or canvas covered, loose leaf binders organized with index and thumb-tab marker for each classification of equipment or data.

**1.10 OPERATING AND MAINTENANCE INSTRUCTIONS**

- A. At the completion of the project, at a time scheduled by the Owner, assemble key mechanics, subcontractors, vendors, factory representatives and similar personnel required to explain all facets of maintenance and operation of the installed system to the Owner's personnel. Instructions shall include actual operation of systems and methods of maintenance.

**1.11 ALTERNATE BIDS**

- A. Refer to Division 1 for possible effect upon Work of this Division.

**1.12 WARRANTY**

- A. Furnish, prior to application for final payment, three copies of written and signed guarantee effective a period of one year from date of completion and acceptance of entire project; agree to correct, repair and/or replace defective materials and/or equipment or the results of defective workmanship without additional expense to the Owner. Where no response satisfactory to the Owner has occurred within three working days from the written report of a warranty covered defect, the Contractor shall agree to pay for the cost of repair of the reported defect by a Contractor of the Owner's choice.
- B. Where the manufacturer's guarantee exceeds one year, the longer guarantee shall govern and include the Contractor's labor.

**PART 2 PRODUCTS**

**2.01 MATERIALS**



- A. All electrical products installed in this project shall be listed by Underwriters Laboratories, Inc., or be approved in writing by the local inspection authority as required by governing codes and ordinances.
- B. All material shall be new and bear manufacturer's name, model number, electrical characteristics and other identification, and shall be the standard product of manufacturer regularly engaged in production of similar material.
- C. All materials shall be of manufacturer's latest design, and of the best quality. The materials shall be manufactured in accordance with applicable standards listed under Quality Assurance.

**2.02 ACCESS PANELS**

- A. Provide panels of adequate size for equipment requiring service and installed above plaster or gypsum board ceilings, behind walls or in furring. Furnish complete with correct frame for type of building construction involved. Size, number and location of access panels is not necessarily shown on Drawings. Use no panel smaller than 12" x 12" for simple manual access, nor smaller than 16" x 20" where personnel must pass through. Milcor Style A, K, L, or M panels or equivalent Bilco or Potter-Roemer as required by construction. Access panels shall maintain ceiling fire rating.

**2.03 PAINTING**

- A. The work of this Division includes painting of the electrical items. All exposed conduits, boxes, surface raceways, etc. shall be painted per the Architect's direction. See Division 9 for additional painting requirements.

**2.04 FIRE RATINGS**

- A. Electrical items recessed into fire rated walls or ceilings shall be alcoved in gypboard enclosures or be UL listed to maintain the fire rating.

**PART 3 EXECUTION****3.01 LAYOUT AND COORDINATION**

- A. The Contractor shall inspect the job site prior to bidding and become familiar with existing conditions which will affect his work. The Drawings are diagrammatic indicating approximate location of outlets, , electrical equipment, etc. Consult the Architectural, Structural and Mechanical Drawings to avoid conflicts with equipment, structural members, etc. When required, make all deviations from Drawings to make the work conform to the building as constructed, and to related work of others. Minor relocations ordered prior to installation may be made without added cost to the Owner.
- B. Obvious omissions from Drawings or Specifications or differences between Drawings and Specifications shall be called to the Architect's attention at least ten (10) days prior to the bid date for clarification. Failure to do so will be construed as the willingness of this Contractor to supply all necessary materials and labor required for the proper completion of this work in a manner approved by the Architect.
- C. Call to the attention of the Architect any error, conflict or discrepancy in Drawings and/or Specifications. Do not proceed with any questionable items of work until clarification of same has been made.
- D. Supplementary details and plans may be supplied as required and they will become a part of the

Contract Documents.

- E. Work under this Division shall be conducted in a manner to cooperate with all other trades for proper installation of all items of equipment.
- F. Coordination of work with other crafts employed on the project is mandatory. Arrange work to reduce interruption of existing services to minimum. When interruptions are unavoidable, consult Architect and utilities involved and agree in writing, with copy to the Architect, upon a mutually satisfactory time and duration.
- G. Verify the physical dimensions of each item of electrical equipment to fit the available space and promptly notify the Architect prior to roughing-in if conflicts appear. Coordination of equipment to fit the available space and the access routes through the construction shall be the Contractor's liability.
- H. Locations of items shown on the Drawings as existing are partially based on record and other drawings which may contain errors. The Contractor shall verify the correctness of the information shown prior to rough-in or demolition and notify the Architect of any discrepancies.
- I. Coordinate all work and trim with carpet installers. Provide carpet plates on all carpet surfaces, complete as required.
- J. Install equipment such that code-required working clearances are maintained, and allow clearances for future maintenance.
- K. Coordinate installation of electrical conduit, boxes, fittings, anchors, and miscellaneous items to be concealed in precast concrete assemblies.

### **3.02 PROTECTION OF WORK**

- A. Protect electrical work, wire and cable, materials and equipment installed under this Division against damage by other trades, weather conditions or any other causes. Equipment found damaged or in other than new condition will be rejected as defective.
- B. Switchgear, panels, and electrical equipment shall be kept covered or closed to exclude moisture, dust, dirt, plaster, cement, or paint and shall be free of all contamination before acceptance. Enclosures and trims shall be in new condition, free of rust, scratches or other finish defects. Properly refinish in a manner acceptable to the Architect if damaged.
- C. Including products of other Sections, clean, repair and touch-up or replace when directed, products which have been soiled, discolored or damaged.
- D. Provide for dehumidification of equipment during construction when directed by Architect.
- E. Remove debris from project site upon completion or sooner if directed.

### **3.03 GENERAL INSTALLATION METHODS**

- A. Provide raceways and conduits for all electrical system wiring as specified herein. Class II or III systems wiring installed per Article 725 of NEC will be required to be installed in raceway unless otherwise indicated. When open wiring is permitted, raceways will be required in insulated walls and in other inaccessible areas. Low voltage wiring installed in return air plenums shall utilize plenum rated cable.
- B. The extent of the branch circuiting and control wiring shown shall not be changed.

- C. Cross or hash marks on power conduit runs indicate quantity of No. 12 minimum copper branch circuit conductors unless otherwise noted. Where such marks do not appear, provide conductors as required to provide an operable system, sized per local codes.
- D. Repair surfaces damaged during installation to match adjacent undisturbed areas. Surface preparation, including cleaning and priming, shall be in accordance with the paint manufacturer's requirements.
- E. Adjacent panelboards, component cabinets, terminal cabinets, trench duct, and wire gutter exposed in finished areas shall have matching trim and finish.
- F. In general, the mounting heights shall be as noted on the Drawings or as listed below. Where no heights are indicated, request clarification from the Architect. Consult the Architectural, Structural, and Mechanical Drawings to avoid conflicts prior to roughing in. All dimensions are to the center of the device above finished floor unless specified otherwise.
- G. All raceways and wiring shall be concealed where possible. All wiring devices, shall be flush mounted unless otherwise noted.
- H. Relays, panels, cabinets and equipment shall be level and plumb and installed parallel with structural building lines. All equipment and enclosures shall be suitable for the environmental conditions in which they will operate.
- I. The Drawings do not indicate all items necessary. Provide associated equipment, materials, and labor as required for complete and operable systems.

#### 3.04 CUTTING AND PATCHING

- A. Under no conditions are beams, girders, footings or columns to be cut for electrical items unless so shown on Drawings or written approval obtained from the Architect.
- B. Cutting, patching and repairing for the proper installation and completion of the work specified, including plastering, gypsum board, masonry work, concrete work, carpentry work and painting shall be performed by workers skilled in their respective trades.
- C. Follow requirements specified in Division 1.

#### 3.05 SLEEVES AND CHASES

- A. Provide necessary rigid conduit sleeves, openings and chases where conduits or cables are required to pass through floors, ceilings or walls. Seal all openings around conduits against leaks and in a manner to maintain the fire rating of the structure penetrated. Prevent unnecessary cutting in connection with the finished work. Make all repairs and seals in a manner acceptable to the Architect.

#### 3.06 NOISE CONTROL

- A. The entire electrical system apparatus shall operate at full capacity without objectionable noise or vibration.
- B. Outlet boxes at opposite sides of partitions shall not be placed back-to-back, nor shall straight-through boxes be employed, except where specifically permitted on the Drawings by note, to minimize transmission of noise between occupied spaces.
- C. Contactors, transformers, starters, and similar noise-producing devices shall not be placed on walls

which are common to occupied spaces unless specifically called for on the Drawings. Where such devices must be mounted on walls common to occupied spaces, they shall be shock mounted or isolated in such a manner as to effectively prevent the transmission of their inherent noise to the occupied space.

- D. 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.

### 3.07 EQUIPMENT CONNECTIONS

- A. 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.
- B. Verify the rough-in and wiring requirements for all equipment provided under other Divisions of the work and requiring electrical connections with equipment supplier and installer prior to rough-in. Check the voltage and phase of each item of equipment before connecting. Motor connections shall be made for the proper direction of rotation. Pump motors shall not be test run until liquid is in the system and proper lubrication to all bearings in unit is checked. Minimum size flex for mechanical equipment shall be 1/2". Exposed motor wiring shall be jacketed metallic flex.
- C. Conduit, wire and circuit breaker sizes for mechanical equipment and equipment furnished under other Divisions are based on the equipment ratings of one manufacturer. The equipment actually furnished may be of a different brand with different electrical characteristics. Conduit, wire and circuit breakers shall not be ordered or installed until exact electrical requirements are obtained. Responsibility for this coordination shall rest with the Contractor.

### 3.08 TESTS

- A. Complete each system as shown or specified herein and place in operation except where only roughing-in or partial systems are called for. Each system shall be tested and left in proper operation free of faults, shorts, or unintentional grounds.
- B. After the interior wiring system installation is completed, and at such time as the Owner may direct, the Contractor shall conduct an operating test for approval. The equipment shall be demonstrated to operate in accordance with the requirements of the Specification. The test shall be performed in the presence of the Owner or an authorized representative. The Contractor shall furnish all instruments and personnel required for the tests, and the Owner will furnish the necessary electric power. The Contractor shall submit in writing to the Owner upon completion of the project the measured ground resistance of each ground rod, indicating the location of the rod, the resistance, and the soil conditions at the time the measurements were made.

**END OF SECTION**

**ELECTRICAL POWER CONDUCTORS AND CABLES**

**PART 1 GENERAL**

1.01 DESCRIPTION

- A. Provide all conductors, cables, connectors, lugs, cable ties, and terminations for all systems.

1.02 QUALITY ASSURANCE

- A. All conductors shall be Underwriters Laboratories, Inc., listed and comply with Fed. Spec. J-C-30B and UL 83. Materials omitted here but necessary to complete the work are to be of comparable quality.

