

PROJECT MANUAL

for

**BEAVERTON SCHOOL DISTRICT
HIGHLAND PARK MIDDLE SCHOOL HVAC UPGRADES**
7000 SW WILSON AVENUE
BEAVERTON, OREGON 97008
JOB NO. 18049.00.L

Date: 06 March 2019
Construction Documents



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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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NOT USED

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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.

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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. Replace the existing unit ventilators in the classrooms, including modifying the adjacent casework to accommodate the new unit ventilators and the adjacent finishes as required. Unit ventilators will be pre-purchased by the Beaverton School District and the purchase contract will be assigned to the Contractor, who will receive and install them.
 - 2. Replace the existing convector units in the corridors, including repairing the adjacent finishes as required.
 - 3. Relocate existing diesel generator near the boiler room.
 - 4. Remove existing roof-mounted chiller unit and provide new ground-mounted outdoor chiller unit near the boiler room. Include expansion of existing concrete equipment pad, steel pipe bollards, and fencing.
 - 5. Construct new duct chase walls in two classrooms.
 - 6. Removal and replacement of acoustic tile ceilings in offices and storage rooms to accommodate new concealed mechanical units.
- C. The Contractor shall coordinate work with other Contracts including:
 - 1. Abatement of hazardous materials will be performed by an environmental contractor hired by the Owner.
 - 2. The district will be re-roofing the entire building concurrently with this project. All roofing work, aside from demolition of roofing materials to accommodate the new mechanical units and rooftop equipment scheduled to be removed, will be performed by the Owner's roofing contractor.
- D. 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.

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6. Coordinate Project scope with the District's roofing contractor. The District will be performing a re-roofing of the entire building concurrent with this project. All roofing work will be the responsibility of the District's roofing contractor unless noted otherwise.
- E. 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.
 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 Submittal Module on e-Builder 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 24 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. 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.

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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.
 1. The District will be performing a re-roofing of the entire building concurrent with this project. The Contractor shall coordinate roof work with the District's roofing contractor. All roofing work will be the responsibility of the District's roofing contractor unless noted otherwise.
- 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 submittal modules.
- 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

SUMMARY OF WORK

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.
- 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 Module on e-Builder:
 - a. Schedule of values.
 - b. Schedule of submittals. Upload to Submittal Register on e-Builder.
 - 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 e-Builder.
 - 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 e-Builder.
 - 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,

SUMMARY OF WORK

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 e-Builder.
- 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 Module on e-Builder.
- 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 General 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 PRE-ORDERED PRODUCTS

- A. General:
 - 1. To expedite delivery and for other purposes in his own best interests, the Owner negotiated a purchase order with a supplier of material and equipment to be incorporated into the work.
 - 2. This purchase order and commitment is assigned to the Contractor and the costs are included in the Contract Sum.
 - 3. The Contractor's responsibilities are the same as if the Contractor had negotiated the purchase order, including the responsibility to renegotiate purchase if necessary and to execute final purchase order agreements.
- B. Schedule of Pre-Ordered Products:
 - 1. Classroom Unit Ventilators: See Section 23 80 00 TERMINAL HVAC EQUIPMENT
Supplier: TBD
Quantity Ordered: 43
 - UV A-1
 - UV A-2
 - UV A-3
 - UV A-4
 - UV A-5
 - UV A-6
 - UV A-7
 - UV A-8
 - UV A-9
 - UV A-10
 - UV A-11
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UV C-8
UV C-10
UV C-11
UV C-13
UV C-15
UV 110B
UV 210B
UV 310B
UV CL-3
UV CL-4

Cost: TBD

2.2 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.
- 5. Owner's Project Manager contact information:
 - a. Chris Hansen, Project Manager:
 - 1) Cell Phone: 503-715-7902.
 - 2) Office Phone: 503-356-4321.
 - 3) Email: christopher_hansen@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 24, 2019.
- D. Substantial Completion: August 15, 2019.
- E. Final Completion: August 22, 2019.

END OF SECTION

PROJECT UTILITY SOURCES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Refer to contract information on Drawings regarding utility providers' requirements and conditions. Contractor shall coordinate utility providers work and assure utilities are provided as shown.

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 Mechanical Engineer via e-Builder. Mechanical Engineer to forward any substitution to BSD representative for approval via e-Builder prior to acceptance by the Design Team.
- 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. 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. 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 Design Team 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
---------	------	-----------	-------------

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. Design Team will issue a detailed description of proposed changes in the work that may require adjustment to the Contract Sum or Contract Time via e-Builder.
 - b. Request shall be presented on AIA Document G709 or similar form approved by BSD Representative.
 - c. Proposal requests issued by Design Team 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 or proposal request, Contractor shall submit a quotation of cost adjustments to the Contract Sum and Contract Time necessary to execute the change via e-Builder.
 - 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 e-Builder 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 e-Builder. 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 Design Team, the Design Team will prepare the Change Order via e-Builder 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. The Design Team 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 e-Builder.

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 Design Team prior to the first application for payment via e-Builder; and may be used when, and only when, accepted in writing by the Owner and Design Team. Use e-Builder Submittal Module.
- 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 Design Team 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 20th day of each month.
- B. Submit via e-Builder forms requesting payment to the Design Team.
- 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 the Design Team'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.

PROJECT MANAGEMENT AND COORDINATION

- d. Record Document maintenance.
 - e. Hazardous materials.
 - f. Review of existing building conditions.
- B. Date of Conference: Before actual construction begins, when scheduled by the Design Team.
- C. Attendance: The Owner, Design Team, Contractor, and his superintendent shall attend as well as subcontractors and suppliers designated by the Owner, Design Team, 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 e-Builder.
- 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 e-Builder.

1.5 SUBMITTAL PROCEDURES

- A. Submit information as required by each Section of the Specification. Coordinate with construction schedule and allow sufficient time for Design Team 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 e-Builder.

1.7 SAMPLES

- A. Submit full range of manufacturer's standard colors or custom colors where specified, textures and patterns for Architect's final selection. Submit via e-Builder 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 e-Builder.

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 Design Team prior to the start of the Work. The Design Team 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 Design Team 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 Design Team and BSD Representative on the progress of the Work.
- B. Day of Week: To be mutually determined by the Design Team, Owner, and the Contractor.
- C. Attendance: The Owner, Design Team, 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 Design Team.
- 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 e-Builder.
- H. The Contractor shall be responsible for notifying subcontractors and other representatives of scheduled construction meetings where their attendance is requested.

1.13 PRE-INSTALLATION CONFERENCES:

- A. Pre-Installation Conferences: Contractor to arrange and conduct pre-installation conferences prior to initialization of work of major trades as required within the Specifications. Attendance shall include Owner's representative, Contractor, major sub-contractor(s), and Design Team. Include technical representatives of product manufacturers and others recognized as expert or otherwise capable of influencing success of the installation. Review significant aspects of requirements for the work. Record discussion and distribute as plan of action. Review procedures, distribute schedule and discuss requirements pertaining to the work. Designate responsible personnel. Conduct walkover inspection of existing site.
- B. Required Pre-Installation Conferences:
 - 1. Section 02 41 13, Selective Structure Demolition: Pre-Demolition Conference.

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.

PROJECT MANAGEMENT DATABASE (E-BUILDER)

- 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.
- 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 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).
 - 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.

PROJECT MANAGEMENT DATABASE (E-BUILDER)

- 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.

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. 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.

PROJECT MANAGEMENT DATABASE (E-BUILDER)

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, including one aerial view.

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 including one aerial view.

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 Design Team via e-Builder only through Contractor.
 - 2. The Architect/Consultant will forward a marked up set of submittals to the District Representative for review and approval after review by the Design Team.

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 e-Builder.

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 e-Builder. 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 e-Builder Submittal Module.
- 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 e-Builder with 2 days. Action items uploaded to e-Builder 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 e-Builder. 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 Design Team, support values given with data that will substantiate their correctness.

SUBMITTAL PROCEDURES

2.4 PAYMENT REQUESTS

- A. Submit a request each calendar month to e-Builder. 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 Design Team. Submittals issued without the Contractor's review may be returned to the Contractor without being reviewed by the Design Team. Submit to e-Builder.
 - 2. Provide 3" x 4" clear space on each submittal for the Engineer's stamp.
 - 3. Provide additional copies as required by governing authorities.
- B. Shop Drawings-Submit via e-Builder.
 - 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 e-Builder.
 - 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 e-Builder:
 - 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 Design Team.
- 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 Design Team.

2.6 3-WEEK WORK SCHEDULE

- A. Each week, provide to the Design Team a 3-Week Work Schedule on a form approved by the Design Team. Submit via e-Builder. 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 Design Team.
 - 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 Design Team. Notify the Design Team in writing at time of submission of deviation in submittals from requirements of the Contract Documents.
- D. The Design Team shall provide a marked up set of submittals to the District Representative for review and approval after review by the Design Team.
- 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 e-Builder Submittal Register, and each submittal shall be uploaded separately to the Submittal Module in e-Builder.
- 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 DESIGN TEAM'S REVIEW

- A. The Design Team 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 or Engineer 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.

SUBMITTAL PROCEDURES

- 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.
- C. Contractor's responsibility for deviations in submittals from requirements of the Contract Documents is not relieved by the Design Team's review of submittals unless the Contractor has made written request for the deviations and the Design Team 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 Design Team via e-Builder no later than 20 calendar days after Award of Contract.
- B. Shop Drawings: Submit to the Design Team via e-Builder for review. The Design Team 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 Design Team via e-Builder for review. The Design Team 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 Design Team via e-Builder for review. The Design Team 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 Design Team via e-Builder 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 Design Team prior to being used and must be submitted in sufficient time to preclude a delay in meeting the approved Construction Schedule.

SUBMITTAL PROCEDURES

SECTION NUMBER	SECTION NAME	REQUIRED SUBMITTAL
01 11 00	Summary of Work	Asbestos Free Certification Designation of Work Performed by Contractor by Own Forces List of Subcontractors and Major Materials Suppliers Executed Agreement Performance and Labor & Material Payment Bonds Contractor's Liability Insurance Policies Schedule of Values Schedule of Submittals Schedule of All Shop Drawings, Product Data and Samples Copies of Acquired Building Permit Licenses Construction Schedule Application and Certificate for Payment & Backup Notarized Affidavits of Payments Public Works Contractor Wage Certifications & BOLI Payroll Submittals Notice of Substantial Completion Certificate of Occupancy or Occupancy Permit Commissioning Reports
01 25 00	Substitution Procedures	CSI Substitution Form
01 26 00	Contract Modification Procedures	Proposal Requests Proposal Request Log
01 29 00	Payment Procedures	Applications for Payment Schedule of Values
01 31 00	Project Management and Coordination	Schedule of Values Construction Schedule Shop Drawings Color Submittal Samples Product Data Warranties City of Beaverton Reporting Requirements
01 32 33	Photographic Documentation	Photo Submittals Electronic Files
01 33 00	Submittal Procedures	Construction Schedule Schedule of Values 3 Week Work Schedule
01 35 73	Delegated Design Procedures	Submittals
01 45 00	Quality Control	Reports

SUBMITTAL PROCEDURES

SECTION NUMBER	SECTION NAME	REQUIRED SUBMITTAL
01 61 00	Common Product Requirements	Manufacturer's Instructions
01 77 00	Closeout Procedures	Prerequisites to Substantial Completion Prerequisites to Contract Closeout
01 78 00	Closeout Submittals	As-Built Drawings Permit Drawings Operation and Maintenance Manuals Warranty, Maintenance and Operational Manuals Certifications Asbestos Free Certification Certificate of Occupancy Final Permit Inspection and Approvals Record Documents Record Specifications Record Product Data Miscellaneous Record Submittals
03 30 10	Concrete	Product Data Shop Drawings Fabrication Details Bar Schedule Mill Certificates Test Reports
05 45 16	Unistrut	Shop Drawings
05 50 00	Metal Fabrications	Product Data Shop Drawings
06 41 00	Architectural Wood Casework	Shop Drawings Product Data
07 62 00	Sheet Metal Flashing and Trim	Shop Drawings Samples Warranty
07 65 00	Flexible Flashing	Product Data

SUBMITTAL PROCEDURES

SECTION NUMBER	SECTION NAME	REQUIRED SUBMITTAL
07 92 00	Joint Sealants	Product Data MSDS Sheets Closeout Submittals Guarantee Structural Adhesion Warranty Weatherseal Warranty Non-Staining Warranty
08 31 00	Access Doors and Panels	Shop Drawings Manufacturer's Detail Sheets
09 23 00	Gypsum Plastering	Office Samples Product Preparation Instructions and Recommendations Storage and Handling Requirements Installation Methods
09 29 00	Gypsum Board	Product Data Texture Samples Product Preparation Instructions and Recommendations Storage and Handling Requirements Installation Methods
09 51 00	Acoustical Ceilings	Office Samples Design Data Product Preparation Instructions and Recommendations Storage and Handling Requirements Installation Methods
09 91 00	Painting	Product Data Office Samples Product Preparation Instructions and Recommendations Storage and Handling Requirements Installation Methods Finish Schedule Date Schedule Closeout Submittals Extra Stock

SUBMITTAL PROCEDURES

SECTION NUMBER	SECTION NAME	REQUIRED SUBMITTAL
DIVISION 23	HEATING, VENTILATING AND AIR CONDITIONING (HVAC)	As noted within the specification section
DIVISION 26	ELECTRICAL	As noted within the specification section
32 31 00	Fences and Gates	Shop Drawings Product Data

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

- A. The following requirements, as applicable, apply to Work specified herein.
1. Associated General Contractors of America, Inc., “Manual of Accident Prevention in Construction.”
 2. Workmen’s Compensation Board “Safety Code for Construction Work.”
 3. Oregon State Employment Act Safety Requirements.
 4. 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.