1.03 PRODUCT DELIVERY, STORAGE & HANDLING

- A. Deliver conductors and cables in complete coils with UL label and bearing manufacturer's name, wire size, and type of insulation.
- B. Store and handle materials so as not to subject them to corrosion or mechanical damage and in a manner to prevent damage from environment and construction operation.
- C. Deliver conductors No. 10 and smaller in manufacturer's original unopened and undamaged cartons with labels legible and intact.

1.04 SUBMITTAL AND RECORD DOCUMENTATION

- A. None required.

**PART 2 PRODUCTS**

2.01 CONDUCTORS

- A. Conductors No. 10 AWG and smaller may be soft-drawn, stranded, or solid copper. Conductors larger than No. 10 AWG shall be stranded, soft-drawn copper. No aluminum conductors or MC cable allowed.
- B. Insulation for new conductors installed in raceways shall be "THWN" for conductors No. 8 AWG or smaller, and "THWN" or "THHN" for conductors No. 6 AWG or larger, or as noted.
- C. Where adverse conductor exposure exists, code-approved insulation suitable for the conditions encountered shall be used unless shown otherwise on the Drawings.
- D. All wire and cable for feeder circuits shall conform to the latest requirements of the current edition of the NEC and shall meet all ASTM Specifications. Wire and cable shall be new and have wire size, grade of insulation, voltage, and manufacturer's name permanently marked on outer covering at regular intervals.
- E. Sizes shall not be less than indicated. Branch circuit conductors shall not be smaller than No. 12 AWG. Class I remote control and signal circuit conductors shall not be less than No. 14 AWG. Class 2 low energy remote control and signal circuit conductors shall not be less than No. 18 AWG.
- F. All insulation shall be rated 600 volts unless noted otherwise.

- G. Acceptable Manufacturers: General Electric, Hatfield, Anaconda, Rome Cable, Essex, Belden, West Penn, or approved.

## 2.02 SPLICES AND TERMINATIONS

- A. All connectors shall be solderless pressure type per Fed. Spec. W-S-610, properly taped. All taped joints shall be with plastic tape, "Scotch 33," applied in half-lap layers without stretching to deform.
- B. Splices shall utilize Scotch "Hyflex" or "Ideal" wing nut connector installed properly. Splices for No. 8 and larger wires shall be made with tin or silver plated copper compression sleeves.
- C. Splices made in handholes and manholes, or underground splices, shall be made water tight with epoxy resin-type splicing kits.

## PART 3 EXECUTION

### 3.01 CONDUCTORS

- A. Insulation shall be removed with a stripping tool designated specifically for that purpose. All conductors shall be left nick-free.
- B. UL listed pulling compounds may be used with the residue cleaned from the conductors and raceway entrances after the pull is made.
- C. Raceway shall be complete, clean and free of burrs before pulling conductors.
- D. Wire shall not be left extending out of exposed conduit stubs or incomplete raceways where subject to mechanical injury.
- E. Pulleys or blocks shall be used for alignment of the conductors when pulling. Pulling shall be in accordance with manufacturer's specifications regarding tensions, bending radii of the cable and compounds.
- F. Conductors shall be terminated as required.
- G. Conductor sizes for special systems shall be as recommended by the equipment manufacturer except as noted.
- H. Stranded conductors shall not be terminated with post and screw unless compression spade/ring lug is utilized.
- I. 120-volt homeruns over 80 feet in length shall be minimum #10 conductor.

### 3.02 LABELING

- A. Provide color coding of building wiring consistent throughout the work as listed herein, unless required otherwise by local code authority. Band feeder conductors not available in colors where clearly visible at each termination, tape or splice using two full wraps of 3/4" adhesive vinyl tape or equally visible color marking corresponding to the following table.

Less than 250V between phases  
Phase A - Black  
Phase B - Red  
Phase C - Blue

251 to 600V between phases  
Phase A - Brown  
Phase B - Orange  
Phase C - Yellow

Neutral - White  
Ground - Green

Neutral - Gray  
Ground - Green

- B. Switch legs, travelers, etc., to be consistent with the above phases to which they are connected or may be any other color distinctive from those listed above. Complex control circuits may utilize any combination of colors but the identification shall be by labels throughout. Labeling shall be accomplished by using computer-generated heat shrink labels suitable for the wire size used. In no case will hand lettering or wraparound labels be accepted.
- C. Phase color code to be consistent at all feeder terminations, A-B-C left to right or A-B-C top to bottom.
- D. Conductor identification shall be provided within each enclosure where a tap, splice, or termination is made.
- E. Control circuit terminals of equipment shall be properly identified. Terminal and conductor identification shall match that shown on approved shop drawings. Hand lettering or marking is not acceptable.

### 3.03 SPLICES AND TERMINATIONS

- A. Splices are to be made up completely promptly after wire installation. Single wire pigtails shall be provided for fixture and device connections. Wire nuts may be used for fixture wire connections to single wire circuit conductor pigtails.

### 3.04 CONNECTORS

- A. Control and special systems wires shall be terminated with a tool- applied, spade-flared lug when terminating at a screw connection.
- B. All screw and bolt-type connectors shall be made up tight and be retightened after an eight-hour period.
- C. All tool-applied compression connectors shall be applied per manufacturer's recommendations and physically checked for tightness.
- D. Check terminations in all panelboards, switchgear, motor control centers, etc., six months after completion of installation. Supply a confirming letter to the Owner at completion of test.

### 3.05 TESTS

- A. Perform insulation resistance tests on all feeders and circuits over 100 A, 480 volt and below, with a 1,000 volt megger. The written test report listing the results of the test to be included in the Operating and Maintenance Manuals. Equipment which may be damaged by this test shall be disconnected prior to the test.

**END OF SECTION**





**GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

1.01 DESCRIPTION

- A. Provide ground system as specified herein, as shown on the Drawings, and as required by NEC and other rules and regulations pertaining to grounding.

1.02 SUBMITTAL AND RECORD DOCUMENTATION

- A. None required.

**PART 2 PRODUCTS**

2.01 GROUND CONDUCTORS

- A. Equipment or grounding conductors shall be soft drawn copper, stranded per ASTM B8 and, if insulated, shall have green insulation.

2.02 GROUNDING BUSHINGS/WEDGES

- A. Sufficient ampacity with grounding conductor set screw connection.

2.03 CONNECTOR

- A. Cast, set screw or bolted type.

2.04 GROUND RODS

- A. Copper-clad steel, not less than 3/4" in diameter, 8' long, driven full length into the earth.

**PART 3 EXECUTION**

3.01 INSTALLATION

- A. All grounding conductors shall be sized in accordance with Article 250, Tables 250.66 and 250.122 of the NEC.
- B. Except where specifically indicated otherwise, all exposed non-current-carrying metallic parts of electrical equipment, metallic raceway systems, and neutral conductor of the wiring system shall be grounded.
- C. The ground connection shall be made at the main service equipment and shall be extended to the point of entrance of the metallic water service. Connection to the water pipe shall be made by a suitable ground clamp. If flanged pipes are encountered, connection shall be made with the lug bolted to the street side of the flange connection.
- D. Where the metallic water service is used, it shall be grounded as described by Article 250.53 of the NEC.
- E. Generally, all supplemental grounding electrodes shall be ground rods.
- F. All ground wire connections below finished grade, cast in concrete, or bonding solid wire shall be

exothermically welded.

- G. Where there is no metallic water service to the building, ground connections shall be made to driven ground rods on the exterior of the building.
- H. The maximum resistance measured in accordance with IEEE Standard 142 of a driven ground shall not exceed 25 ohms under normally dry conditions. If this resistance cannot be obtained with a single rod, additional rods shall be installed not less than 6' on centers, or if sectional-type rods are used, additional sections may be coupled and driven with the first rod. If the resultant resistance exceeds 25 ohms measured not less than 48 hours after rainfall, the Engineer shall be notified immediately.
- I. Grounding conductor connectors shall be made up tight and located for future servicing and to ensure low impedance.
- J. The Contractor shall submit in writing to the Owner upon completion of the project the measured ground resistance of each ground rod, indicating the location of the rod and the resistance and the soil conditions at the time the measurements were made.
- K. Where new circuits are to be served by existing panels with no ground bus, provide supplemental copper ground bus in panel.

**END OF SECTION**

**HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

1.01 DESCRIPTION

- A. Provide all electrical equipment and wiring with adequate supports of specified type required for a complete installation.

1.02 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit shop drawings indicating details of fabricated products and materials.

**PART 2 PRODUCTS**

2.01 FASTENERS

- A. Fastenings shall be by wood screws or screw-type nails to wood; by toggle bolts on hollow masonry units; by expansion bolts on concrete or brick; by machine screws, welded threaded studs, heat-treated or spring steel tension clamps on steel work; for new concrete installation use cast-in-concrete inserts. Kindorf D-255 or approved.
- B. Hammer-driven and trigger-fired anchors may be used only after obtaining specific written authorization from the Architect.

2.02 OUTLET BOX SUPPORTS

- A. Wood Stud Walls: Adjustable bar hangers with "C" channel cross section Steel City 6010 series, or approved, or mounted on solid blocking. 4-inch square boxes adjacent to wood studs may be side nailed and back braced with Steel City No. 50 box brace.
- B. Light steel construction, bar hangers with 1-inch long studs between metal studs or metal stud "C" brackets snapped on and tab-locked to metal studs.
- C. Concrete or masonry walls boxes shall be flush cast in place.
- D. Concrete or masonry walls where boxes are not possible to be cast in place. Flush anchors or concrete inserts.
- E. Flush Ceiling Outlets: Steel City 6010 series or equal bar hangers.

2.03 CONDUIT SUPPORTS

- A. One Hole Malleable Straps: Steel City, Appleton, T&B, Diamond, Raco, or approved.
- B. Conduit Clips: Caddy, Raco, or approved.
- C. Nail-Up Straps: 1/2" through 1", Raco 2252, 2253, 2254, or approved.
- D. Adjustable Hangers for Conduits 1-1/2" and Larger: Steel City C-149 with threaded steel rod of proper size.
- E. Adjustable trapeze hangers to support groups of parallel conduits; Steel City B-905 steel channel, H-119 square washer, C-105 strap, threaded rod. Components of Unistrut, Globe Strut, Harvey Alstrut, Kindorf, Thomas & Betts, or approved.

## 2.04 HANGER ROD ATTACHMENTS

- A. Side Beam Connector, Kindorf E-244; 90 degree fitting, Kindorf B-916; clamp type anchor clips Kindorf Type "C," Unistrut P2675 or approved, spot type concrete insert Kindorf B-255 with "Galv-Krom" finish.

## 2.05 SUPPORT CHANNELS

- A. Conduit: Kindorf B-905 with Galv-Krom finish, and C-105 single bolt channel pipe straps.
- B. Lighting: Kindorf B-900 with G-969 closure strip and G-977 swing connector.
- C. Recessed in Concrete: Kindorf D-980 with D-982 anchored end caps and D-983 joiner clips.

**PART 3 EXECUTION**

## 3.01 INSTALLATION

- A. Every fastening device and support for electrical equipment (includes fixtures, panels, outlets, conduits, and cabinets) shall be capable of sustaining not less than four times the ultimate weight of the object or objects. Fasten support to the building or a building structural member.
- B. Provide independent supports to the building or building structural member for electrical fixtures, materials, or equipment installed in or on ceiling, walls, or in void spaces and/or over the furred or suspended ceilings. Chain or additional ceiling wires may be used for light fixture supports.
- C. Other crafts' fastening devices shall not be used for the supporting means of electrical, equipment, materials, or fixtures.
- D. Supports and/or fastening devices shall not be used to support more than one particular item.
- E. Vertical support members for equipment and fixtures shall be straight and parallel to building walls.
- F. Examine all equipment locations to determine type of supports required.
- G. Raceways or pipe straps shall not be welded to steel structures.
- H. Holes cut to a depth of more than 1-1/2" in reinforced concrete beams or to a depth of more than 3/4" in concrete joists shall avoid cutting the main reinforcing bars. Holes not used shall be filled.

## 3.02 BOXES

- A. Boxes and pendants for surface-mounted fixtures on suspended ceilings shall be supported independently of the ceiling supports.
- B. In open overhead spaces, cast metal boxes threaded to raceways need not be separately supported except where used for fixture support; cast metal boxes having threadless connectors and sheet metal boxes shall be supported directly from the building structure or by bar hangers.
- C. Where bar hangers are used, the bar shall be attached to raceways on opposite sides of the box and the raceway shall be supported with an approved fastener not more than 24" from the box.

## 3.03 RACEWAYS

- A. Support conduits within 18" of outlets, boxes, panels, cabinets, couplings, elbows, and deflections. Maximum distance between supports shall not exceed ten (10) foot spacing.
- B. Conduit up to and including 1" EMT may be supported from ceiling fixture wires by conduit clips or other approved devices only with written approval of the installer of the ceiling support system. All other conduit runs shall be secured to the structure by two-hole straps or supported on Kindorf or Unistrut hangers. Wire will not be permitted for supporting conduit. All visible conduit runs will be parallel to the building structural lines.
- C. Anchor conduit installed in poured concrete to the steel reinforcing with No. 14 black iron wire.
- D. In partitions of light steel construction, sheet metal screws may be used, and bar hangers may be attached with saddle-suspended ceiling construction only. Lighting system branch circuit raceways shall be fastened to the ceiling supports.
- E. Support suspended feeder conduits by metal ring or trapeze hangers with threaded steel rods. Wire ties to prevent displacement, using not less than No. 14 iron wire, may be used only for concealed runs in concrete for conduit up to 1-1/4".
- F. At main distribution and surface mounted branch panels and cabinets where conduit exits from the top, provide support channels on wall 24" above panel and at 6'-0" intervals from there on for support of conduits.

**END OF SECTION**



**RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS****PART 1 GENERAL****1.01 DESCRIPTION**

- A. Provide all raceways, fittings, and boxes of specified type required for complete project. Install all systems in raceways unless specifically noted otherwise. Provide all outlet boxes, junction boxes, pull boxes and special boxes required for pulling of wires, making connections, and mounting of devices or fixtures.

**1.02 QUALITY ASSURANCE**

- A. Underwriters Laboratories, Inc., listed and NEC approved
- B. All boxes shall be Underwriters Laboratories, Inc., listed. Where special fabrication is required, the work shall be performed by a listed facility in accordance with UL 50, and all products of manufacture shall bear a label. Outlet and junction boxes shall be sized in accordance with NEC requirements for "THHN" wire or as noted on Drawings.

**1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver raceways with Underwriters Laboratories, Inc., label and bearing manufacturer's name on each length.
- B. Deliver fittings in manufacturer's original unopened and undamaged packages with labels legible and intact.

**1.04 APPLICATION**

- A. Areas of use:

Underground	PVC
Within poured Concrete (except slab-on grade) or CMU	GRC, IMC, PVC
Dry concealed locations	GRC, IMC, EMT
Wet or Dry exposed locations, subject to damage	GRC, IMC
Dry exposed locations, not subject to damage	GRC, IMC, EMT
Hazardous Class I or II	GRC, IMC

- B. Underground conduit shall be minimum 3/4" trade size. PVC shall not be used inside building. Unless otherwise approved, all conduits shall be installed under reinforcing steel.
- C. Where the contractor elects to utilize PVC in lieu of GRC, the contractor shall provide supplemental ground bus in terminating switch and panelboards, and green ground wire in conduit according to code rules.
- D. For the purposes of this section, poured concrete slabs on grade and under-the-building slabs are not classified as dry locations.
- E. Flexible metal conduit will be permitted only where flexibility is necessary. Exceptions are connections to recessed light fixtures. Flexible metal conduit shall be used for connection to all equipment subject to movement or vibration such as motors, transformers, etc. Liquid-tight

flexible metal conduit shall be used when moisture may be present and for exposed motor and equipment connections.

- F. Surface raceway may be used only where specifically called for on the Drawings or in the Specifications.
- G. Aluminum conduit and Romex (NM cable) are not permitted.

#### 1.05 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit product data for surface raceway and wireway.
- B. Submit product data for floor boxes. Submit shop drawings for nonstandard boxes, enclosures, and cabinets. Include layout drawings showing components and wiring.

### PART 2 PRODUCTS

#### 2.01 ACCEPTABLE MANUFACTURERS

- A. Allied Tube & Conduit, Western Tube & Conduit, Triangle, Bridgeport, AFC, Carlon, Western Plastics, Alfex, or approved substitute. Wiremold, Walker, or approved substitute. Raco, Thomas & Betts, or approved substitute.

#### 2.02 CONDUITS

- A. Galvanized Rigid Conduit (GRC) shall be hot-dip zinc, galvanized inside and out, mild steel pipe manufactured in accordance with UL-6 and ANSI C80.1. All threads shall be galvanized after cutting.
- B. Electrical Metallic Tubing (EMT) shall be steel only and shall comply with UL-797 and ANSI C80.3. Exterior shall be hot-dip zinc galvanized and interior protected by a corrosion-resistant lubricating coating.
- C. Intermediate Metallic Conduit (IMC) shall comply with UL-1242 and ANSI C80.6. Exterior shall be hot-dip zinc galvanized and interior protected by a corrosion-resistant lubricating coating.
- D. Rigid non-metallic conduit (PVC) polyvinyl chloride shall be schedule 40 unless otherwise noted, and shall comply with UL-651 and NEMA TC 2.
- E. Surface raceway shall utilize snap-in cover and fittings as recommended by the manufacturer and shall comply with UL 5 standard. Material and size shall be as indicated on the Drawings.
- F. Flexible metal conduit shall be steel and comply with UL 1 and ANSI standards. Liquid-tight flexible metal conduit shall comply with UL 360 and ANSI standards.

#### 2.03 WIREWAYS

- A. Gutters: Steel, painted, square in cross section, preformed knockouts on standard spacing, screw cover, suitable for environment.
- B. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for a complete system.
- C. Exterior wireways and fittings/accessories shall be stainless steel.



## 2.04 FITTINGS

- A. GRC and IMC shall be coupled and terminated with threaded fittings. Ends shall be bushed with insulating bushings equal to T&B 1220 or 1230 series.
- B. Connectors and couplings for EMT shall be steel concrete tight compression type or set screw type with insulated throats on connectors. Indent type connectors shall not be used.
- C. Conduits piercing a building waterproof membrane shall be provided with O-Z type FSR fittings.
- D. Flexible metal conduit shall utilize screw-in type connectors. Couplings and set-screw type connectors are not permitted.
- E. Seal-offs with filler fiber, compound, large removable cover. All components shall be of the same manufacturer.
- F. Expansion Couplings:
  - 1. Exposed Conduit Runs: Expansion couplings shall be weatherproof with external bonding jumper, providing at least 4" longitudinal movement with bushed conduit ends.
  - 2. Concealed Conduit Runs: Expansion couplings shall be water tight with an internal bonding jumper and neoprene construction. The fitting shall allow 3/4" movement in any direction or deflection of 30 degrees from normal.
- G. Locknuts shall be galvanized steel.

## 2.05 BOXES

- A. Boxes for use with raceway systems shall not be less than 4" square and 1-1/2" deep except where shallower boxes required by structural conditions are approved.
- B. Flush and Concealed Outlet Boxes: Galvanized stamped steel with screw ears, knock-out plugs, mounting holes, fixture studs if required.
- C. Surface Outlet Boxes: Galvanized stamped steel same as above for use on ceilings and walls above 14 feet.
- D. Boxes shall be of the cast-metal hub type when located in normally wet locations and when surface mounted on outside of exterior surfaces.
- E. Boxes installed for concealed wiring shall be provided with suitable extension rings or plastic covers as required.
- F. Cast-metal boxes installed in wet locations and boxes installed flush with the outside of exterior surfaces shall be gasketed.
- G. Provide boxes suitable for the intended environment and sized as required to accommodate the equipment within. Exterior boxes shall be stainless steel.
- H. Pull boxes of not less than the minimum size required by the National Electrical Code shall be constructed of code-gauge aluminum or galvanized sheet steel except where cast-metal boxes are required in locations specified above. Boxes shall be furnished with screw-fastener covers. Where several feeders pass through a common pull box, the feeders shall be tagged to indicate clearly the electrical characteristics, circuit number, and panel designation.