SECURITY PROCEDURES

- 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.
- 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.

SECURITY PROCEDURES

- 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.
- 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 Sadomasochistic abuse or sexual conduct in live show
 - 167.075 Exhibiting an obscene performance to minor.
 - 167.080 Displaying obscene materials to minors

SECURITY PROCEDURES

- 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
- 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

SECURITY PROCEDURES

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.
- 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.

SECURITY PROCEDURES

- 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



Facilities Development
16550 SW Merlo Road
Beaverton, OR 97003
Fax 503-356-4475

Confidential Criminal Background Check Certification Form

Project Name: _____ Project Manager: _____ Location: _____

Legal Name: _____
(Legal First) (Full Middle) (Legal Last)

Phone Number: _____ Date of Birth: _____
(mm/dd/yyyy)

Address: _____

City: _____ State: _____ Zip Code: _____

Last four digits of your Social Security Number: _____ Gender: M / F

Have you ever been convicted of any of the crimes listed below? No _____ Yes _____

Signature: _____

None of this information will be used for immigration status checks. Any warrants for arrest discovered in the process will be reported to the appropriate law enforcement agency. Falsifying or not disclosing information may result in disqualification of your application or termination of your ability to work on BSD job sites.

Crimes Rendering Ineligibility

163.095 Aggravated murder	166.005 Treason	475.864 Unlawful possession of marijuana within 1,000 feet of school
163.115 Murder	166.087 Abuse of corpse in the first degree	475.866 Unlawful manufacture of 3,4 methylenedioxyamphetamine
163.185 Assault in the first degree	167.007 Prostitution	475.868 Unlawful manufacture of 3,4 methylenedioxyamphetamine within 1,000 feet of school
163.235 Kidnapping in the first degree	167.008 Patronizing a prostitute	475.870 Unlawful possession of 3,4 methylenedioxyamphetamine within 1,000 feet of school
163.355 Rape in the third degree	167.012 Promoting prostitution	475.872 Unlawful delivery of 3,4 methylenedioxyamphetamine within 1,000 feet of school
163.365 Rape in the second degree	167.017 Compelling prostitution	475.874 Unlawful possession of 3,4 methylenedioxyamphetamine
163.375 Rape in the first degree	167.057 Luring a minor	475.876 Unlawful manufacture of cocaine
163.385 Sodomy in the third degree	167.062 Sodomasochistic abuse or sexual conduct in live show	475.878 Unlawful manufacture of cocaine within 1,000 feet of school
163.395 Sodomy in the second degree	167.075 Exhibiting an obscene performance to minor.	475.880 Unlawful delivery of cocaine
163.405 Sodomy in the first degree	167.080 Displaying obscene materials to minors	475.882 Unlawful delivery of cocaine within 1,000 feet of school
163.408 Unlawful sexual penetration in the second degree	167.090 Publicly displaying nudity or sex for advertising purposes	475.884 Unlawful possession of cocaine
163.411 Unlawful sexual penetration in the first degree	475.808 Unlawful manufacture of hydrocodone within 1,000 feet of school	475.886 Unlawful manufacture of methamphetamine
163.415 Sexual abuse in the third degree	475.810 Unlawful delivery of hydrocodone	475.888 Unlawful manufacture of methamphetamine within 1,000 feet of school
163.425 Sexual abuse in the second degree	475.812 Unlawful delivery of hydrocodone within 1,000 feet of school	475.890 Unlawful delivery of methamphetamine
163.427 Sexual abuse in the first degree	475.818 Unlawful manufacture of methadone within 1,000 feet of school	475.892 Unlawful delivery of methamphetamine within 1,000 feet of school
163.432 Online sexual corruption of a child in the second degree	475.820 Unlawful delivery of methadone	475.894 Unlawful possession of methamphetamine
163.433 Online sexual corruption of a child in the first degree	475.822 Unlawful delivery of methadone within 1,000 feet of school	475.904 Unlawful manufacture or delivery of controlled substance within 1,000 feet of school
163.435 Contributing to the sexual delinquency of a minor	475.828 Unlawful manufacture of oxycodone within 1,000 feet of school	475.906 Penalties for distribution to minors
163.445 Sexual misconduct	475.830 Unlawful delivery of oxycodone	475.992 Unlawful possession, manufacture or delivery of a controlled substance
163.465 Public indecency	475.832 Unlawful delivery of oxycodone within 1,000 feet of school	161.405 Attempt to commit any of the above listed crimes.
163.515 Bigamy	475.848 Unlawful manufacture of heroin within 1,000 feet of school	
163.525 Incest	475.850 Unlawful delivery of heroin	
163.547 Child neglect in the first degree	475.852 Unlawful delivery of heroin within 1,000 feet of school	
163.575 Endangering the welfare of a minor	475.854 Unlawful possession of heroin	
163.670 Using child in display of sexually explicit conduct	475.856 Unlawful manufacture of marijuana	
163.675 Sale of exhibition of visual reproduction of sexual conduct by child	475.858 Unlawful manufacture of marijuana within 1,000 feet of school	
163.680 Paying for viewing sexual conduct involving a child	475.860 Unlawful delivery of marijuana	
163.684 Encouraging child sex abuse in the first degree	475.862 Unlawful delivery of marijuana within 1,000 feet of school	
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		

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 23 - HVAC: Seismic Anchorage.
 - 2. Division 26 - Electrical: Seismic Anchorage
- 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: MFIA, Inc., BBL Architects, or their consulting structural 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 the Design Team for review prior to submitting to Permit Authority.
 - 2. The Design Team 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 to be uploaded to e-Builder:
 - 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 compiled 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. Grading permit, if any.
 - 2. Building permit.
 - 3. Mechanical and plumbing permit.
 - 4. Electrical permit.
 - 5. 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.
 - 6. 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.
 - 7. The Contractor shall secure and closeout all permits. BSD will pay all system development charges, traffic impact fees, land use fees, 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 land use fees and 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. 2014 Oregon State Structural Specialty Code (Based on the 2012 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 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 Design Team 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 Design Team 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 2012 International Building Code (IBC) and the 2014 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. Contractor to provide temporary power, phone & data service for job trailer and for construction work. Existing electrical services not to be used if at all possible. Contractor to establish a utility allowance to cover cost of services.
- 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

TEMPORARY CONSTRUCTION

PART 1 - GENERAL

1.1 SITE MAINTENANCE

- A. Burning or burying of rubbish and waste materials on site is prohibited.
- B. Disposal of volatile fluid wastes (such as mineral spirits, oil or paint thinner) in storm or sanitary sewer systems is prohibited.
- C. Keep site and surrounding areas clear of accumulations of waste material and rubbish resulting from operations under this Contract. Remove waste from site systematically during the progress of construction and immediately upon completion of Work.

1.2 TEMPORARY CONSTRUCTION AND SUPPORT FACILITIES INSTALLATION

- A. Provide a neat and uniform appearance in temporary construction and support facilities acceptable to the Architect and the Owner.
- B. Locate field offices, storage and fabrication sheds, and other support facilities for easy access to the Work.
- C. Make the change-over to use of permanent services and facilities at the earliest feasible date to minimize hazards and interferences with performance of the Work.
- D. Maintain field offices, storage and fabrication sheds, temporary sanitary facilities, waste collection and disposal systems, recycling bins, and project identification and temporary signs until near Substantial Completion. Immediately prior to Substantial Completion remove these facilities. Personnel remaining at the site after Substantial Completion will be permitted to use permanent facilities, under restricted use conditions.

1.3 TEMPORARY HEAT

- A. Provide temporary heat where needed for performance of the Work, for curing or drying of recently installed work, or for protection of work in place from adverse effects of low temperatures or high humidity.
- B. Provide UL or FM tested and labeled heating units known to be safe and without adverse effect upon work in place or being installed.
- C. Coordinate with ventilation requirements to produce the ambient condition and minimize fuel or energy consumption.
- D. Maintain a minimum temperature of 45°F in permanently enclosed portions of the building and areas where finished Work has been installed.
- E. Except where use of the permanent heating system is available and authorized, provide properly vented self-contained LP gas or fuel oil heaters with individual space thermostatic control for temporary heat.
- F. Do not use open burning or salamander type heating units.
- G. Minimum Interior Ventilation: Provide local exhaust ventilation to prevent harmful dispersal of hazardous substances into the atmosphere at all times. Provide ventilation for materials being cured.

TEMPORARY CONSTRUCTION

1.4 FIELD OFFICES

- A. Provide standard prefabricated or mobile units, or the equivalent job-built field offices of sufficient size to accommodate required office personnel at the site. Pay for temporary mobile unit permits as required by the local governing authorities.
- B. Provide vented space heater capable of maintaining an indoor temperature of 68 degrees F and an air conditioning unit capable of maintaining a maximum indoor temperature of 72 degrees F.
- C. Provide switch controlled fluorescent light fixtures and 110-120 volt duplex outlets spaced at 12'-0" intervals with a minimum of one per wall in each room.
- D. Furnish with a desk, chair, 4 drawer file cabinet, plan table, plan rack, and a 6 shelf bookcase. Equip with a drinking water cooler, paper cups and medicine cabinet unit.

1.5 STORAGE AND FABRICATION SHEDS

- A. Install storage and fabrication sheds as required to accommodate the Work. Maintain temperatures and ventilation as required for materials being stored.
- B. Sheds may be open shelters or fully enclosed spaces. Where fully enclosed, provide one ABC Type portable fire extinguisher in each shed.

1.6 FIRST AID SUPPLIES

- A. Provide required first aid facilities. Comply with governing regulations and recognized recommendations within the construction industry.

1.7 MISCELLANEOUS SERVICES AND FACILITIES

- A. Design, construct, and maintain miscellaneous services and facilities as needed to accommodate performance of the work, including temporary stairs, ramps, ladders, staging, shoring, scaffolding, temporary partitions, waste chutes, and similar items.

1.8 TEMPORARY FIRE PROTECTION

- A. Until fire protection needs may be fulfilled by permanent facilities, install and maintain temporary fire protection of the types needed to protect against losses.
- B. Comply with recommendations of NFPA Standard 10.
- C. Locate fire extinguishers where most effective. Provide not less than one on each floor at or near each stairwell.
- D. Provide type "A" fire extinguishers for temporary offices and spaces where there is minimal danger of electrical or flammable liquid fires. Provide type "ABC" dry chemical extinguishers elsewhere.
- E. Store combustible materials in containers in fire-safe locations.
- F. Review fire prevention and protection needs with local fire department officials and establish procedures to be followed in the event of fire.