**PART 3 EXECUTION****3.01 INSTALLATION**

- A. Ends of metal conduits shall be reamed and left free of burrs.
- B. Provide pull boxes or vaults where shown or required to limit the number of bends in any conduit to not more than three 90 degree bends, or to ease pulling tension. Use boxes of code-required size with removable covers, installed so that covers will be accessible after work is completed.
- C. Conceal all wiring in finished spaces so far as practicable. Exposed conduit shall be used only in unfinished spaces.
- D. Exposed raceways shall be parallel or at right angles to structural lines, and shall be neatly offset into boxes. Exposed raceways shall follow existing exposed piping/ductwork/conduit paths as far as practicable.
- E. Conduit stubbed from a concrete slab or wall to serve an outlet mounted on a table or to supply a machine shall have a rigid conduit coupling flush with the surface of the slab. Provide plug where conduit is to be used in future.
- F. Keep conduit and raceway closed with suitable plugs or caps during construction to prevent entrance of dirt, moisture, concrete or foreign objects. Raceways shall be clean and dry before installation of wire and at the time of acceptance.
- G. Remove all foreign matter from raceways and pull mandrel through conduits larger than 1-1/2" prior to installing conductors.
- H. Where no conduit size is noted on the Drawings, conduit may be the minimum code permitted size for the quantity of type THHN conductors installed, but in no case smaller than 1/2" trade diameter. Conductor quantities indicated in conduits do not include ground wire unless otherwise noted. Adjust conduit sizes accordingly.
- I. Where the contractor elects to combine branch circuit runs shown as separate runs on the Drawings, provide a minimum 3/4" conduit or increase raceway size to provide a minimum of 25 percent spare capacity for future conductors. Feeder runs shall not be combined.
- J. All conduits installed in concrete construction, underground, or under the building slab shall be minimum 3/4", unless otherwise noted.
- K. Assemble, glue and seal PVC conduit in straight lengths prior to installation in trench.
- L. Seal-offs shall be installed in all conduits which route from warm areas into refrigerated areas.
- M. Install PVC conduit in accordance with manufacturer's instructions. Cut the conduit ends square and apply an approved solvent to clean the joint. Apply an approved cement and allow to set 24 hours before installing conductors.
- N. Conduits shall be fastened to all sheet metal boxes and cabinets with two locknuts where required by the National Electrical Code, where insulating bushings are used, and where bushings cannot be brought into firm contact with the box; otherwise, a single locknut and bushing may be used.
- O. A pull wire shall be inserted into each empty raceway in which wiring is to be installed by others. The pull wire shall be of No. 15 AWG zinc-coated steel, or of plastic having not less than 200-pound tensile strength. Not less than 10" of slack shall be left at each end of the pull wire.

- P. Raceway shall not be installed under the fire pits of boilers and furnaces and shall be kept 6" away from parallel runs of flues, steam pipes and hot water pipes.
- Q. Changes in direction of runs shall be made with symmetrical bends or cast-metal fittings. Field-made bends and offsets shall be made with an approved hickey or conduit-bending machine. Crushed or deformed raceways shall not be installed.
- R. Expansion fittings complete with grounding jumpers shall be installed where raceways cross expansion joints, construction joints, sawed joints, and where shown.
- S. Where conduit is shown stubbed into a telephone, computer or communication terminal area, conduit shall be stubbed up 6" above floor or 12" below ceiling and terminated with insulating bushings.
- T. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate head room, working clearance, and access to both boxes and other equipment.
- U. The end of a conduit stub shall have an insulated bushing.
- V. 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 partitions.
- W. Install intumescent material around ducts, conduits, etc., to prevent spread of smoke or fire where installed in sleeves or block-outs penetrating fire-rated barriers. An alternate method utilizing intumescent materials in caulk and/or putty form may be used.
- X. Outlet boxes shall be designed for the intended use. Flush outlet boxes shall be installed flush with finished surface lines.
- Y. Outlet boxes on flex connected fixtures shall be installed within five feet of conduit knock-out in fixture.
- Z. Coordinate layout and installation of raceway and boxes with other construction elements to ensure adequate head room, working clearance, and access to both boxes and other equipment.

### 3.02 INSTALLING CONDUIT BELOW SLAB-ON-GRADE OR IN THE GROUND

- A. All electrical wiring below slab-on-grade shall be protected by a conduit system.
- B. No conduit system shall be installed horizontally within concrete slab-on-grade. For slab-on-grade construction, horizontal runs of rigid plastic shall be installed below the floor slab.
- C. Conduit passing vertically through slab-on-grades shall be coated rigid steel.
- D. Slope conduits away from terminal equipment; drain away from the building interior.
- E. Rigid steel or IMC conduits, metal boxes, and couplings installed below slab-on-grade or in the earth shall be field-wrapped with 0.010" pipe-wrapping plastic tape applied with a 50 percent overlay, or shall have a factory applied plastic resin, epoxy, or coal-tar coating system. Zinc coating may be omitted from rigid steel conduit, or IMC which has a factory-applied epoxy system. All joints shall be threaded, sealed and wrapped with tape to prevent entry of water. Use 20 mil pipe wrapping tape to cover wrench marks, field cuts, or abrasions to the outer factory installed anti-corrosion covering.
- F. Provide duct seal at ends of all underground and under-slab conduits.

**END OF SECTION**

**IDENTIFICATION FOR ELECTRICAL SYSTEMS**

**PART 1 GENERAL**

1.01 DESCRIPTION

- A. Clearly and properly label the complete electrical system to indicate the loads served or the function of each item of equipment connected under this work.

1.02 SUBMITTAL AND RECORD DOCUMENTATION

- A. None required.

**PART 2 PRODUCTS**

2.01 IDENTIFICATION MARKERS

- A. Unless otherwise specified, all identification nameplates shall be made of laminated three-ply plastic in accordance with Fed. Spec. L-P-387 equal to "Lamicoid." Nameplates shall be minimum 1/16" thick, with black outer layers and a white core, red outer ply for all emergency applications. Edges shall be chamfered.
- B. Provide identification nameplates for starters, switchboards, safety switches, panelboards, motor control centers, transformers, equipment (air handling units, exhaust fans, pumps, etc.), with a minimum of 1/4" high letters.
- C. Provide identification nameplates for control power transformers, control devices (relays, contactors, etc.), with a minimum of 1/8" high letters.
- D. Where switches control remote lighting, exhaust fans, or power outlets, or where switches in the same gang (two or more) serve different purposes, such as light, power, intercom, etc., or different areas, such as corridor and outlet, furnish engraved cover plates with 1/8" black letters indicating function of each switch or outlet.

**PART 3 EXECUTION**

3.01 LABELING

- A. Major items of electrical equipment and major components shall be permanently marked with an identification nameplate to identify the equipment by type or function and specific unit number as shown on the Drawings.
- B. Provide typewritten branch panel schedules with protective clear, transparent covers accounting for every breaker installed. Use actual room designations assigned by name or number near completion of the work, and not the designation on the construction drawings. Minimum panel schedule width shall be 4" with 1/4" height allowed for each circuit line. Panel schedules shall be the type which install in a metal frame or pocket. Panel schedules shall be of the odd/even sequence (1-3-5-7-9... and 2-4-6-8-10...).
- C. Identify service entrance and distribution switchboards with engraved nameplate corresponding with the plans, mounted on the face of the switchboard. Identify each feeder, breaker, and switch with engraved nameplate corresponding with the plans.
- D. Identify branch panels with engraved nameplate corresponding with the main or subdistribution panel labeling, mounted on the face of the door. No brand labels or other markings shall be on the

outside of the panels.

- E. Label all disconnect switches, relays, contactors, starters and time switches indicating voltage, amperage, power panel source, circuit number and equipment served with laminated plastic label.
- F. Nameplates shall be secured with screws or pop rivets. Adhesive-only fasteners shall not be permitted.

**END OF SECTION**

**PANELBOARDS**

**PART 1 GENERAL**

1.01 DESCRIPTION

- A. Provide at locations shown on the Drawings, panelboards of a type indicated and specified herein.

1.02 COORDINATION

- A. Coordinate with other Trades affecting or affected by Work of this Section.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

- A. Protect against damage and moisture. Store materials off ground. Remove damaged materials from site immediately after detection.
- B. Deliver with UL label and bearing manufacturers name. Panelboard exterior trim separately packaged to prevent damage during delivery and storage on site.
- C. Store and handle panelboards so as not to subject them to corrosion or mechanical damage and in a manner to prevent damage from environment and construction operation.

1.04 QUALITY ASSURANCE

- A. Underwriters Laboratories, Inc. listing/approval.
- B. Underwriters Laboratories, Inc. Standards.
  - 1. Panelboards - UL67.
  - 2. Cabinet and Boxes - UL50.
- C. National Electrical Code.
- D. NEMA Standard - PB1.

1.05 SUBMITTAL AND RECORD DOCUMENTATION

- A. Approval documents shall include drawings. Drawings shall contain overall panel dimensions, interior mounting dimensions, and wiring gutter dimensions. The location of the main, branches, and solid neutral shall be clearly shown. In addition, the drawing shall illustrate one-line diagrams with applicable voltage systems. Include copy of panel schedules in record documents.

**PART 2 PRODUCTS**

2.01 PANELBOARDS

- A. Panels shall be factory pre-assembled using copper bussing and bolt-on circuit breakers. Separate feeder lugs shall be provided for each feeder conductor. They shall be so designed that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors, so that circuits may be changed without machine drilling or tapping.
- B. Branch circuits shall be arranged using double row construction except when narrow column panels are indicated. A nameplate shall be provided listing panel type and ratings.
- C. Unless otherwise noted, full size insulated neutral bars shall be included. Bus bar taps for panels

with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection. A separate ground bus shall be included in all panels. There shall be a neutral and ground bus space for each breaker location listed as space.

- D. Panelboard boxes shall be at least 20" wide, made from galvanized steel. Provide minimum gutter space in accordance with National Electrical Code. Maximum panel depth shall be 5-3/4", unless otherwise shown or specifically approved by the Owner. Surface panel boxes shall be painted to match trim.
- E. Switching device handles shall be accessible. Doors and panelboard trims shall not uncover any live parts.
- F. All panel doors shall be provided with a flush type combination catch and lock with two milled keys. On doors more than 48" high, a three point combination catch and lock shall be provided with a vault type handle. All locks shall be keyed alike. All panel trims shall be "hinged front" construction, meaning trim has a piano hinge down one side, door opens by a single latch, and entire trim hinges open by removing two screws.
- G. Single pole breakers shall be full module size; two poles shall not be installed in a single module. Each breaker shall be securely fastened to prevent movement and trims shall fit neatly and tightly to the breaker assembly. Interrupting capacity shall be minimum 10,000 ampere or as indicated on the Drawings and shall conform to Fed. Spec. W-C-375. All 15 or 20 ampere single pole breakers shall have "switching-duty" capability.
- H. Permanent numbers, engraved, stamped or painted shall be affixed to each pole next to breakers. Stick-on numbers are not acceptable.
- I. Panelboards shall be coated with a rust inhibiting phosphate primer and two coats of light gray enamel. Trims to be separately packed and protected from scratching and marring.
- J. Panelboards shall be tested, listed, and marked for use with a UL witnessed and recognized fuse/breaker combination.

## 2.02 ACCEPTABLE MANUFACTURERS

- A. Siemens, Square D, Eaton, Cutler-Hammer/Westinghouse, and GE.

## PART 3 EXECUTION

### 3.01 INSTALLATION

- A. Breaker handle guards shall be provided on each circuit supplying obviously constant loads to prevent accidental shutting off. Such loads are contactor controlled circuits, freeze protection, etc.
- B. Provide typed schedules as in Section 26 05 53.
- C. Provide engraved laminated name plates under the provisions of Section 26 05 53.
- D. Provide one 3/4" spare conduit stubbed into an available accessible space above for every three single pole spare or space in new flush branch panels.