TEMPORARY CONSTRUCTION

- G. At temporary water outlets, provide hoses of sufficient length to reach construction areas. Hang hoses with a warning sign indicating that hoses are for fire protection purposes and are not to be removed.
- H. At the earliest feasible date, complete installation of the permanent fire protection facility, including connected services, and place into operation and use. Instruct key personnel at the site on how to use facilities that may not be self-explanatory.

1.9 ENVIRONMENTAL PROTECTION

- A. Conduct construction activities, and by methods that comply with environmental regulations, minimize the possibility that air, waterways, and subsoil might be contaminated or polluted, or that other undesirable effects might result from the performance of work at the site.
- B. Avoid the use of tools and equipment that produce harmful noise.
- C. Restrict the use of noise making tools and equipment to hours of use that will minimize complaints.

END OF SECTION

VEHICULAR ACCESS AND PARKING

PART 1 - GENERAL

1.1 ACCESS, PARKING, AND TRAFFIC

- A. Parking area for project visitors and construction personnel shall be at location designated by the Owner's Designated Representative.
- B. Provide barricades, warning signs, flagmen, or other traffic regulators that may become necessary for protection of the public, construction personnel, or property.
- C. Street/Parking Lot work to not impede flow of traffic.
- B. The provision of designation signage and temporary traffic flow signage is required if construction changes parking and/or access flow.

END OF SECTION

TEMPORARY ENCLOSURES

PART 1 – GENERAL

1.1 TEMPORARY ENCLOSURE

- A. Provide temporary enclosure of materials, equipment, work in progress, and completed portions of the Work to provide protection from exposure, foul weather, other construction operations, and similar activities.
 - 1. Subcontractor is solely responsible for security of their own tools and equipment.
- B. Coordinate with ventilating, material drying, or curing requirements to avoid dangerous conditions.
- C. Close openings through the floor or roof decks and other horizontal surfaces with substantial load-bearing wood-framed or similar construction.

1.2 COLLECTION AND DISPOSAL OF WASTES

- A. Establish a system for daily collection and disposal of waste materials.
- B. Enforce requirements strictly.
- C. Do not retain collected materials longer than 7 days during normal weather or 3 days when the daily temperature is expected to rise above 80 degrees F.
- D. Handle waste materials that are hazardous, dangerous or unsanitary separately from other waste by containerizing.
- E. Dispose of waste material in a lawful manner.
- F. Burying or burning of waste materials on the site or washing waste material down sewers will not be permitted.
- G. Provide silt bags in catch basins and biobags around the basins adjacent to construction work.
- H. Offsite Disposal: Disposal of all waste materials caused by the construction will be off the site and will be the responsibility of the Contractor. Provide paperwork to landfill stating that no hazardous material is present in trash being dumped.

1.3 SECURITY AND PROTECTION FACILITIES INSTALLATION

- A. Provide a neat and uniform appearance in security and protection facilities acceptable to the Architect and the Owner.
- B. Maintain site in a safe, lawful and publicly acceptable manner.

1.4 BARRICADES, WARNING SIGNS AND LIGHTS

- A. Comply with recognized standards and code requirements for erection of substantial barricades where needed to prevent accidents.
- B. Paint with appropriate colors and provide warning signs to inform personnel at the site and the public of the hazard being protected against.
- C. Provide lighting where needed including flashing red lights where appropriate.

TEMPORARY ENCLOSURES

1.5 ENCLOSURE FENCE

- A. Install an enclosure fence with lockable entrance gates to enclose the entire site or portion sufficient to accommodate the construction operation.
- B. Install so as to prevent persons, dogs, and similar animals from entering the site except through the entrance gates.
- C. Provide No. 11 gage galvanized open-mesh, chain-link fabric fencing 6 feet high with galvanized barbed wire top strand and galvanized steel pipe posts, 1-1/2" for line posts and 2-1/2" for corner posts.
- D. Set posts in precast post blocks.

1.6 CONSTRUCTION AID BARRIERS

- A. Provide ramps, ladders, stairs, guardrails, chutes and material hoists as required. Construct and maintain to requirements of governing agencies. Furnish for safety of public and construction personnel.
- B. Provide barriers to protect materials, equipment, new and existing work, construction personnel and the public.
- C. Provide temporary dust barriers and other appropriate protection, as required, to prevent dust from entering the existing portions of the building.
- D. Completely remove temporary materials and equipment upon completion of construction.
- E. Repair damage caused by installation of temporary items and restore finishes to specified condition.

END OF SECTION

PROJECT IDENTIFICATION

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The BSD Representative will direct the type of project identification signage to be placed at each project. General contractor to install BSD provided sign. No sign or advertising media of any nature shall be permitted on the site of Work or enclosing structures without the written approval of the BSD Representative. Any approved signs shall comply with the applicable laws, ordinances, and/or rules. Contractor shall not use in its external advertising, marketing programs, or other promotional efforts, any data, pictures or other representation of the District, except with prior specific written authorization from the BSD Representative.

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 Design Team.
- 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 Design Team 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 Design Team and Owner before ordering or fabricating that material or product.

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

EXAMINATION AND PREPARATION

PART 1 – GENERAL

1.1 SUMMARY

- A. Comply with requirements in individual Specification Sections for examination and preparation of work areas prior to installation of new work.

PART 2 – PRODUCTS (Not Used)

PART 3 – EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Examine areas of work prior to demolition or construction activities. Report the condition of the roof substrate and other deterioration encountered to the Design Team.
- B. See additional requirements in:
 - 1. Section 02 41 13 SELECTIVE STRUCTURE DEMOLITION.
 - 2. Part 3 of individual Sections within these Specifications.

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, the Design Team 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 Design Team'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 the Design Team'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 the Design Team 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 the Design Team for such additional services, and
 - 2. Owner will deduct the amount of such compensation from the final payment to the Contractor.

- D. Submissions to e-Builder: Submit all closeout submittals to e-Builder.

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, Design Team; 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 e-Builder. 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 e-Builder: Submit all closeout submittals to e-Builder.

CLOSEOUT SUBMITTALS

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.
- 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 e-Builder.
 - 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 Design Team. 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.

CLOSEOUT SUBMITTALS

- 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.
 - 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 Design Team 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 Design Team 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 e-Builder.

- 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

DEMONSTRATION AND TRAINING

PART 1 - GENERAL

1.1 INSTRUCTION OF OWNER'S PERSONNEL

- A. Prior to Final Completion or acceptance, fully instruct the Owner's Designated Representative and maintenance personnel in the operation, adjustment, and maintenance of all products, equipment, and systems.
 - 1. BSD reserves the right to video tape training sessions.
- B. Operating and maintenance manual shall constitute the basis of instruction.
 - 1. Review contents of manual with Owner's personnel in full detail to explain all aspects of operations and maintenance.
 - 2. Review complete heating and cooling cycles with Owner's Designated Representative. Review location of dampers, valves, and control equipment.
- C. Building Operators:
 - 1. Operational and safety training shall be attended by building personnel and maintenance staff.
 - 2. Provide training that emphasizes daily maintenance requirements, cleaning and safety procedures.
 - 3. Training for maintenance shall cover specialized material handling requirements including concerns during application, cleaning, disposal, and safety concerns.
- D. Maintenance:
 - 1. Maintenance training shall provide a minimum of the following:
 - a. Review of complete O&M manuals, including but not limited to, Material Safety Data Sheets (MSDS), required maintenance and troubleshooting, and must include contact names and phone numbers for factory support.

END OF SECTION

COMMISSIONING GENERAL REQUIREMENTS

PART 1 - GENERAL

1.1 SUMMARY

- A. The District will engage the Commissioning Agent through a direct contract instead of including that work scope under the Contractor as a subcontract. The Commissioning Agent will perform in a Consultant's role providing:
 - 1. A commissioning plan.
 - 2. Monitoring, recording, and reporting commissioning test results.
 - 3. Adjustments to allow systems being commissioned to meet design performance criteria.

- B. The Contractor will retain responsibility to setup tests, operate equipment and systems, make adjustments to settings and place the systems in final operational mode.

PART 2 – PRODUCTS (NOT USED)

PART 3 – EXECUTION (NOT USED)

END OF SECTION

SELECTIVE STRUCTURE DEMOLITION

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all selective building demolition necessary and preparatory to construction. Refer to the Drawings for location of existing materials requiring removal. Verify existing conditions at the site of the work and include all work evident by inspection.
- B. Provide for the salvage of existing materials for the Owner or for reuse as indicated at the end of this Section.

1.2 REFERENCES

- A. Oregon Administrative Rules (OAR), Department of Human Services, Public Health Division: Chapter 333, Division 70 Renovation, Repair and Painting Activities Involving Lead-Based Paint.
- B. Code of Federal Regulations: 40 CFR: Protection of the Environment.

1.3 QUALITY ASSURANCE

- A. Regulatory Agency Requirements: Comply with applicable codes and ordinances concerning demolition operations and refuse removal.
- B. Pre-demolition Meeting: Meet at the Site with the Mechanical Engineer, Architect, and Owner. Review location of service lines. The Contractor shall be responsible for protection from dust and water damage and flying aggregate. Establish location of interior dust barriers.

1.4 SITE CONDITIONS

- A. Traffic Control: Do not close or obstruct public streets, walks, or required exit passageways without written permission from authorities having jurisdiction.
- B. Exterior Dust Control: Keep exposed demolition debris damp to control dust.
- C. Interior Dust Control: Provide dust control barriers consisting of curtains or doors to limit the spread of demolition dust and debris in construction work. Use all precautions to confine dust to the work area. Maintain throughout the construction process.
- D. Elevator Usage:
 - 1. Use all precautions while using the Owner's freight elevator in protecting finished surfaces and following the Owner's schedule of usage.
 - 2. The Contractor will not be allowed to use the Owner's passenger elevators for the movement of any construction materials.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Sawing Equipment: Use diamond edged saw blades of proper size for depth of cut.
- B. Drilling Equipment: Use non-impact rotary tool with diamond core drills.

SELECTIVE STRUCTURE DEMOLITION

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection: Provide protection and conduct demolition operations to prevent personal injury or property damage.
- B. Service Disconnection: Disconnect existing service lines to be abandoned and cap exposed service lines to be maintained.
- C. Interior Demolition:
 - 1. Provide slurry control to protect all existing facilities from water damage during sawing and drilling.
 - 2. Provide dust barriers inside the existing building until completion of demolition work.
 - 3. Install bracing and shoring prior to sawing structural components.
 - 4. All floor materials indicated to be removed are to include the striping of the adhesive to the concrete substrate.

3.2 HAZARDOUS MATERIALS

- A. Removal: A licensed abatement contractor will remove all accessible hazardous-containing materials prior to the commencement of the building and site demolition work.
- B. Copies of the asbestos surveys and abatement specifications will be provided by the School District for reference by the demolition contractor.
- C. During the course of demolition work, additional hazardous materials may be encountered. If hazardous materials are encountered, this contractor shall immediately notify the School District Representative. The District's hazardous material abatement consultant will evaluate the suspected hazardous material and provide additional direction for the handling of the material.
- D. If any hazardous material is damaged during the course of the demolition work, immediately evacuate non-trained personnel. Clean up of the area and decontamination of personnel shall be at the direction of the Owner's hazardous material abatement consultant.
- E. Lead Base Paint: For renovations, repairs and painting (RRP) in "Child-Occupied Facilities" (where kids under the age of 6 regularly spend time and built before 1978), the General Contractor shall follow all Federal, State and local rules (including OSHA and US EPA rules and Oregon Administrative Rules Chapter 333, Division 70) associated with lead-based paints (LBP).
 - 1. The Contractor is responsible for the identification of LBP hazards and providing engineering controls for trigger activities that disturb LBP.
 - 2. Any time painted surfaces are disturbed, the work must be performed by a certified firm with a trained and certified "renovator" in accordance with *40 CFR (including Part 745.82 Lead)*.
 - 3. Post the areas of the building that will be affected with appropriate signage warning of the potential hazard.

3.3 DEMOLITION

- A. Remove existing materials as indicated on the Drawings.
- B. Remove abandoned plumbing and electrical lines to concealed spaces and cap.
- C. Sprinkle and dampen debris and rubbish with water to control dust. Remove debris from the site as demolition progresses and do not allow accumulation on the premises.
- D. Save and protect existing utilities shown to remain. Notify the Architect at once if unknown utilities are found in the work.

SELECTIVE STRUCTURE DEMOLITION

- E. Execute the demolition in an orderly and careful manner with due consideration for the Owner and the public. Provide mufflers for compressors and other noisy motors.
- F. Provide shoring and bracing as required at saw cutting areas. Do not over-cut corners.
- G. Recycle as much of the demolition waste as possible.
- H. Mechanical Demolition:
 - 1. Remove and dispose of unused heating piping, and air handling equipment ductwork where accessible during the normal course of work. Any utilities that serve equipment in operation or that is required for building use are to be kept in operation. Refer to the Mechanical Demolition Drawings for piping and ducts left in service. Exercise care in removing used piping and ducts.
 - 2. Avoid damage to piping and ductwork that will remain installed to keep the fans and other systems in operation.
 - 3. Where existing equipment is to remain for future connection, leave sufficient pipe ends for capping during demolition for protection, removal of cap, and connection of new pipe.
 - 4. Where parts of existing equipment are removed and stored for reinstallation, the Contractor shall record the location of each part as removed on a clean 1/8" scale floor plan. All parts shall be marked with a system corresponding to the plan so that the part can be easily located in its original location when reinstalled.
 - 5. If during demolition, any pipe, duct, or equipment is found that is not noted to remain or to be removed, or may require review by the Architect or the Owner to determine service, the Contractor will immediately notify the Architect. The Owner and the Architect will then review the pipe, duct, or equipment and direct Contractor on its disposition.
- I. Electrical Demolition:
 - 1. Remove and dispose of all electrical devices, conduits, and conductors that are shown to be removed. Refer to the Electrical Demolition Drawings for locations.
 - 2. Take necessary precautions while removing electrical devices, conduits, and conductors so that power, fire alarms, and the communication system are maintained while work is being accomplished.
 - 3. Provide all required temporary lighting during demolition.
 - 4. Do not remove any electrical conduits, conductors, or cabling that penetrates the construction area en route to any other area or floor unless shown on the Drawings.
 - 5. The demolition of all electrical devices including light fixtures, wiring devices, alarm equipment, mechanical, equipment, telephone equipment, wiring, etc., must be performed by a licensed electrician.
 - 6. If during demolition, any electrical items or equipment are found that are not noted to remain or be removed, or may require review by the Architect or the Owner to determine service, the Contractor will immediately notify the Owner. The Owner and the Architect will then review the electrical item or equipment and direct Contractor on its disposition.

3.4 ADJUSTING AND CLEANING

- A. Clean-up: Remove all demolition debris, including broken concrete and masonry, from the building as soon as selective demolition has been completed.
- B. Disposal:
 - 1. Do not store, sell, or burn demolished or salvaged materials on the Site.
 - 2. Transport debris to an approved and licensed land fill area.
- C. Repairs: Repair damage to existing facilities and adjacent property to meet conditions existing prior to demolition operations.

SELECTIVE STRUCTURE DEMOLITION

- D. Cleaning: Broom clean interior surfaces, exterior slabs, and paving that have been soiled by demolition activities. Vacuum ducts and replace air filters at the end of demolition work.

3.5 SALVAGE SCHEDULE

- A. Items to be Salvaged for Reuse:
 - 1. Library book shelves.
 - 2. Wall access panel in Library.
 - 3. Roof-mounted condensing units as indicated on the drawings.
 - 4. Roof-mounted exhaust fans as indicated on the drawings.
 - 5. Roof-mounted gas piping as indicated on the drawings.

END OF SECTION

LEAD HANDLING PROCEDURES

PART - GENERAL

1.1 WORK INCLUDED

- A. This section covers all contractors performing any task such as; demolition, selective demolition, plaster removal, sanding, patching, paint preparation, on-site chemical stripping, torch burning, welding, abrasive blasting or any task performed on painted or varnished surfaces which may result in occupational exposures to lead. All contractors performing tasks as identified under OAR 437-03-001 (Lead for the Construction Industry Standard, Oregon) shall be required to perform work in accordance with the standard and these specifications.
- B. Work Requirements under this section include but are not limited to; Initial testing and evaluation of work practices, development of a written lead compliance program, lead awareness training, employee monitoring, respiratory protection, engineering controls, containment, wash facilities and signage.
- C. Lead-Based Paint and varnishes are located throughout the building. Unless noted otherwise on the plans, contractors are to assume painted or varnished surfaces to be lead containing.
- D. Any Contractor that is subject to potential lead exposure shall provide all labor, materials, equipment, services, necessary to comply with OSHA standard.
- E. The General Contractor and its subcontractors shall endeavor to select work methods that minimize the creation or spreading of lead dust. If work practices or surface preparation methods (e.g. dry sanding, abrasive blasting) create dust that cannot be readily controlled via wet methods or by using basic work area isolation, then the District will utilize its Hazardous Material Abatement contractor to perform all or portions of the work. The Contractor shall coordinate with the District and its Hazardous Material Abatement Contractor as necessary to accommodate the work.

1.2 DEFINITIONS

- A. Action Level: Employee exposure, without regard to the use of respirators, to an airborne concentration of lead of 30 micrograms per cubic meter of air averaged over an 8-hour period.
- B. Air Monitoring: The process of measuring the airborne concentrations of a specific volume of air in a stated period of time.
- C. Atomic Absorption: A method of measuring elements such as lead. The lead is vaporized at high temperature, usually several thousand degrees, and light of a very specific wavelength is shined through the vapor.
- D. Biological Monitoring: The analysis of a person's blood and/or urine, to determine the level of lead contamination in the body.
- E. Containment: A process for protecting both workers and the environment by controlling exposures to lead dust and debris created during lead handling tasks.
- F. Contractor: The General Contractor, Subcontractor, Abatement Contractor or person performing lead handling procedures specified herein.
- G. Engineering Controls: Measures implemented at the work site to contain, control and/or otherwise reduce exposure to lead dust and debris.
- H. Exposure Monitoring: The personal air monitoring of an employee's breathing zone to determine the amount of contaminant (e.g. lead) to which he/she is exposed.

LEAD HANDLING PROCEDURES

- I. Fixed Object: Fixtures that are attached to the building or are too heavy or bulky to remove from the work area.
- J. Independent Testing Laboratory: A qualified AIHA ELPAT laboratory financially independent from and hired by the Owner or Contractor.
- K. Industrial Hygienist: The representative assigned to monitor work progress, perform sampling and visually inspect areas during and after lead handling procedures.
- L. The Industrial Hygienist will be certified by the American Board of Industrial Hygiene or an industrial hygienist in training, or an individual with appropriate education or experience.
- M. Medical Removal: The temporary removal of workers due to elevated blood lead levels as defined in the OSHA Lead Standard.
- N. Micrograms: One millionth of a gram: μg : The prefix "micro" means "1/1,000,000 of" (one millionth of). Since there are 453 grams in one pound and 16 ounces in one pound, one gram equals 0.035 ounces. A microgram is equal to about 35/1,000,000,000 (thirty-five billionths) of an ounce.
- O. Movable Object: Furnishings which are not attached to the building structure and can be removed from the work area.
- P. Off-Site Paint Removal: The removal of paint or varnish at a site away from the project such as the stripping of lead paint from the surface of a component at the facilities of a commercial paint-stripping operation occurring in chemical tanks.
- Q. Paint Removal: Stripping or removal of lead paint from surfaces of components.
- R. ppm: Stands for "parts per million", meaning the weight of one part per weight of the total amount of material. For example, a lead concentration of 1 ppm expresses the ratio of one gram of lead dissolved into one million (1,000,000) grams of water.
- S. Public Area: Any area outside the isolated work area. When work area isolation measures are removed, the work area becomes a public area.
- T. Regulated Area: An area where the Permissible Exposure Limit has been or is expected to be exceeded and where only trained personnel with appropriate personal protective equipment are allowed.
- U. TCLP: Toxic Characteristic Leaching Procedure is one of the tests for the determinations of whether a solid waste is classified as a hazardous substance via EPA Method 1311.

1.3 SUBMITTALS AND NOTICES

- A. The Contractor shall submit three copies of the following information to the Architect, Owner and Environmental Consultant prior to beginning work on the project.
 - 1. Worker Training Programs: Submit written proof indicating that all employees impacting lead-containing materials have received training per OAR 437-03-001.

LEAD HANDLING PROCEDURES

2. Lead Compliance Plan: Submit a written "Compliance Plan" satisfactory to the Architect, Owner And Environmental Consultant describing the methods for lead handling procedures, and plans for construction and location of decontamination enclosure systems, worker training and protection measures, engineering controls, dust control and collection techniques, etc. in compliance with OAR 437 Division 3-001, these Specifications and applicable regulations. The Contractor shall update the Lead Compliance Plan as necessary while work progresses. The General Contractor may elect to incorporate affected subcontractors individual work plans into an overall project lead compliance program.
 3. Product Information and Material Safety Data Sheets: Submit complete product information for chemical removal agents and for any materials, products and procedures for which the Contractor requests approval for use on this job. The Contractor shall identify any concerns with possible chemical reaction with new materials, coatings, etc. to be installed after chemical stripping.
- B. Contractor shall not begin work until submittals are complete, reviewed and accepted by District and the Environmental Consultant. Allow a five day review period.
- C. During the work the Contractor shall submit all sampling and exposure monitoring data.

1.4 LEAD EXPOSURE MONITORING AND TESTING REQUIREMENTS

- A. Contractors shall perform employee exposure assessments as required under OAR 437-03-001 for any employees performing tasks that may result in exposures above the Action Level.
- B. An Independent Testing Laboratory shall be retained by the contractor. All exposure monitoring analysis shall be performed in accordance with 29 CFR Part 1926.62 as adopted by OR-OSHA.
- C. The District reserves the right to monitor Contractor's performance via air, dust wipe and TCLP samples during removal work, in addition to the Contractor's exposure monitoring and testing.

1.5 QUALITY ASSURANCE

- A. Periodic monitoring of air and surface dust may be analyzed by the Districts Environmental Consultant in occupied spaces and containment areas. The following lead exposure limits shall apply to all areas where lead handling procedures are undertaken.
1. Air Samples:
 - a. 30 µg/m³ - OSHA Action Level
(8-hour Time-Weighted Average)
 - b. 50 µg/m³ - OSHA Permissible Exposure Limit
(8-hour Time-Weighted Average)
 2. Dust Samples: (Expected levels at completion of major demolition)
 - a. 40 µg/ft² - Clearance for Stripped Surfaces, Components, etc.
 - b. 40 µg/ft² - Clearance Level for floors
 - c. 250 µg/ft² - Clearance Level for interior window sills
 - d. 250 µg/ft² - Clearance Level for rough surfaces
 - e. Note: The above noted Dust Sample standards shall only apply to elementary, pre-school and Day Care facilities. The District Representative may modify these standards, if appropriate, in other facilities.
 3. Blood Lead Levels:
 - a. 40 µg/dl (OSHA) permissible blood level for worker
 - b. 50 µg/dl (OSHA) blood level requiring medical removal of worker
 4. Dispose of as Hazardous Waste: 5-ppm Pb (analyzed as "leachable" using Toxicity Characteristic Leachate Procedure - TCLP EPA Method 1311)
 5. Paint: Painted surfaces with lead concentrations greater than the limits of detection as determined by atomic absorption, EPA Method 7420-3050.