**END OF SECTION**



**WIRING DEVICES**

**PART 1 GENERAL**

1.01 DESCRIPTION

- A. Provide all wiring devices and finish plates as required unless specifically indicated otherwise.

1.02 QUALITY ASSURANCE

- A. Underwriters Laboratories, Inc., listed and NEC approved.
- B. Wiring devices shall be specification grade, with special devices as noted on the Drawings. Should the Drawings indicate a device other than those listed herein, such device shall be of same grade and manufacture as specified below.
- C. All lighting switches and duplex receptacles installed shall be from the same manufacturer and have identical appearance characteristics.

1.03 SUBMITTAL AND RECORD DOCUMENTATION

- A. Submit product data for wiring devices and cover plates.

**PART 2 PRODUCTS**

2.01 MATERIALS

- A. Wall Switches: 20 ampere, 120/277 volt AC, quiet type, Hubbell HBL1221 Series, color as selected by Architect. Single pole, double pole, 3-way, locking, or other type as indicated.
- B. Receptacles: Single and duplex receptacles shall be rated 20 amperes, 125 volts, two-pole, three-wire, grounded type, Hubbell HBL5362 Series. Receptacles shall have nylon faces, one-piece brass mounting strap with integral ground contacts and bypass power contacts; color as selected by Architect.
- C. Receptacles with ground fault interrupters shall be in accordance with UL 943.
- D. Special purpose or heavy duty receptacles shall be of the type and of ratings and number of poles indicated or required for the anticipated purpose. Contact surfaces may be either round or rectangular. One appropriate straight or angle-type plug shall be furnished with each receptacle. Locking facilities, where indicated, shall be accomplished by the rotation of the plug.
- E. Device plates of the one-piece type shall be provided for all outlets and fittings to suit the devices installed. Plates on unfinished walls and on fittings shall be of zinc-coated sheet steel, cast metal, or impact resistant plastic having rounded or beveled edges. Plates on finished walls shall be impact-resistant plastic, color as selected by the Architect.
- F. Receptacles in wet locations shall be in a weatherproof enclosure, the integrity of which is not affected when the receptacle is in use. The enclosure shall be of high-impact polycarbonate construction, with a keyhole hinge without a spring and other metal parts, with a gasketless translucent lid that is lockable and tinted and has large cord openings. The enclosure shall be one or two-gang, and shall be securely secured to the receptacle box with tamper-proof fasteners through factory-drilled or field-drilled through factory-prepared drill points. Bell "Rayntite II", Intermatic WP1000 series, or equal.

**2.02 ACCEPTABLE MANUFACTURERS**

- A. Hubbell, Bryant, P&S, Leviton, and Cooper.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Devices and finish plates to be installed plumb with building lines.
- B. Finish plates and devices not to be installed until final painting is complete. Scratched or splattered finish plates and devices will not be accepted.
- C. Wall mounted receptacles shall be installed vertically at centerline height shown on the Drawings unless otherwise specified.
- D. Plates shall be installed with all four edges in continuous contact with finished wall surfaces without the use of mats or similar devices. Plaster fillings will not be permitted. Plates shall be installed with an alignment tolerance of 1/16 inch.
- E. All outlets shall have a cover plate. Provide blank cover plate to match surrounding area if none other is specified.

**3.02 TESTS**

- A. Test all receptacles for line to line, line to neutral, line to ground, and neutral to ground, opens or shorts, and correct defective wiring.

**3.03 LABELING**

- A. See Section 26 05 53, Identification for Electrical Systems.

**END OF SECTION**

**CIRCUIT PROTECTIVE DEVICES****PART 1 GENERAL****1.01 DESCRIPTION**

- A. Provide overcurrent protective devices of a type as specified herein.
- B. Provide disconnect switches of a type as specified herein and where required by the National Electrical Code. Provide fused or unfused switches as required by equipment manufacturer or circuit requirements.

**1.02 QUALITY ASSURANCE**

- A. Underwriters Laboratories, Inc., listed.
- B. The circuit breaker(s) referenced herein shall be designed and manufactured according to the latest revision of the following standards.
  - 1. NEMA AB 1 - Molded Case Circuit Breakers and Molded Case Switches
  - 2. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures
  - 3. UL 943 - Standard for Ground Fault Circuit Interrupters
  - 4. CSA C22.2 No. 5.1 - M91 - Molded Case Circuit Breakers
  - 5. NEC

**1.03 PRODUCT DELIVERY, STORAGE, AND HANDLING**

- A. Deliver equipment with Underwriters Laboratories, Inc. label and bearing manufacturer's name.

**1.04 SUBMITTAL AND RECORD DOCUMENTATION**

- A. Submit product data for each disconnect switch, circuit breaker, and fuse type, including descriptive data, outline drawings with dimensions, time-current curves, let-through current curves for fuses with current limiting characteristics, and coordination charts and tables and related data.

**PART 2 PRODUCTS****2.01 MOLDED CASE CIRCUIT BREAKERS**

- A. General Requirements
  - 1. Circuit breakers shall be constructed using glass reinforced insulating material. Current carrying components shall be completely isolated from the handle and the accessory mounting area.
  - 2. Circuit breakers shall have an over center, trip free, toggle operating mechanism which will provide quick-make, quick-break contact action. The circuit breaker shall have common tripping of all poles.
  - 3. The circuit breaker handle shall reside in a tripped position between ON and OFF to provide local trip indication. Circuit breaker escutcheon shall be clearly marked ON and OFF in addition to providing International I/O markings.
  - 4. The maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings shall be clearly marked on face of circuit breaker.
  - 5. Each circuit breaker larger than 100A shall be equipped with a push-to-trip button, located on the face of the circuit breaker to mechanically operate the circuit breaker tripping mechanism for maintenance and testing purposes.
  - 6. Circuit breakers shall be factory sealed with a hologram quality mark and shall have date

- code on face of circuit breaker.
7. Branch circuit breakers exposed to fault currents higher than their AIC rating shall be series-rated with upstream feeder breaker, unless noted otherwise on Drawings. Circuit breaker/circuit breaker and fuse/circuit breaker combinations for series connected interrupting ratings shall be listed by UL as recognized component combinations. Any series rated combination used shall be marked on the end use equipment along with the statement "Caution - Series Rated System. \_\_\_\_\_A Available. Identical Replacement Component Required".
  8. Manufacturer shall provide electronic and hard copy time/current characteristic trip curves (and  $I_p$  &  $I^2t$  let through curves for current limiting circuit breakers) for each type of circuit breaker.
  9. Circuit breakers shall be equipped with UL Listed electrical accessories as noted on the Drawings. Circuit breaker handle accessories shall provide provisions for locking handle in the ON and OFF position.
  10. All circuit breakers shall be UL Listed for reverse connection without restrictive line and load markings and be suitable for mounting in any position.
  11. Circuit breakers shall have factory installed mechanical lugs. All circuit breakers shall be UL Listed to accept field installable/removable mechanical type lugs. Lug body shall be bolted in place; snap in design not acceptable. All lugs shall be UL Listed to accept solid (not larger than #8 AWG) and/or stranded copper conductors.
  12. All circuit breakers shall be capable of accepting bus connections.
  13. Circuit breakers used for motor disconnects and not in sight of the motor controller shall be capable of being locked in the open (OFF) position.
  14. Acceptable Manufacturers: Siemens, Square D, Cutler-Hammer/Westinghouse, and GE.
- B. Thermal-Magnetic Circuit Breakers
1. Circuit breakers shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole.
  2. Thermal trip elements shall be factory preset and sealed. Circuit breakers shall be true rms sensing and thermally responsive to protect circuit conductor(s) in a 40 deg C ambient temperature.
  3. Circuit breaker frame sizes above 100 amperes shall have a single magnetic trip adjustment located on the front of the circuit breaker.
  4. Standard two- and three-pole circuit breakers up to 250 amperes at 600 VAC shall be UL Listed as HACR type.
- C. Equipment Ground Fault Protection (in Thermal Magnetic Circuit Breakers)
1. Where indicated on the Drawings, circuit breakers shall be equipped with a Ground Fault Module.
  2. Ground fault sensing system shall be modified zero sequence sensing type.
  3. The ground fault system shall require no external power to trip the circuit breaker.
  4. Companion circuit breaker shall be equipped with a ground-fault shunt trip.
  5. The ground fault sensing system shall be suitable for use on grounded systems. The ground fault sensing system shall be suitable for use on three-phase, three-wire circuits where the system neutral is grounded but not carried through the system or on three-phase, four-wire systems.
  6. Ground fault pickup current setting and time delay shall be field adjustable. A switch shall be provided for setting ground fault pickup point. A means to seal the pickup and delay adjustments shall be provided.
  7. The ground fault sensing system shall include a ground fault memory circuit to sum the time increments of intermittent arcing ground faults above the pickup point.
  8. A means of testing the ground fault system to meet the on-site testing requirements of the NEC shall be provided.
  9. Local visual ground fault trip indication shall be provided.
  10. Where noted on Drawings, the ground fault sensing system shall be provided with zone selective interlocking communication capabilities compatible with other thermal

- magnetic circuit breakers equipped with ground fault sensing, electronic trip circuit breakers with integral ground fault sensing and external ground fault sensing systems.
11. The companion circuit breaker shall be capable of being group mounted.
  12. The ground fault sensing system shall not affect interrupting rating of the companion circuit breaker.

D. Electronic Trip Circuit Breakers

1. Where indicated on Drawings, provide electronic trip circuit breakers per the following.
2. Breakers shall have a microprocessor-based tripping system which consists of three current sensors, a trip unit, and a flux-transfer shunt trip. The trip unit shall use microprocessor-based technology to provide the adjustable time-current protection functions. True RMS sensing circuit protection shall be achieved by analyzing the secondary current signals received from the circuit breaker current sensors and initiating trip signals to the circuit breaker trip actuators when predetermined trip levels and time delay settings are reached.
3. Interchangeable rating plugs shall establish the continuous trip ratings of each circuit breaker. Rating plugs shall be fixed type as indicated. Rating plugs shall be interlocked so they are not interchangeable between frames, and interlocked such that a breaker cannot be closed and latched with the rating plug removed. Circuit breakers shall be UL listed to carry 80% of their ampere rating continuously.
4. System coordination shall be provided by the following microprocessor-based programmable time-current curve shaping adjustments. The short-time pick-up adjustment shall be dependent on the long-time pick-up setting.
  - a. Programmable long-time pick-up.
  - b. Programmable long-time delay with selectable  $I^2t$  and  $I^4t$  curve shaping.
  - c. Programmable short-time pick-up.
  - d. Programmable short-time delay with selectable flat or  $I^2t$  curve shaping and zone selective interlocking.
  - e. Programmable instantaneous pick-up.
  - f. Programmable ground fault pick-up trip or alarm.
  - g. Programmable ground fault delay with selectable flat or  $I^2t$  curve shaping and zone selective interlocking.