LEAD HANDLING PROCEDURES

6. Soil: 400-ppm – High Traffic Play Areas; 1,200-ppm – Non-Play Areas
 7. Waste Water: (.7 mg/l Pb or less to dispose of in the sanitary sewer). Verify with the City on local requirements.
- B. If, at any time during the work, analysis of occupied area air or wipe samples taken by the Contractor, District, or District's representative, indicates a concentration in excess of the allowable maximums specified, the contractor shall immediately notify:
1. The General Contractor's Superintendent
 2. The Environmental Consultant: PBS Engineering + Environmental, (503) 248-1939.
- C. Immediately upon being notified of concentrations exceeding the specified maximum allowable levels, the Contractor shall perform the following steps in order presented, at no additional cost to the District:
1. Stop Lead related work.
 2. The Environmental Consultant will determine the affected area and affected adjacent areas considered to be contaminated and will determine the actions to be taken.
 3. Modify work procedures, if feasible and make other changes determined to be the possible cause of high lead concentrations.
 4. Carefully resume work under close supervision and monitoring.
 5. The Contractor shall be responsible for costs of any testing, cleanup, repair, down time loss, etc. that is a result of the Contractor's negligence, poor maintenance of containment areas or improper procedures.

1.6 PERSONNEL PROTECTION

- A. Training:
1. When demolition or lead handling activities result or are expected to exceed the Action Level, the Contractor shall follow personnel protection and work area isolation procedures outlined in this section.
 2. Prior to commencement of work, Contractor shall ensure all workers have been adequately trained as specified in 29 CFR 1926.62.
 3. The Contractor shall provide and post at hand wash locations, the decontamination, respirator, and work procedures to be followed by the workers as outlined in the written Lead Compliance Program.
 4. Workers shall not eat, drink, chew gum or apply cosmetics in the established work area. Smoking or using other tobacco products is prohibited.
 5. Workers shall be fully protected with respirators and protective clothing immediately prior to the first disturbance of lead-containing or contaminated material and until final cleanup is completed.
- B. Building Security and Protection:
1. The Contractor shall post adequate warning signs at all potential entrances to work areas as required by EPA and OSHA.
 2. Contractor shall protect all existing fixed equipment, existing building finishes that are to remain, and existing systems and functions from damage. Extra precautions are to be taken in protecting existing electrical panels, light fixtures, etc. Any damage to existing building, services, and/or equipment shall be remedied by the Contractor at his expense.
 3. Contractor shall maintain access and use of existing fire lanes.

1.7 SAFETY

- A. With regard to the work of this contract, the safety of the Contractor's employees, the District's employees, and the public is the sole responsibility of the Contractor.

LEAD HANDLING PROCEDURES

1.8 PROTECTION

- A. Damaged or deteriorating materials shall not be used and shall be removed from the premises by the Contractor. Materials that become contaminated with lead shall be disposed of in accordance with the applicable regulations by the District.

1.9 SUBCONTRACTORS

- A. Any Subcontractors employed by the Contractor shall be bound to all the work and safety standards specified elsewhere in this Specification. Subcontractor's personnel shall be fully trained and supervised by the Contractor during performance of this work.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Plastic Sheet: Plastic sheet shall be fire-retardant polyethylene material sized in lengths and widths to minimize the frequency of joints. The minimum thickness shall be 6-mil.
- B. Plastic Bags: Plastic bags shall be 6-mil polyethylene printed with warning labels per OSHA and EPA regulations.
- C. Tape: Tape shall be capable of sealing joints of adjacent sheets of plastic and for attachment of plastic sheet to finished or unfinished surfaces of dissimilar materials and capable of adhering under dry and wet conditions, including use of amended water.
- D. Disposal Containers: Disposal containers for all listed hazardous waste shall be ODOT-approved #1-A2 55-gallon steel drums unless approved otherwise by the TSD and Environmental Consultant.
- E. Warning Labels and Signs: Warning labels and signs shall be posted as required by OR-OSHA, ODOT and DEQ regulations.
- F. Chemical Strippers: Use of chemical strippers shall require review from the District, Architect, General Contractor and Environmental Consultant.

2.2 TOOLS AND EQUIPMENT

- A. Water Sprayer: The water sprayer shall be an airless or other low-pressure sprayer for high phosphate wash water application.
- B. Scaffolding: Scaffolding, as required to accomplish the specified work, shall meet all applicable safety regulations. All special scaffolding shall have drawings and calculations stamped and signed by a civil or structural engineer registered in the state of Oregon.
- C. Electrical: Electrical tools, equipment and lighting shall meet all applicable codes and regulations. Ground fault protection as required by OSHA, shall be in effect at all times. Contractor shall take all additional precautions and measures necessary to insure a safe working environment during wet removal.

LEAD HANDLING PROCEDURES

PART 3 – EXECUTION

3.1 WORK AREA CONTAINMENT PREPARATION

- A. The Contractor shall perform lead handling procedures under full or partial containment when work practices are expected to create exposures greater than the Permissible Exposure Limit (PEL) of 50 µg/m³. The following lead handling procedures shall always be performed under full containment: abrasive blasting, welding and torch cutting, grinding or dry sanding, heat gun removal, and chemical stripping of lead paints or varnishes with volatile and caustic chemicals. Partial containment will be acceptable for tasks such as selective demolition, spot chemical removal and patching of surfaces.
- B. Contractor shall perform the following containment procedures in the order in which they are presented. Alternative engineering control methods considered by the Contractor must be proven by historical data and approved by the Environmental Consultant. The liberal use of water spray, ventilation and HEPA air filtration devices are most effective for reducing airborne lead concentrations.

3.2 PARTIAL CONTAINMENT WORK AREA PREPARATION

- A. Tasks requiring partial containment include items such as: Selective demolition, exterior paint removal, patching and repair of painted components and other tasks where incidental exposures to airborne lead concentrations are likely to occur. Historical monitoring of similar procedures may alleviate partial containment requirements.
- B. Contractor shall perform the following procedures in the order in which they are presented and describe procedures for exterior paint removal and other work in non-isolated work areas.
 - 1. Seal off airflow HVAC systems serving other building areas.
 - 2. Restrict access to work area and post warning signs.
 - 3. Install localized HEPA exhaust fan in work area if feasible. Locate fan intake to immediate area of work in such a manner that any lead dust released will be drawn away from the worker and into intake duct.
 - 4. Cover floor and other surfaces below work area with 6-mil plastic sheeting.
 - 5. Have emergency cleanup equipment and supplies, including HEPA vacuum, wash water, disposal bags, mop, buckets, towels and sponges, on hand prior to start of abatement work.
- C. When work is complete, the Contractor shall remove all visible debris from the work area. Once area has been cleaned, the Contractor shall notify the District Environmental Consultant to perform Dust Wipe Sampling as specified in this section. If the area is clean and free of dust and debris, but sample analysis shows concentrations above the stated levels, the District may choose to have its Hazardous Materials Abatement Contractor perform additional cleaning.

3.3 WASTE DISPOSAL

- A. General: Disposal of building demolition waste coated with lead-based paint will generally not require a hazardous waste determination (i.e., TCLP testing) if demolition debris is disposed of at a solid waste landfill that is permitted by DEQ and which meets the current design standards for municipal solid waste disposal facilities of 40 CFR Part 258.
- B. Other Contractor generated waste streams shall be tested and properly disposed of by the Contractor. Concentrated lead-based paint waste will require a hazardous waste determination (i.e., TCLP testing). The Contractor shall properly dispose of concentrated lead-based paint waste that is deemed hazardous.

END OF SECTION

CONCRETE

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide concrete at chiller and generator bad as indicated on the Drawings and as specified herein.

1.2 REFERENCES

- A. ASTM International (ASTM):
 1. ASTM A185: Standard Specification for Steel Welded Wire Reinforcing, Plain, for Concrete.
 2. ASTM A615: Standard Specification for Deformed and Plain Carbon-Steel Bars for Concrete Reinforcement.
 3. ASTM C31: Standard Practice for Making and Curing Concrete Test Specimens in the Field.
 4. ASTM C33: Standard Specification for Concrete Aggregates.
 5. ASTM C39: Standard Test Method for Compressive Strength of Cylindrical Concrete Specimens.
 6. ASTM C94: Standard Specification for Ready-Mixed Concrete.
 7. ASTM C143: Standard Test Method for Slump of Hydraulic Cement Concrete.
 8. ASTM C150: Standard Specification for Portland Cement.
 9. ASTM C172: Standard Practice for Sampling Freshly Mixed Concrete.
 10. ASTM C260: Standard Specification for Air-Entraining Admixtures for Concrete.
 11. ASTM C494: Standard Specification for Chemical Admixtures for Concrete.
- B. American Concrete Institute (ACI):
 1. ACI 304R: Guide for Measuring, Mixing, Transporting, and Placing Concrete.
 2. ACI 305R: Hot Weather Concreting.
 3. ACI 306R: Cold Weather Concreting.
 4. ACI 347R: Guide to Formwork for Concrete.

1.3 QUALITY ASSURANCE

- A. Workmanship: Set and maintain screeds, lines, and forms within the following tolerance limits:
 1. Variations from Plumb: $\pm 1/8$ " per foot not cumulative; not to exceed 1/4" in 10 feet.
 2. Variations from Grade: $\pm 1/8$ " per foot not cumulative; not to exceed 1/4" in 10 feet.
 3. Finish Floor Slabs: 1/8" in 10 feet and 1/16" per foot.
- B. The Owner may employ a separate testing laboratory to evaluate concrete delivered to and placed at the site.

PART 2 – PRODUCTS

2.1 MATERIALS

- A. Materials for Concrete:
 1. Portland Cement: ASTM C150, type as required.
 2. Aggregates: ASTM C33.
 3. Water: Clean, free of oils, acids, and organic matter.
 4. Air-Entraining Admixture: ASTM C260.
 5. Water-Reducing Admixture: ASTM C494, Type A.
- B. Form Materials:
 1. Unexposed Concrete Surfaces: Suitable material dressed on at least 2 edges and 1 side for tight fit.

CONCRETE

- 2. Exposed Concrete Surfaces: Provide 3/4" PS 1, Type I, concrete form grade plywood with grade and type stamped.
 - 3. Form Coating Manufacturers: Nox-crete, Edcoc Burke-Release, or accepted substitute non-staining pine oil derivative type.
- C. Reinforcing Bars and Dowels: ASTM A615, Grade 40.
- 2.2 MIXES
- A. Ready-Mixed Concrete: ASTM C94, Mix Design Alternate No. 3; and in addition:
 - 1. Minimum Cement Content per Cubic Yard: 470-pounds.
 - 2. Slump for Flat Work: 4" maximum (plus 0, minus 2-1/2").
 - 3. Use air-entraining admixture in concrete exposed to freezing and thawing, providing not less than 4% or more than 8% entrained air.
 - B. Compressive Strength: 3000-psi minimum at 28-days.

PART 3 - EXECUTION

3.1 FORMING AND PLACING CONCRETE

- A. Formwork: Construct so concrete members and structures are of correct size, shape, alignment, elevation, and position complying with ACI 347.
- B. Provide openings in formwork to accommodate work of other trades. Accurately place and securely support items built into forms.
- C. Surface Preparation: Remove loose material from the compacted sub-base surface immediately before placing concrete.
- D. Clean and adjust forms prior to concrete placement. Apply form release agents or moisten forms, as required. Re-tighten forms after concrete placement to eliminate mortar leaks as required.
- E. Reinforcement: Position, support, and secure reinforcement against displacement. Locate and support with metal chairs, runners, bolsters, spacers and hangers, and cinder blocks as required. Set wire ties so ends are directed into concrete, not toward exposed concrete surfaces.
- F. Installation of Embedded Items: Set and build into the Work, anchorage devices and other embedded items required for other work that is attached to or supported by cast-in-place concrete. Use setting diagrams, templates, and instructions provided by others for locating and setting.
- G. Concrete Placement:
 - 1. Comply with ACI 304R. Do not begin placement until work of other trades affecting concrete has been completed.
 - 2. Consolidate placed concrete using mechanical vibrating equipment with hand rodding and tamping, so that concrete is worked around reinforcement and other embedded items and into all parts of forms.
 - 3. Protect concrete from physical damage or reduced strength due to weather extremes. In cold weather, comply with ACI 306R. In hot weather, comply with ACI 305R.

3.2 CONCRETE FINISHES

- A. Medium-to-fine broom finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.

CONCRETE

3.3 CURING

- A. Begin initial curing as soon as free water has disappeared from exposed surfaces. Where possible, keep continuously moist for not less than 72-hours. Continue curing by use of moisture-retaining cover or membrane-forming curing compound.
- B. Provide protection to prevent damage to exposed concrete surfaces.

3.4 CONCRETE TESTING

- A. When required by Chapter 17, Structural Tests and Inspections, of the 2012 International Building Code (IBC) and the Oregon 2014 Structural Specialty Code Amendments.
- B. Comply with the 2012 International Building Code (IBC) and the Oregon 2014 Structural Specialty Code Amendments, Section 1903, Specifications for Tests and Materials, and Section 1904, Durability Requirements, for evaluation and acceptance of concrete.
- C. Test one field cured cylinder prior to removing shoring under structural slabs, joists, or beams.
- D. When required, perform tests as follows:
 - 1. Sampling: ASTM C172.2.
 - 2. Slump: ASTM C143, one test for each truck load at point of discharge for ready mixed concrete and each batch of Site mixed concrete.
 - 3. Air Content: ASTM C31, one for each set of compressive strength specimens.
 - 4. Compressive Strength: ASTM C39, one set for each day of structural concrete pour or each 50-cubic yards, or fraction thereof of each class of concrete. Two specimens tested at 7 days, two specimens tested at 28 days, and one retained for later testing if required.

END OF SECTION

METAL SUPPORTS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all Unistrut Metal Framing material, fittings and related accessories for the reinstallation of the salvaged condensing units and the new condensing unit as indicated on Drawings and as specified herein.

1.2 QUALITY ASSURANCE

- A. Manufacturer's Qualifications:
 - 1. The manufacturer shall not have had less than 10 years' experience in manufacturing Strut Systems.
 - 2. The manufacturer must certify in writing all components supplied have been produce in accordance with an established quality assurance program.
- B. Installer's Qualifications:
 - 1. Installer must be a Unistrut trained manufacturer's authorized representative/installer with no less than 5 years' experience in the installation of Strut Systems of this sis and conformation.
 - 2. All Strut System components must be supplied by a single manufacturer.
- C. Standards:
 - 1. Work shall meet the requirements of the following standards:
 - a. Federal, State and Local Codes.
 - b. American Iron and Steel Institute (AISI) Specification for the Design of Cold-Formed Steel Structural Members, 2007 Edition.
 - c. ASTM International (ASTM).

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit all shop/assembly drawings necessary to completely install the Strut System in compliance with the Contract Drawings.
 - 2. Submit all pertinent manufacturer's published data.

1.4 PRODUCT DELIVERY

- A. Deliver all material to the Work Site in original factory packaging to avoid damage to finish.
- B. Upon delivery to the Work Site, protect all components from the elements by a shelter or other covering.

1.5 GUARANTEE

- A. Provide manufacturer's guarantee, valid for a period of 1 year, against any defect that may arise from the manufacture of the Strut System components.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. All Strut System components shall be manufactured by UNISTRUT Corporation or approved equal as determined by the Architect or Engineer of record in writing in an Addendum.

METAL SUPPORTS

2.2 MATERIALS

- A. Fabricate all channel members from structural grade steel conforming to one of the following ASTM specifications:
 - 1. A1011 SS GR 33, A653 GR 33.
- B. Fabricate all fittings from steel conforming to one of the following ASTM specifications:
 - 1. A575, A576, A36 or A635.

2.3 FINISHES

- A. Finish Strut System components in accordance with one of the following standards:
 - 1. Hot-Dipped Galvanized (HG): Zinc coated after all manufacturing operations are complete. Coating shall conform to ASTM A123 or A153.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The installer shall inspect the work area prior to installation. If work conditions are unsatisfactory, installation shall not proceed until satisfactory corrections are completed.

3.2 INSTALLATION

- A. Installation shall be accomplished by a fully trained manufacturer authorized installer.
- B. Set Strut System components into final position true to line, level and plumb, in accordance with approved shop drawings.
- C. Anchor material firmly in place. Tighten all connections to their recommended torques.

3.3 CLEANUP

- A. Upon completion of this Section of Work, remove all protective wraps and debris. Repair any damage due to installation of this Section of Work.

3.4 PROTECTION

- A. During installation, it shall be the responsibility of the installer to protect his work from damage.
- B. Upon completion of this scope of work shall become the responsibility of the General Contractor to protect this Work from damage during the remainder of construction on the Project and until Substantial Completion.

END OF SECTION

METAL FABRICATIONS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide items made from iron and steel shapes, plates, bars, strips, tubes, pipes and castings which are not a part of structural steel or other metal systems specified elsewhere as indicated on the Drawings and as specified herein. Includes:
 - 1. Steel bollards.
- B. Structural Support Steel: Provide steel plates, angles, and channels to provide structural support for the following items:
 - 1. Mechanical and electrical equipment.
 - 2. Loose bearing and leveling plates.
 - 3. Miscellaneous framing and supports.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A36: Standard Specification for Carbon Structural Steel.
 - 2. ASTM A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless.
 - 3. ASTM A123: Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 4. ASTM 153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 5. ASTM A307: Standard Specification for Carbon Steel Bolts and Studs, 60,000-psi Tensile Strength.
 - 6. ASTM A325: Standard Specification for Structural Bolts, Steel Heat Treated, 120/105-ksi Minimum Tensile Strength.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Submit shop drawings for fabrication and erection of miscellaneous metal fabrications. Include plans, elevations and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor and bolt installation by others.

1.4 QUALITY ASSURANCE

- A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General Metal Surfaces: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, seam marks, roller marks, rolled trade names and roughness.
- B. Steel Pipe: ASTM A53; Type and grade (if applicable) as selected by fabricator and as required for design loading; black finish unless galvanizing is indicated; standard weight Schedule 40, unless otherwise indicated.

METAL FABRICATIONS

- C. Concrete Inserts: Wedge type; galvanized ferrous castings, either malleable iron, ASTM A47, or cast steel, ASTM A27. Provide bolts, washers and shims as required, hot-dip galvanized, ASTM A153. Kwik-Bolt by Hilti, Red Head Trubolt Wedge Anchors by ITW/Ramset, Rawl-Stud by Rawlplug Co. Inc., Sup-R-Stud by U.S.E. Diamond, or accepted substitute.
- D. Standard Bolts: ASTM A307, Grade A, regular hexagon head type.

2.2 GENERAL FABRICATION PROCESS

- A. Workmanship: Use materials of size and thickness indicated or, if not indicated, as required to produce strength and durability in finished product for use intended. Work to dimensions indicated or accepted on shop drawings, using proven details of fabrication and support.
- B. Fabricate of welded construction, drill and tap as required to receive hardware and similar items. Include required anchors for building into other works.
- C. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32" unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- D. Form exposed connection with hairline joints, flush and smooth, using concealed fasteners. Only if necessary, use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts.
- E. Provide for anchorage of type indicated, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.
- F. Cut, reinforce, drill and tap miscellaneous metal work as indicated to receive finish hardware and similar items.
- G. Galvanized Shop Finish: Provide ASTM A153 for iron and steel hardware, or ASTM A123 for fabricated shapes, plates, bars and strip.
- H. Fabricate joints that will be exposed to weather in a manner to exclude water and provide weep holes where water may accumulate.

2.3 CUSTOM FABRICATED ITEMS

- A. Loose Bearing and Leveling Plates: Provide loose bearing and leveling plates for steel items bearing on masonry or concrete construction, made flat, free from warps or twists, and of required thickness and bearing area. Drill plates to receive anchor bolts and for grouting as required. Galvanize after fabrication.
- B. Structural Connectors for Wood Framing: Provide custom fabricated bolts, plates, tie rods, anchors, dowels and other steel shapes for framing, supporting and anchoring wood framing. Provide washers for bolts bearing on wood.
- C. Steel Bollards: Fabricate to dimensions indicated. Grind exposed end smooth. Galvanize areas not to be embedded in concrete.

METAL FABRICATIONS

PART 3 - EXECUTION

3.1 PREPARATION

- A. Field Measurements: Take field measurements prior to preparation of shop drawings and fabrication, where possible. Allow for trimming and fitting where taking field measurements.
- B. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, including, concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors, which are to be embedded in concrete or masonry construction.

3.2 GENERAL INSTALLATION

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors as required.
- B. Cutting, Fitting and Placement: Perform cutting, drilling and fitting required for installation of miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from established lines and levels. Provide temporary bracing or anchors in formwork for items that are to be built into concrete masonry or similar construction.
- C. Fit exposed connections accurately together to form tight hairline joints. Weld connections that are not to be left as exposed joints, but cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat. Do not weld, cut or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication, and are intended for bolted or screwed field connections.
- D. Setting Loose Plates: Clean concrete and masonry bearing surfaces of any bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.
- E. Set loose leveling and bearing plates on wedges, or other adjustable devices. After the bearing members have been positioned and plumbed, tighten the anchor bolts. Do not remove wedges or shims, but if protruding, cut-off flush with the edge of the bearing plate before packing with grout. Use metallic non-shrink grout in concealed locations where not exposed to moisture; use non-metallic non-shrink grout in exposed locations, unless otherwise indicated. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.
- F. Steel Framing: Anchor steel framing to building structure with concrete anchors or bolts with strength required to meet structural loads.

3.3 STEEL BOLLARDS

- A. Steel Bollards: Fill structural steel pipe or tube bollards with concrete. Smooth trowel to 1" high convex slope at top of pipe or tube.

3.4 ADJUSTING AND CLEANING

- A. Correct or replace defective members and adjust alignment as required. Remove pits, bumps and irregular weld grinds from exposed surfaces.

METAL FABRICATIONS

- B. Touch-Up Painting:
 - 1. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting.
 - 2. Apply by brush or spray to provide a minimum dry film thickness of 2.0-mils.
- C. Galvanized Surfaces: Clean field welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A780. Aervoe #142, Brite Galvanize, (800) 227-0196, or accepted substitute.

3.5 PROTECTION

- A. Apply protecting material to face of metal in areas of potential galvanic activity between contacting dissimilar metal materials.

END OF SECTION

WOOD FRAMING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide lumber framing and accessories for wall, roof framing, and roof curbs as indicated on the Drawings and as specified herein.

1.2 REFERENCES

- A. U.S. Department of Commerce: PS 20, American Softwood Lumber Standard.
- B. ASTM International (ASTM):
 - 1. ASTM A307: Standard Specification for Carbon Steel Bolts and Studs, 60,000-psi Tensile Strength.
 - 2. ASTM D226: Standard Specification for Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing.
- C. 2012 International Building Code (IBC) and the Oregon 2014 Structural Specialty Code.
- D. Federal Specification/Standard; General Services Administration Specifications Branch (FS).
- E. West Coast Lumber Inspection Bureau (WCLIB): No. 17 Standard Grading Rules.
- F. Western Wood Products Association (WWPA).

1.3 DELIVERY, STORAGE, AND HANDLING

- A. Wrap, cover, and protect lumber products and trusses in shipment and while stored on the site to prevent weather exposure and damage. Maintain stacks neat and in good order; level and off ground or floors; raised on pallets or dunnage to prevent contact with water or earth.

PART 2 - PRODUCTS

2.1 CONCEALED FRAMING LUMBER

- A. Wood framing: Douglas Fir, Standard or Better per WWPA.
- B. Species and Dressing: Douglas Fir or Douglas Fir-Larch, standard or better quality, smooth four sides (S4S).
- C. Minimum Grades and Bending Stress Rating: (WCLB and WWPA).
 - 1. Post and Beams: (5x5 and larger) No. 1 grade.
 - 2. Beams and Stringers: (5x9 and larger) No. 1 grade.
 - 3. Structural Framing: (2x6 to 4x14) No. 2 grade.
 - 4. Studs: (2x2 to 4x6) Stud grade.
 - 5. Light Framing for Blocking and Bridging: (2x2 to 4x4) Utility grade or No. 3 grade and Standard grade or No. 2 grade.
 - 6. Boards For Furring: (1x2 to 1x4) Standard grade of No. 3 common.
- D. Moisture Content: Kiln dry lumber 4x or less to 19% moisture content at time of dressing.