The microprocessor-based trip unit shall have a powered/unpowered selectable thermal memory to provide protection against cumulative overheating should a number of overload conditions occur in quick succession.

5. Means to seal the trip unit adjustments in accordance with the NEC shall be provided.
6. Local visual trip indication for overload, short circuit and ground fault trip occurrences shall be provided.
7. An ammeter to individually display all phase currents flowing through the circuit breaker shall be provided. Indication of inherent ground fault current flowing in the system shall be provided on circuit breakers with integral ground fault protection. All current values shall be displayed in true rms with 2% accuracy.
8. Long Time Pickup indication to signal when loading approaches or exceeds the adjusted ampere rating of the circuit breaker shall be provided.
9. The trip system shall include a Long Time memory circuit to sum the time increments of intermittent overcurrent conditions above the pickup point. Means shall be provided to reset Long Time memory circuit during primary injection testing.
10. Circuit breakers shall be equipped with back-up thermal and magnetic trip system.
11. Circuit breaker trip system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing. Test set shall be capable of verifying the operation of all trip functions with or without tripping the circuit breaker.

- A. Fuses 0 through 600 amperes:
  - 1. Circuits protected with fuses 0 through 600 amperes shall be protected by current-limiting Class RK1 or J dual-element time-delay fuses.
  - 2. All fuses shall have separate overload and short-circuit elements.
  - 3. Fuses shall incorporate a spring activated thermal overload element that has a 284 degrees Fahrenheit melting point alloy.
  - 4. The fuses shall hold 500% of rated current for a minimum of 10 seconds with an interrupting rating of 300,000 amperes RMS symmetrical, and be listed by a nationally recognized testing laboratory.
  - 5. Peak let-through currents and i2t let-through energies shall not exceed the values established for Class RK1 or J fuses.
- B. Fuses 601 through 6000 amperes.
  - 1. Circuits protected with fuses 601 through 6000 amperes shall be protected by current-limiting Class L time-delay fuses.
  - 2. Fuses shall employ "O" rings as positive seals between the end bells and the glass melamine fuse barrel.
  - 3. Fuse links shall be pure silver (99.9% pure) in order to limit the short-circuit current let-through values to low levels and comply with NEC Sections requiring component protection.
  - 4. Fuses shall be time-delay and shall hold 500% of rated current for a minimum of 4 seconds, clear 20 times rated current in 0.01 seconds or less, with an interrupting rating of 300,000 amperes RMS symmetrical, and be listed by a nationally recognized testing laboratory.
  - 5. Peak let-through currents and i2t let-through energies shall not exceed the values established for Class L fuses.
- C. Spares:
  - 1. Upon completion of the project, the Contractor shall provide the Owner with the following:
    - a. 10% (minimum of 3) of each type and rating of installed fuses shall be supplied as spares.
    - b. Spare fuse cabinet(s) shall be provided to store the above spares.
- D. Acceptable Manufacturers: Bussman, Littelfuse, and Gould-Shawmut.

## 2.03 DISCONNECTS

- A. Enclosed safety switches shall be horsepower rated in conformance with Table III or Fed. Spec. W-S-865. Switches shall disconnect all ungrounded conductors.
- B. Safety and disconnect switches shall be NEMA type HD (heavy duty), quick-make, quick-break, dual rated with electrical characteristics as required by the system voltage and the load served. Switches shall be equipped with a defeatable cover interlock. Operating handles shall be located to side of switches.
- C. Enclosures shall be NEMA 1 for indoor use, unless specifically noted otherwise, NEMA 3R where installed exposed to the weather or designated by the subscript "WP," and explosionproof where designated with the subscript "EP" or as required by the environment. Exterior enclosures shall be stainless steel.
- D. Disconnects shall be fusible or non-fusible as required by function or code. Equip all fusible disconnects with dual element fuses required by the equipment served. Coordinate fuse sizes at the time equipment is connected. Adjust fuse sizes if necessary to accommodate actual equipment installed. In no case shall fuses be sized smaller than the starter heaters on motor circuits.

- E. For single-phase motors, a single- or double-pole toggle switch, rated only for alternating current will be acceptable for capacities less than 30 amperes, provided the ampere rating of the switch is at least 125 percent of the motor rating.
- F. All disconnects shall be of same manufacturer.
- G. Switches identified for use as service equipment are to be labeled for this application.
- H. Switches used for motor disconnects and not in sight of the motor controller shall be capable of being locked in the open (OFF) position.
- I. Acceptable Manufacturers: Square D, Siemens, Cutler-Hammer/Westinghouse, and GE approved.

**PART 3 EXECUTION**

**3.01 INSTALLATION**

- A. Install overcurrent protective devices as indicated, in accordance with manufacturer's written instructions and with recognized industry practices to ensure that protective devices comply with requirements. Comply with NEC and NEMA standards for installation of overcurrent protective devices.
- B. Coordinate with other work, including electrical wiring work, as necessary to interface installation of overcurrent protective devices with other work.
- C. Fasten circuit breakers without causing mechanical stresses, twisting or misalignment being exerted by clamps, supports, or cabling.
- D. Inspect circuit breaker operating mechanisms for malfunctioning and, where necessary, adjust units for free mechanical movement.
- E. Adjust all adjustable/programmable features of electronic trip circuit breakers in accordance with results of electrical power system studies. Reference Section 26 05 73.
- F. Fuses shall not be installed until equipment is ready to be energized. This measure prevents fuse damage during shipment of the equipment from the manufacturer to the job site, or from water that may contact the fuse before the equipment is installed.
- G. Install safety and disconnect switches where indicated, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation," and in accordance with recognized industry practices to ensure that products serve the intended function.
- H. Install disconnect switches used with motor-driven appliances, motors, and controllers within sight of the controller position and within 25 feet.

**3.02 TESTING**

- A. Prior to energization of overcurrent protective devices, test devices for continuity of circuitry and for short circuits. Correct malfunctioning units, and then demonstrate compliance with requirements.

**END OF SECTION**





**FIRE ALARM AND DETECTION SYSTEM MODIFICATION****PART 1 GENERAL****1.01 DESCRIPTION**

- A. The Contractor shall provide modifications to the existing fire alarm system as specified herein and as indicated on the Drawings.
- B. The modifications shall include signal initiating devices, audible and visual alarm devices, battery back-up, conduit and wiring system, and all accessory devices required to provide a fully functional system. Wiring and system connections to fire alarm equipment furnished and installed by the other divisions are included to the extent that device locations are shown on the Drawings.

**1.02 QUALITY ASSURANCE**

- A. The system shall comply with the applicable provisions of the National Fire Protection Association Standard Number 70, "National Electrical Code," Standard Number 72, "National Fire Alarm Code," and meet all requirements of the local authorities having jurisdiction.
- B. All equipment and devices shall be listed by the Underwriters Laboratories, Inc., or approved by Factory Mutual Laboratories and shall meet Federal Specification Standards.
- C. All material and equipment shall be the latest standard products of a manufacturer regularly engaged in the manufacture of the products.
- D. Equipment shall be represented by a firm with a local service organization that is factory trained and certified. The name of this organization shall be furnished to the Owner.
- E. The Contractor shall include in the basic bid all installation charges rendered by the supplier.
- F. The installing company shall employ NICET (minimum Level II Fire Alarm Technology) technicians on site to guide the final checkout and to ensure the system's integrity.

**1.03 SYSTEM OPERATION**

- A. The fire alarm system shall be fully functional at the close of the project. The fire alarm will be checked to verify the entire system, both modified and existing, is fully operational.
- B. System operation will remain as it was prior to system modification. The new components shall operate exactly as the system was originally designed, unless otherwise requested by the AHJ.

**1.04 SUBMITTALS**

- A. General:
  - 1. Two copies of all submittals shall be submitted to the Architect/Engineer for review.
  - 2. All references to manufacturer's model numbers and other pertinent information herein is intended to establish minimum standards of performance, function and quality. Equivalent compatible UL-listed equipment from other manufacturers may be substituted for the specified equipment as long as the minimum standards are met.
  - 3. All substitute equipment proposed as equal to the equipment specified herein, shall meet or exceed the following standards. For equipment other than that specified, the Contractor shall supply proof that such substitute equipment equals or exceeds the features, functions, performance, and quality of the specified equipment.

- B. Shop Drawings:
  - 1. Sufficient information, clearly presented, shall be included to determine compliance with drawings and specifications.
  - 2. Include manufacturer's name(s), model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
  - 3. Show annunciator layout, configurations, and terminations.
- C. Manuals:
  - 1. Submit simultaneously with the shop drawings, complete operating and maintenance manuals listing the manufacturer's name(s), including technical data sheets.
  - 2. Wiring diagrams shall indicate internal wiring for each device and the interconnections between the items of equipment.
  - 3. Provide a clear and concise description of operation that gives, in detail, the information required to properly operate the equipment and system.
  - 4. Approvals will be based on complete submissions of manuals together with shop drawings.
- D. Software Modifications:
  - 1. Provide the services of a factory trained and authorized technician to perform all system software installations, modifications, upgrades or changes. Response time of the technician to the site shall not exceed 4 hours.
  - 2. Provide all hardware, software, programming tools and documentation necessary to modify the fire alarm system on site. Modification includes addition and deletion of devices, circuits, zones and changes to system operation and custom label changes for devices or zones. The system structure and software shall place no limit on the type or extent of software modifications on-site. Modification of software shall not require power-down of the system or loss of system fire protection while modifications are being made.
- E. Certifications: Together with the shop drawing submittal, submit a certification from the major equipment manufacturer indicating that the proposed supervisor of the installation and the proposed performer of contract maintenance is an authorized representative of the major equipment manufacturer. Include names and addresses in the certification.
- F. Fire alarm documents are to be submitted together for review.
- G. Additional requirements maybe set by Architect verify prior to submittal.

## PART 2 PRODUCTS

### 2.01 ACCEPTABLE MANUFACTURERS

- A. Match existing.
- B. Documentation from the manufacturer shall be presented to the Architect and Engineer certifying that the persons making the final connections, system programming, check-out and providing the warranty are factory trained technicians in the employ of the factory authorized representative.

### 2.02 MAIN FIRE ALARM CONTROL PANEL:

- A. The FACP shall be modified as required for additional circuits.