WOOD FRAMING

- E. Sillbor Boron Preservative Treatment: Treat cants, nailers, blocking, stripping, and similar items in conjunction with roofing and flashing in accordance with AWPA P5. Retention rate minimum, 0.28 pcf boric oxide. Sodium octaborate is listed in AWPA preservative standard P5 and is referred to as SBX. SillBor® wood meets the requirements of AWPA standard U1 and past standards C9 and C31. It is suitable for Use Category 2.

2.2 ACCESSORIES

- A. Steel Connectors: Simpson, Bowman, Silver, KC Metals, or accepted substitute. (Numbers indicated on the Drawings are from Simpson Company.)
- B. Bolts, Nuts, and Screws:
 - 1. Expansion Shields, Lag Screws, Lag Bolts: FS FF-B-561.
 - 2. Wood screws: FS FF-S-111.
 - 3. Bolts: FS FF-B-575.
 - 4. Nuts: FS FF-N-836.
- C. Nails and Staples: FS FF-N-105.
 - 1. Exterior: Galvanized Common Nails.
 - 2. Interior: Common Nails.
- D. Powder Driven Fasteners: Ramset, Hilti, or accepted substitute.
- E. Concrete Anchors: Hilti, ITT Phillips, Ramset, USM Corporation, or accepted substitute.
- F. Epoxy Grout: Five Star Epoxy Grout by U.S. Grout; Sikadur Grout-Pack, Hi-Mod Systems by Sika; or accepted substitute.
- G. Waterproof Anchoring Cement: Pourable, cement base, non-shrinking quick setting hydraulic compound. Fast Setting Cement by Burke; Anchor Tite by Concrete Products; Embecco 153 by Master Builders; Thorogrip by Standard Dry Wall; or accepted substitute.
- H. Felt Building Paper: ASTM D226, Unperforated, asphalt saturated, 15 pound.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Steel Framing Connectors: Install with nails or bolts of sizes and type specified by manufacturer of connector. Provide "U" type hangers where joists and beams frame into side of beams or headers.
- B. Fasteners: Minimum fasteners per the 2013 International Building Code (IBC) and the Oregon 2014 Structural Specialty Code Amendments Table 2304.9.1, Fastening Schedule, or as indicated on the Drawings.
- C. Bolting: Provide standard plate washers under heads and nuts of bolts bearing on wood. Soap threads of lag bolts prior to installing.
- D. Structural Blocking: Locate as indicated and as required to support plumbing, fire sprinkler, mechanical, and electrical equipment. Solid block joists and rafters at bearing walls and beams.
- E. Fire Blocking: Provide required fire blocking in wood framing as follows.
 - 1. Block wood-framed walls and partitions at floor and ceiling lines.
 - 2. Block double stud wood-framed walls and partitions at maximum horizontal intervals of 10 feet.

WOOD FRAMING

3. Block along and in line with the run of each stairway in adjacent wood stud walls and partitions.
 4. Block all similar combustible blind spaces exceeding 10 feet in any dimensions to the effect that a barrier to the passage of flame is provided at maximum intervals, both vertical and horizontal, of 10 feet.
- F. Bridging: Provide code-required bridging between structural joists, rafters, and trusses.
- G. Framing: Install framing members at not more than 16" on center unless approved by BSD representative and at spacing indicated on the Drawings. Double floor joists under parallel partitions. Use standard moisture content framing except where indicated kiln dried. Interior doors must be framed in wood with two king studs and a trimmer on each side or have a continuous welded hollow metal frame grouted in place. See Section 08 11 00 Metal Doors and Frames.
- H. Install pressure treated framing at locations where wood framing is in contact with concrete. The end cuts of all pressure treated wood shall have a preservative applied. Hot dipped galvanized nails shall be used with preservative applied wood per the Oregon Structural Specialty Code (2304.9.5).
- I. Temporary Support: Adequately brace structure for wind and earthquake forces until roof and wall panels have been secured. Interior gypsum wallboard panels are used for bracing. Continue bracing until interior gypsum wallboard is fully nailed.

3.2 MINIMUM NAILING SCHEDULE FOR FRAMING

- A. Minimum Quantity and Size For End Nailing:
1. Blocking to Joist Each End: 2-8d or 2-10d.
 2. Stud to Sole or Top Plate: 2-16d.
- B. Minimum Quantity and Size For Toe Nailing:
1. Blocking to Plate and Bridging to Joist Each End: 2-8d or 2-10d.
 2. Stud to Sole Plate: 4-8d or 4-10d at 2x4 studs and 6-8d or 6-10d at 2x6 studs.
 3. Stud to Header: 3-8d or 3-10d.
 4. Joist to Plate or Beam: 3-8d or 3-10d at 2x4 studs and 4-8d or 4-10d at 2x6 studs.
 5. Rafter to Plate: 3-8d or 3-10d at 2x4 studs and 4-8d or 4-10d at 2x6 studs.
- C. Minimum Quantity and Size For Face Nailing:
1. Double Top Plates Spiked Together: 16d at 16" on center or 10d at 8" on center at 2x4 studs or 16d at 12" on center at 2x6 studs.
 2. Double Header Top and Bottom Edges Staggered: 16d at 16" on center or 10d at 8" on center along each edge.
 3. Double Studs: 16d at 24" on center or 10d at 12" on center at 2x4 studs and 16d at 16" on center at 2x6 studs.
 4. Bottom Plate to Joists or Blocking: 16d at 16" on center or 10d at 8" on center.
 5. Rafter to Joist: 3-16d.
 6. Double Joist Lapped Over Partition or Beam: 3-16d.
 7. Double Top Plates at Laps and Intersections: 2-16d or 4-10d each face at 2x4 studs and 3-16d at 2x6 studs.
 8. Roof Stripping to Purlins or Joists: 2-8d or 2-10d at 12" on center.

3.3 MINIMUM BOLTING

- A. Anchor Bolts, Plates to Foundation: 4'-0" on center maximum.
- B. Lag Bolts, Pre-drill Holes:
1. 5/8" Diameter Bolt: Drill 1/2" diameter hole.

WOOD FRAMING

2. 3/4" Diameter Bolt: Drill 9/16" diameter hole.

END OF SECTION

ARCHITECTURAL WOOD CASEWORK

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide custom casework and specified associated accessories where shown on the Drawings and as specified herein.
- B. Modify existing casework in classrooms and spaces receiving new mechanical units where shown on the Drawings and as specified herein.
- C. Include shop fabricated cabinets, casework, countertops, cabinet hardware, preparation for utilities, and shelving.

1.2 REFERENCED STANDARDS

- A. Quality Standards: Except as herein modified, materials and workmanship grades shall be as defined in Architectural Woodwork Standards, published by the Architectural Woodwork Institute.

1.3 SUBMITTALS

- A. Shop Drawings:
 - 1. Show layout, dimensions, profiles, joint details, and other pertinent items.
 - 2. Show connections to adjacent work, and complete assembly whether or not materials are furnished by the cabinet shop.
 - 3. Include the manufacturer's descriptive literature for specialty items.
 - 4. Identify each item as to location, material grade, workmanship grade, wood species, finish, plastic laminate color, and location of casework

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver products to jobsite until the project is conditioned and prepared to handle and store casework products without damage. Coordinate delivery to comply with job requirements.
- B. Protect all casework from damage during shipment, handling, and storage.

1.5 JOB CONDITIONS

- A. Temperature and Humidity Requirements: Maintain temperature and relative humidity within 5% of the amounts expected during operation of the building. Maintain materials within these limits for 48 hours prior to and during field finishing of materials.
- B. Maintain 50°F minimum in spaces where casework and shelving are being stored.
- C. Coordinate with other trades affecting or affected by the work of this Section.
- D. Protect other surfaces against damage or discoloration caused by the work of this Section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Plywood: APA, PS 1 for softwood; PS 51 and Industry Standard, I.S. 1 for hardwood. 5-ply minimum.
- B. General Particleboard: 45-pounds per cubic foot minimum density with 8% maximum moisture content. Weyerhaeuser Timblend or Duraflake, Champion Novaply, or accepted substitute.

ARCHITECTURAL WOOD CASEWORK

- C. Low Pressure Laminate: MDL Milamine Overlay, Selply Polyester Overlay, Roseberg Forest Products, or accepted substitute, in color to match Roseberg Forest Products "Dove Gray".
- D. High Pressure Laminate:
 - 1. Manufacturers: Formica, Nevamar, Wilsonart, or accepted substitute.
 - 2. Thickness and NEMA Type:
 - a. Countertops, Splashes, and Countertop Edges: 0.048" (HGS)
 - b. Vertical Exposed Surfaces: 0.028" (VGS)
 - c. Semi-Concealed Backing: 0.020" (CLS).
 - d. Concealed Backing: 0.020" (BKL).
 - 3. Color: Provide all high pressure laminate in colors as scheduled at the end of this Section or to match existing casework.
- E. Plastic Edge Banding: Fabricator's choice of PVC, minimum 0.018" to match the adjacent laminate color. **NO "F" AND "T" MOLDING ALLOWED.**
- F. Casework Countertop Edge Profiles: Countertop edge shall have a radius or be finished in a way that eliminates sharp edges.
- G. Fasteners: Nails, staples and screws to comply with Section 10 of the AWS.
- H. Standard Adhesives: Urea, Resorcinol, P.V.A. and Contact adhesives as selected by the cabinet manufacturer, meeting the AWS and building code requirements.

2.2 FINISH HARDWARE

- A. Hinges:
 - 1. Heavy Duty Cabinet Door Hinges: 2-3/4", five knuckle hinge, 0.095" steel, hospital tips. Provide in Satellite Chrome color. Rockford Process Control, Inc. #374-26D (815-966-2000) or accepted substitute. Mount with 5mm EURO screws.
- B. Pulls: Match existing.
- C. Door Locks: Olympus National 100DR-200DW or accepted substitute. Provide with dead bolt and metal strike, rosette and 5-pin minimum tumbler lock. Provide two keys per lock and all locks keyed to a master system per the Owner. Color to match existing casework hardware.

2.3 FABRICATION

- A. General:
 - 1. AWS Fabrication Style: Frameless cabinets are approved where matching casework is not required. Door style to be fully overlay.
 - 2. AWS Fabrication Grade: Premium grade.
 - 3. Conform to AWS Section 10 Casework, and Section 11 Countertops except as noted.
 - 4. All shelves adjustable unless identified as fixed on Drawings.
 - 5. Verify dimensions of sinks and other items to be built into cases and counters.
 - 6. Assemble at shop where feasible.
 - 7. Conceal end grain in exposed and semi-exposed surfaces.
 - 8. Assemble cases with adhesive.
 - 9. Use concealed mounting clips to attach casework to the wall.
 - 10. Use concealed screws and bolts where required for strength and rigidity.
 - 11. Install finish hardware specified herein at shop.
 - 12. Install adjustable shelf standards to full height of space where adjustable shelves are shown and recess flush into cabinet sides.
 - 13. Countertop edges and backsplashes are to be sealed to wall surface.

ARCHITECTURAL WOOD CASEWORK

15. No exposed fasteners allowed for attachment to wall surface or to other cabinets without Architect's prior approval.
- B. Materials:
1. Exposed Surfaces: High Pressure Plastic Laminate. Includes the outside surfaces and top surfaces of all casework and the inside surfaces of bookcase units.
 2. Semi-exposed and Concealed Surfaces: MDL, Selply, or accepted substitute.
 3. Countertop Substrate: 3/4" thick general particleboard or INT-DFPA plybase "B-D" grade at countertops without sinks. 3/4" thick Medex particleboard at countertops with sinks or lavatories.
 4. Storage and Adjustable Shelving: Minimum 1" thick particleboard with low pressure plastic laminate on both surfaces. All 4 edges of all shelves are to receive PVC edge banding.
 5. Casework Components: Sides, tops, bottoms, and fronts to be 3/4" particleboard with overlay as specified. Cabinet backs to be 1/4" MDL, Selply, or accepted substitute.
 6. Edge Banding: Provide at exposed particleboard edges in accordance with AWS Standards and as specified herein. Edge band all edges of shelving. **No "F" or "T" molding allowed on new casework.**

PART 3 - EXECUTION

3.1 EXISTING CONDITIONS

- A. Verify that surfaces to receive casework, countertops, and shelving are straight, plumb, true, rigid, and otherwise properly prepared. Notify Contractor of any defects requiring correction prior to starting work. Do not start work until corrections have been made and are satisfactory.
- B. Verify that solid blocking has been properly installed to support casework and accessories.