### 2.03 ANNUNCIATORS

- A. Alphanumeric LCD Type Annunciator:
1. The alphanumeric display annunciator shall be a supervised, remotely located backlit LCD display containing a minimum of eighty (80) characters for alarm annunciation in clear English text.
  2. The LCD annunciator shall display all alarm and trouble conditions in the system.
  3. An audible indication of alarm shall be integral to the alphanumeric display.
  4. The display shall be UL listed for fire alarm application.
  5. It shall be possible to connect up to 32 LCD displays and be capable of wiring distances up to 6,000 feet from the control panel.
  6. The annunciator shall connect to a separate, dedicated "terminal mode" EIA-485 interface. This is a two-wire loop connection and shall be capable of distances to 6,000 feet. Each terminal mode LCD display shall mimic the main control panel.
  7. The system shall allow a minimum of 32 terminal mode LCD annunciators. Up to 10 LCD annunciators shall be capable of the following system functions: Acknowledge, Signal Silence and Reset, which shall be protected from unauthorized use by a key switch or password.
  8. The LED annunciator shall offer an interface to a graphic style annunciator and provide each of the features listed above.

#### 2.04 SYSTEM COMPONENTS - ADDRESSABLE DEVICES

- A. Addressable Devices – General:
1. Addressable devices shall use simple to install and maintain decade (numbered 0 to 9) type address switches.
  2. Addressable devices, which use a binary-coded address setting method, such as a DIP switch, are not an allowable substitute.
  3. Detectors shall be intelligent (analog) and addressable, and shall connect with two wires to the fire alarm control panel signaling line circuits. Detectors shall be supplied with dual auxiliary contacts for connection to air handlers, elevator controls, and other systems as required.
  4. Addressable smoke and thermal detectors shall provide dual alarm and power/polling LEDs. Both LEDs shall flash under normal conditions, indicating that the detector is operational and in regular communication with the control panel, and both LEDs shall be placed into steady illumination by the control panel, indicating that an alarm condition has been detected. If required, the LED flash shall have the ability to be removed from the system program. An output connection shall also be provided in the base to connect an external remote alarm LED.
  5. The fire alarm control panel shall permit detector sensitivity adjustment through field programming of the system. The panel on a time-of-day basis shall automatically adjust sensitivity.
  6. Using software in the FACP, detectors shall automatically compensate for dust accumulation and other slow environmental changes that may affect their performance. The detectors shall be listed by UL as meeting the calibrated sensitivity test requirements of NFPA Standard 72, Chapter 7.
  7. The detectors shall be ceiling-mount and shall include a separate twist-lock base with tamper proof feature. Base shall include a sounder base with a built-in (local) sounder rated at 85 DBA minimum, a relay base and an isolator base designed for Style 7 applications.
  8. The detectors shall provide a test means whereby they will simulate an alarm condition and report that condition to the control panel. Such a test may be initiated at the detector itself (by activating a magnetic switch) or initiated remotely on command from the control panel.
  9. Detectors shall also store an internal identifying type code that the control panel shall use to identify the type of device (ION, PHOTO, THERMAL).
  10. Detectors will operate in an analog fashion, where the detector simply measures its designed environment variable and transmits an analog value to the FACP based on real-

- time measured values. The FACP software, not the detector, shall make the alarm/normal decision, thereby allowing the sensitivity of each detector to be set in the FACP program and allowing the system operator to view the current analog value of each detector.
11. Detectors shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LEDs shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
  12. Addressable devices shall provide address-setting means using decimal switches and shall also store an internal identifying code that the control panel shall use to identify the type of device. LED(s) shall be provided that shall flash under normal conditions, indicating that the device is operational and is in regular communication with the control panel.
  13. A magnetic test switch shall be provided to test detectors and modules. Detectors shall report an indication of an analog value reaching 100% of the alarm threshold.
- B. Addressable Pull Box (Manual Station):
1. Addressable pull boxes shall, on command from the control panel, send data to the panel representing the state of the manual switch and the addressable communication module status. They shall use a key operated test-reset lock, and shall be designed so that after actual emergency operation, they cannot be restored to normal use except by the use of a key.
  2. All operated stations shall have a positive, visual indication of operation and utilize a key type reset.
  3. Manual stations shall be constructed of Lexan with clearly visible operating instructions provided on the cover. The word FIRE shall appear on the front of the stations in raised letters, 1.75 inches (44 mm) or larger.
- C. Intelligent Photoelectric Smoke Detector: The detectors shall use the photoelectric (light-scattering) principal to measure smoke density and shall, on command from the control panel, send data to the panel representing the analog level of smoke density.
- D. Intelligent Thermal Detectors: Thermal detectors shall be intelligent addressable devices rated at 135 deg. F (58 degrees C) and have a rate-of-rise element rated at 15 deg. F (9.4 degrees C) per minute. It shall connect via two wires to the fire alarm control panel signaling line circuit.
- E. Duct Smoke Sensor: The detector is to be Photoelectric type.
1. If possible the detector and housing will be a one-piece design. The housing and detector separate is allowed if a one-piece unit is not available.
    - a. The duct detector housing shall be supplied with a clear cover so the presence of smoke can be monitored.
    - b. Shall be supplied with either a magnetic test feature or an injection tube for device testing.
    - c. Designed to operate with air velocity in the range of 300-4000fpm.
    - d. Coordinate with mechanical plans for duct size and provide the appropriate length of sampling tubes.
    - e. For maintenance purposes, it shall be possible to clean the duct housing sampling tubes by accessing them through the duct housing front cover.
  2. Detectors of either design will be provided with relays to connect to the fire alarm panel and DDC panel, as well as connect to a remote status LED.
  3. Remote status LED will display the detector status exactly the same as the detector. The remote status LED is to indicate the detector is operational, in trouble mode, or in alarm.
    - a. The remote status LED is required if the duct detector is over 10' off the finished floor or is not visible because of a drop ceiling.
    - b. Verify exact location to mount the remote status LED with the local AHJ prior to installation.

- F. Addressable Dry Contact Monitor Module
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional alarm initiating devices (any N.O. dry contact device) to one of the fire alarm control panel SLCs.
  2. The monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box.
  3. The IDC zone shall be suitable for Style D or Style B operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
  4. For difficult to reach areas, the monitor module shall be available in a miniature package and shall be no larger than 2-3/4 inch (70 mm) x 1-1/4 inch (31.7 mm) x 1/2 inch (12.7 mm). This version need not include Style D or an LED.
- G. Two-Wire Detector Monitor Module:
1. Addressable monitor modules shall be provided to connect one supervised IDC zone of conventional 2-wire smoke detectors or alarm initiating devices (any N.O. dry contact device).
  2. The two-wire monitor module shall mount in a 4-inch square (101.6 mm square), 2-1/8 inch (54 mm) deep electrical box or with an optional surface backbox.
  3. The IDC zone may be wired for Class A or B (Style D or Style B) operation. An LED shall be provided that shall flash under normal conditions, indicating that the monitor module is operational and in regular communication with the control panel.
- H. Addressable Control Module:
1. Addressable control modules shall be provided to supervise and control the operation of one conventional NACs of compatible, 24 VDC powered, polarized audio/visual notification appliances. For fan shutdown and other auxiliary control functions, the control module may be set to operate as a dry contract relay.
  2. The control module shall mount in a standard 4-inch square, 2-1/8 inch deep electrical box, or to a surface mounted backbox.
  3. The control module NAC may be wired for Style Z or Style Y (Class A/B) with up to 1 amp of inductive A/V signal, or 2 amps of resistive A/V signal operation, or as a dry contact (Form-C) relay. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.
  4. Audio/visual power shall be provided by a separate supervised power circuit from the main fire alarm control panel or from a supervised, UL listed remote power supply.
  5. The control module shall be suitable for pilot duty applications and rated for a minimum of 0.6 amps at 30 VDC.
- I. Addressable Relay Module: Addressable Relay Modules shall be available for HVAC control and other building functions. The relay shall be form C and rated for a minimum of 2.0 Amps resistive or 1.0 Amps inductive. The relay coil shall be magnetically latched to reduce wiring connection requirements, and to insure that 100% of all auxiliary relay or NACs may be energized at the same time on the same pair of wires.

## 2.05 ALARM INDICATING DEVICES

- A. Horns shall be of sufficient number so that an alarm shall be clearly audible to all occupants of the building and/or fire area, as required by these specifications. Wall mounted devices shall be mounted in such a way that the lens is not less than 80" and not greater than 96" above the finished floor. Locations where ceilings prevent the installation at 96" centerline, the centerline of the unit shall be 6" below the ceiling.
- B. Audible alarm signals shall produce a sound level at least 15 dBA above the average ambient sound level or 5 dBA above the maximum sound level having a duration of a least 60 seconds

(whichever is greater) measured 5 feet above the floor in each occupied area. The average ambient sound level is the root mean square, a weighted sound pressure measured over a 24-hour period.

- C. Strobes shall be installed as shown on the drawings in accordance with the requirements of the UL 1971 standard and NFPA 72. Where multiple visual notification appliances can be seen from any location, circuitry shall be incorporated for the synchronization of flash rate.
1. Strobes shall produce a flash rate of one (1) flash per second minimum over the listed input voltage (20VDC - 31VDC) range.
  2. Strobes shall incorporate a Xenon flashtube enclosed in a rugged Lexan lens or equivalent with solid-state circuitry.
  3. Strobe intensity shall be rated per UL 1971 for 15/75, 30/75, 60/75, 75 or 110 Candela. Dual listing strobes of 15/75 intensity for UL 1971/near-axis requirements shall be used where acceptable.
  4. Strobes shall be available for semi-flush or surface mounting and in conjunction with audible appliances as required.
- D. Provide manufacturer's standard wireguard where so indicated on the Drawings.

## 2.06 CONDUIT AND WIRE:

- A. Conduit:
1. Conduit shall be in accordance with The National Electrical Code (NEC), local and state requirements.
  2. Where required, all wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.
  3. Cable must be separated from any open conductors of power, or Class 1 circuits, and shall not be placed in any conduit, junction box or raceway containing these conductors, per NEC Article 760-29.
  4. Wiring for 24 volt DC control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.
  5. Conduit shall not enter the fire alarm control panel, or any other remotely mounted control panel equipment or backboxes, except where conduit entry is specified by the FACP manufacturer.
  6. Conduit shall be 3/4 inch (19.1 mm) minimum.
- B. Wire:
1. All fire alarm system wiring shall be new.
  2. Wiring shall be in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits.
  3. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.
  4. Wire and cable not installed in conduit shall have a fire resistance rating suitable for the installation as indicated in NFPA 70 (e.g., FPLR).
  5. Wiring used for the multiplex communication circuit (SLC) shall be twisted and shielded and support a minimum wiring distance of 10,000 feet. In certain applications, the system shall support up to 2 SLCs with up to 1,000 feet of untwisted, unshielded wire. The design of the system shall permit use of IDC and NAC wiring in the same conduit with the SLC communication circuit.

- C. Terminal Boxes, Junction Boxes and Cabinets: All boxes and cabinets shall be UL listed for their use and purpose.

### PART 3 EXECUTION

#### 3.01 OPERATION

- A. The fire alarm components (i.e. pull stations, smoke detectors, photoelectric smoke detectors, horns, magnetic door holders, fire alarm panel, batteries, chargers, fire alarm cable, etc.) will be supplied, installed and connected by Division 16 Contract Work. Duct smoke detectors are to be installed by Division 15, supplied and wired by Division 16.
- B. The fire alarm system operation subsequent to the alarm activation of any pull station or automatic detection device shall be as follows:
  - 1. Sound the building audible alarm devices.
  - 2. Display on the control panel the English language description of the alarm and its location.
  - 3. Print on the printer the alarm type, location, time and date.
  - 4. Activate programmed output modules points.
  - 5. Report the condition to the central station.
  - 6. Log in the event buffer all system activity.
  - 7. Recall the elevator if the alarm is activated from the lobby smoke detector(s).
  - 8. Release magnetically held fire doors.
  - 9. Deactivate the 120 volt smoke damper circuits.
  - 10. Operate the elevator power module shunt trip switch to disconnect elevator power if the alarm is activated from the elevator heat detector(s).
- C. Zoning: Provide each initiating device with its own address. This includes all detectors, pull stations, sprinkler flow switches, tamper switches, low air switches and any other monitored point.

#### 3.02 INSTALLATION

- A. Boxes, Enclosures and Wiring Devices:
  - 1. Boxes shall be installed plumb and firmly in position.
  - 2. Extension rings with blank covers shall be installed on junction boxes where required.
  - 3. Junction boxes served by concealed conduit shall be flush mounted.
  - 4. Upon initial installation, all wiring outlets, junction, pull and outlet boxes shall have dust covers. Dust covers shall not be removed until wiring installation when permanent dust covers or devices are installed.
  - 5. All junction box covers shall be painted fire department red and be affixed with a decal or silk-screened label "Fire Alarm System."
  - 6. Wet or damp locations shall require a NEMA rated enclosure suitable for the environment in which an addressable field device or module are to be installed. (i.e. monitoring of sprinkler water flow, tamper switches and OS&Y valves)
  - 7. Termination junction boxes shall be of adequate size and room to facilitate ease of accessibility to work on wiring and to provide ample space for proper identification labeling. Enclosure design shall incorporate the use of a back plate within the enclosure to provide ease of installation. Terminal blocks shall be affixed to a secured mounting rail. Terminal enclosures shall be painted fire department red and stenciled "Interior Fire Alarm System."
  - 8. Electrical conduits shall enter only at the side or the bottom of control cabinets, unless designed and approved for entry on the top.
  - 9. All conduits shall be grounded to a water main by approved ground clamps with a conductor equal in size to the largest conductor used in the system; but in no case shall the ground conductor be smaller than no. 10 AWG.

## B. Conductors:

1. Each conductor shall be identified as shown on the drawings at each with wire markers at terminal points. Attach permanent wire markers within 2 inches of the wire termination. Marker legends shall be visible.
2. All wiring shall be supplied and installed in compliance with the requirements of the National Electric Code, NFPA 70, Article 760, and that of the manufacturer-wiring guides.
3. Wiring in accessible locations (i.e. above removable ceiling tiles) may be open fire alarm cable. The cabling is to be supported off the ceiling grid by means of D-rings, J-Hooks, or other products manufactured for the purpose. The cable is to be supported at least every 5' and will not share a cable path with any other system. Cable shall not be attached to conduit, pipe, or ceiling stringers used by any other trade.
4. Wiring in inaccessible locations (i.e. walls, above gyp ceilings) shall be in a conduit raceway system. The Contractor has the option to re-use the existing fire alarm raceway system if applicable and found to be in good condition. All conductors installed in existing raceway shall be THHN. Verify wiring with equipment supplier and increase conduit size where required.
5. Wiring for analog loop circuits, conventional detection circuits, speaker circuits and telephone circuits shall be based on the fire alarm manufacturer's wiring guidelines, but shall not be smaller than #18 AWG.
6. Splices shall be made with UL listed wire nuts of the appropriate size for the cable gauge and count.
7. Crimp-on type spade lugs shall be used for terminations of stranded conductors to binder screw or stud type terminals. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
8. A consistent color code for fire alarm system conductors throughout the installation shall be provided. The Installation Contractor shall submit for approval prior to installation of wire, a proposed color code for system conductors to allow rapid identification of circuit types.
9. All nominal voltage branch circuit power feeds (120/220 VAC) shall be identified "labeled" at both ends of the circuit to indicate its source and purpose.
10. Wiring within system control panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance and to isolate nominal voltage wiring from system low voltage wiring.
11. Splices in electrical conductors in vertical risers are prohibited.
12. Initiating circuits shall be arranged to serve like categories (manual, smoke, waterflow). Mixed category circuitry shall not be permitted except on signaling line circuits connected to intelligent reporting devices.
13. Communication circuits give off RF noise. Maintain at least an eighteen-inch distance from all other communication circuits, where possible.

## 3.03 FIELD QUALITY CONTROL

- A. Certificate of Compliance: Complete and submit to the project engineer in accordance with NFPA 72, paragraph 1.7.2.

## B. Field-Testing General:

1. Each addressable analog smoke detector shall be individually field tested prior to installing the device at its designated location to ensure reliability after shipment and storage conditions. A dated log indicating correct address, type of device, sensitivity and initials of the technician performing test - using test equipment specifically designed for that purpose - shall be prepared and kept for final acceptance documentation. After testing, the detection devices and base shall be labeled with the system address, date and initials of installing technician. Labeling shall not be visible after installation is complete.



2. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Tests shall check for stray voltage not to exceed 1 volt AC/DC unless otherwise specified by the manufacturer. Resistance, current and voltage readings shall be made as work progress.
  3. All test equipment, instruments, tools and labor required to conduct the system tests shall be made available by the installing Contractor.
  4. In addition to the testing specified to be performed by the installing Contractor, the installation shall be subject to test by the acceptance inspector.
- C. Final Acceptance Testing:
1. Testing shall be in accordance with NFPA72 and this specification.
  2. A final As-built Function Matrix shall be prepared by the installing Contractor referencing each alarm input to every output function affected as a result of an alarm, trouble or supervisory condition on that input. In the case of outputs programmed using more complex logic functions involving "any," "or," "not," "count," "time," and "timer" statements; the complete output equation shall be referenced in the matrix.
  3. The installing Contractor prior to testing shall prepare a complete listing of all device labels for alphanumeric annunciator displays and logging printers.
  4. The acceptance inspector shall use the system record drawings during the testing procedure to verify operation as programmed. In conducting the tests, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
    - a. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
      - 1) Open, shorted and grounded intelligent analog signaling line circuit.
      - 2) Open, shorted and grounded network signaling line circuit.
      - 3) Open, shorted and grounded conventional initiating device circuits.
      - 4) Intelligent device removal.
      - 5) Primary power or battery disconnected.
      - 6) Incorrect device address.
      - 7) Printer trouble, off line or out of paper.
      - 8) Loss of data communications between system control panels.
      - 9) Loss of data communications between system annunciators.
    - b. System evacuation alarm indicating appliances shall be demonstrated as follows:
      - 1) All alarm notification appliances actuate as programmed.
      - 2) Audibility and visibility at required levels.
    - c. System indications shall be demonstrated as follows:
      - 1) Correct message display for each alarm input, at the control panel, each remote alphanumeric LCD display.
      - 2) Correct annunciator light for each alarm input, at each annunciator and color graphic terminal.
      - 3) Correct printer logging for all system activity.
    - d. System on-site and/or off-site reporting functions shall be demonstrated as follows:
      - 1) Correct alarm custom message display, address, device type, date and time transmitted for each alarm input.
      - 2) Correct trouble custom message display, address, device type, date and time transmitted for each alarm input.
      - 3) Trouble signals received for disconnect.
    - e. Secondary power capabilities shall be demonstrated as follows:
      - 1) System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.
      - 2) System primary power shall be restored for forty-eight hours and system-charging current shall be normal trickle charge for a fully

- charged battery bank.
  - 3) System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.
- 5. In the event of system failure to perform as specified and programmed at the discretion of the acceptance inspector, the test shall be terminated.
  - a. The installing Contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
  - b. In the event that software changes are required during the testing, the system manufacturer to compare the edited program with the original shall furnish a utility program. This utility shall yield a printed list of the changes and all system functions, inputs and outputs affected by the changes. The items listed by this program shall be the minimum acceptable to be retested before calling for resumption of the testing. The printed list and the printer log of the retesting shall be submitted before scheduling of the testing.
  - c. The acceptance inspector may elect to require the complete testing to be performed again if modifications to the system hardware or software warrant complete retesting.
- D. Notify Owner representative one week prior to all system testing days so they may witness tests.
- E. Documentation:
  - 1. System documentation shall be furnished to the Owner and shall include but not be limited to the following:
    - a. System record drawings and wiring details including one set of reproducible masters and drawings on CD (compact disks) in a compatible format (as chosen by the Owner) suitable for use in a CAD drafting program.
    - b. System operation, installation and maintenance manuals.
    - c. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output commands.
    - d. Documentation of system voltage, current and resistance readings taken during the installation and testing.
    - e. System program "hard copy" showing system functions, controls and labeling of equipment and devices. Also provide a CD with system file.
- F. Test Equipment: The Contractor shall furnish to the Owner all test equipment as required to program the field analog devices, specifically an intelligent device programmer-tester or a calibrated smoke generator with power source.
- G. Warranty/Services: The Contractor shall warrant the entire system against system hardware and electrical defects including programming software defects for a period described in the contract general conditions, but not less than one year. This period shall begin upon satisfactory completion and certification of final acceptance testing of the system. Contractor shall provide to Owner a letter stating the start-date and end-date of warranty period. In addition, the Contractor shall also provide an updated list of name(s) and phone number(s) for normal and off-hours contacts necessary to respond to warranty issues. Response to warranty notification shall require a reply within 24 hours of initial contact.

### 3.04 MAINTENANCE INSTRUCTIONS

- A. Complete maintenance instructions for all devices including trouble-shooting procedures shall be provided to the Owner. Owner's personnel shall receive a minimum of six hours of hands on system training.

### 3.05 OPERATION AND MAINTENANCE MANUALS

- A. Provide manuals in accordance with Section 26 05 00. Manuals are to contain as-built drawings on disk utilizing Autocad, spare parts list, operating procedures, trouble shooting guide, operating system data file print out, operating system data file on disk, a one year service proposal on the system and a copy of the completed NFPA "Record of Completion."

**END OF SECTION**