3.2 FIELD MEASUREMENTS

- A. Verify field measurements prior to fabrication. If field measurements differ slightly from drawing dimensions, modify work as required for accurate fit. If any measurement differs substantially, notify the Architect prior to fabrication.
- B. At casework to be modified to accommodate new mechanical units, verify size of new mechanical unit and coordinate modifications with size and location of new mechanical units.

3.3 INSTALLATION

- A. Verify existing cabinet bases for suitability. If replacement is required, provide continuous bases under in-line base casework unless otherwise indicated.
- B. Secure casework in place plumb, square, true, level, and without distortion. Level where necessary with concealed shims.
- C. Anchorage: Secure countertops to grounds, furring, and solid blocking with countersunk fasteners and blind nailing as required. Anchor wall standards for open wall mounted adjustable shelving to solid framing.
- D. Accurately scribe face plates, filler strips, and trim strips to adjacent surface irregularities.
- E. Ease sharp external corners prior to finishing.
- F. At casework to be modified to accommodate new mechanical units:
 1. Verify size and location of new mechanical unit. Modifications to casework will affect casework to each side of the existing mechanical unit.

ARCHITECTURAL WOOD CASEWORK

2. Remove existing metal trim at countertop edge all around mechanical unit opening.
3. Remove existing end panels directly adjacent to existing mechanical unit at each side of the mechanical unit. Salvage for reinstallation.
4. Remove existing shelves and shelf hardware. Trim shelves to new cabinet dimension with fine saw, taking care to not damage the existing wood veneer. Cuts shall be clean, straight, and neat.
5. Trim existing back panels to new cabinet dimension with fine saw, taking care to not damage the existing wood veneer. Cuts shall be clean, straight, and neat.
6. Trim existing countertop in place:
 - a. First cut to the countertop shall be made with a fine saw to a dimension approximately 1/4" longer than the final dimension.
 - b. Remove final 1/4" with a router in order to create a clean, straight, and neat final condition taking care not to chip or damage existing plastic laminate surface.
 - c. Provide new metal trim to protect edge of plastic laminate and countertop.

3.4 ADJUSTMENTS, CLEANING, AND REPAIRING

- A. Adjust moving parts to operate satisfactorily at time of project Substantial Completion and during warranty period.
- B. Damage Adjustments: Repair damaged or defective work as directed. Touch up finish as required. Remove and refinish damaged areas of finish.
- C. Cleaning: Clean exposed and semi-exposed surfaces. Remove labels from exposed plastic laminate finish.
- D. Including work of other trades, clean, repair, and touch-up or replace, when directed, any products that have been soiled, discolored, or damaged by work of this Section.
- E. Leave surfaces ready for finishing specified in other Sections.
- F. Remove debris from project site upon work completion or sooner, if directed.
- G. Provide protective cover on counter tops until project acceptance.

3.5 COLOR SCHEDULE

- A. Classroom C-13:
 1. Countertop and Edge: Match existing.
 2. Cabinet Vertical Faces: Match existing.
- B. All other classrooms if replacement of finishes is required:
 1. Countertop and Edge: Match existing.
 2. Cabinet Vertical Faces: Match existing.

END OF SECTION

SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Sheet metal flashing, condensing unit curb caps, and multi-pipe penetration hoods as indicated on the Drawings and as specified herein.

1.2 REFERENCES

- A. ASTM International (ASTM):
- B. ASTM A167: Standard Specification for Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- C. ASTM A480: Standard Specification for General Requirements for Flat-Rolled Stainless and Heat-Resisting Steel Plate, Sheet, and Strip.
- D. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
- E. ASTM B32: Standard Specification for Solder Metal.
- F. ASTM B209: Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
- G. ASTM B370: Standard Specification for Copper Sheet and Strip for Building Construction.
- H. ASTM C920: Standard Specification for Elastomeric Joint Sealants.
- I. ASTM D4586: Standard Specification for Asphalt Roof Cement, Asbestos-Free.
- J. Sheet Metal and Air Conditioning National Association, Inc. (SMACNA): Architectural Sheet Metal Manual, latest edition.

1.3 SYSTEM DESCRIPTION

- A. Moisture Retention Requirements: Finish work free from water leakage under all weather conditions.

1.4 SUBMITTALS

- A. Shop Drawings: Submit shop drawings of flashing details showing dimensions, anchorage, and joint construction.
- B. Samples: Submit 3 samples of factory finished metal for color selection.

1.5 QUALITY ASSURANCE

- A. SMACNA Manual: Comply with latest edition of the "Architectural Sheet Metal Manual" by SMACNA. Conform to details and description in reference standards unless otherwise indicated on the Drawings.

SHEET METAL FLASHING AND TRIM

1.6 SEQUENCING AND SCHEDULING

- A. Coordinate with the new roofing work performed by the District's roofing contractor.

1.7 WARRANTY

- A. Provide installer's written warranty against defects in materials and workmanship for a period of not less than 2 years.
- B. Provide manufacturer's standard 20 years warranty on coil coated steel sheet.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Galvanized Steel: 24-gage or 26 gage, hot-dip galvanized steel conforming to ASTM A653, G90 coating class.

2.2 ACCESSORIES

- A. Clips: Same gage and type as metal covering, 2" wide.
- B. Continuous Clips: Same gage and type as coil coated steel used for metal flashings.
- C. Concealed Fasteners: Hot-dip galvanized steel, or cadmium plated screws of type as appropriate for materials and substrates encountered.
- D. Exposed Fasteners: Hot-dip galvanized steel or stainless steel nails or cadmium plated screws with neoprene grommets washers and head to match sheet metal color. Color matching rivets may be used on exposed flashing. Provide type(s) as appropriate for the substrates encountered.
- E. Sealants: ASTM C920; Type as required for conditions being sealed, compatible with materials encountered. ChemKalk 900, Sonnebourn NP1, or accepted substitute.
- F. Plastic Cement: Non-running, heavy-body flashing cement composed of mineral ingredients to meet ASTM D4586.

2.3 FABRICATION

- A. Minimum Sheet Thickness: 24-gage.
- B. Shop Forming Requirements:
 - 1. Fabricate sheet metal flashing and wall liners as detailed and in accordance with reviewed shop drawings. Use the SMACNA Architectural Sheet Metal Manual Specifications and Details as a guide and basis for fabrication wherever applicable.
 - 2. Provide for thermal movement of sheet metal.
 - 3. Angle bottom edges of exposed vertical surfaces to form hemmed drip edge.
 - 4. Fabricate to dimensions indicated on shop drawings.
 - 5. Fabricate sheet metal with lines, brakes and angles sharp and true, and surfaces free from oilcanning, wave, warp, or buckle.
 - 6. Fold exposed edges of sheet metal back to form 1/2" wide hem on side concealed from view.
 - 7. Provide galvanic protection in areas where dissimilar metals are adjacent to each other.
 - 8. Spring Locks: Provide flashing pieces fabricated to spring lock where indicated on the Drawings.

SHEET METAL FLASHING AND TRIM

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Do not proceed with Work until construction to receive the Work is completed.
- B. Examine substrates and conditions under which Work is to be performed. Do not proceed until unsatisfactory conditions have been corrected. Surfaces to receive sheet metal shall be clean, even, smooth, dry, and free from defects and projections that might adversely affect the application. Verify slope prior to installation.

3.2 PREPARATION

- A. Verify that flashing membrane material, specified under roofing work, has been installed prior to sheet metal installation. Refer to Drawings for membrane and sheet metal application.

3.3 INSTALLATION

- A. Cleating at Seams: For size and spacing, refer to Drawings and SMACNA Manual. Secure one end with two fasteners and fold the cleat over the fastener heads. Unless otherwise indicated, use 2" x 3" long cleats of the same material and thickness of metal being installed.
- B. Seams: Comply with SMACNA Manual details (Figures 3-2 and 3-3 and other Figures as applicable to specific installations). Orient seams properly for direction of water flow.
 - 1. Standing Seams: Finish seams 1" high as detailed and in accordance with SMACNA standards. Fold the ends over to form watertight, 45° finished ends.
 - 2. Flat Lock Seams: Provide four-ply flat lock horizontal seams at cap flashing on top of parapet and crickets. Solder lap seams around roof scuppers. Solder exposed gutter and downspouts seams. Finish not less than 1" wide.
 - 3. All cap flashing is to have standing seams as indicated above.
 - 4. Cap is to extend a minimum of 3" over edge, with felts tucked underneath or single ply to extend over top of curb or parapet wall. Use fastening clip at parapet and curb flashing. No screws through top of parapet. Seal at corners with Dow Corning 795.

3.4 SCHEDULE

- A. Fabricate sheet metal flashing and trim from the following materials of the minimum thicknesses indicated, unless otherwise required on the Drawings or to meet performance requirements.
- B. Roof-Penetration Multi-Pipe Lineset Hood Flashings:
 - 1. Stainless Steel: 0.025 inch (22 gauge) thick.
- C. Equipment Support Flashing:
 - 1. Galvanized Steel: 0.028 inch (24 gauge) thick.
- D. Miscellaneous Flashings: Fabricate with profiles as shown on Drawings and from sheet metal materials as indicated.

END OF SECTION

FLEXIBLE FLASHING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide flexible membrane flashing for new condensing unit bases and chiller unit infill as indicated on the Drawings and as specified herein.

1.2 PERFORMANCE REQUIREMENTS

- A. It is required that membrane be watertight and not deteriorate in excess of limitations published by the manufacturer. Membrane shall be fully adhered to the surface it is applied.

1.3 SUBMITTALS

- A. Product Data: Submit product data and the general recommendations from the membrane manufacturer. Include data substantiating that material complies with requirements.

1.4 STORAGE, DELIVERY AND HANDLING

- A. Protect all rolls from rain and physical damage. Store where temperatures will not exceed 90°F for extended periods. Store in a dry area away from high heat, flames or sparks. Store only as much material at point of use as required for each day's work.

1.5 PROJECT/SITE CONDITIONS

- A. Substrate: Proceed with the Work after substrate construction, openings, and penetrating work has been completed.
- B. Temperature and Moisture Requirements: Do not install during wet weather or when ambient temperature is less than 40°F. Do not install on wet, damp, or frost covered surfaces.

PART 2 - PRODUCTS

2.1 ACCEPTED MANUFACTURERS

- A. Type 1 : Factory made, self-adhering, cold-applied flashing membrane.
 - 1. Roof Detail Membrane by W.R. Grace & Co. (Specification Base)
 - 2. Or accepted substitute.
- B. Type 2 : Factory made, self-adhering, cold-applied roofing underlayment flashing membrane.
 - 1. Grace Ultra, Self Adhered Roofing Underlayment by W.R. Grace & Co. (Specification Base)
 - 2. Or accepted substitute.

FLEXIBLE FLASHING

2.2 MATERIALS

- A. Detail Membrane: Factory made, self-adhering, cold-applied sheet composites with a thickness of 0.040" consisting of a 0.004" high density, cross-laminated polyethylene film coated on one side with a 0.036" layer of rubberized asphalt adhesive, interwound with a disposable silicone-coated release sheet.
- B. Roofing Underlayment: Factory made, self-adhering, cold-applied sheet composite with a thickness of 30 mils consisting of a layer of high density cross laminated polyethylene backed by a butyl rubber based adhesive; embossed, slip resistant surface provided on the polyethylene; interwound with a disposable silicone-coated release sheet.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine surface specified to receive membrane or underlayment to assure that surface is in condition acceptable to the manufacturer's requirements.
 - 1. Surface shall be dry and clean of oil, grease, dust, loose debris, or other contaminants.
 - 2. Surface shall be free of voids, spalled areas, and sharp protrusions.

3.2 INSTALLATION

- A. Apply primers to substrate surfaces as recommended by manufacturer for full adhesion. Prime only areas that will be covered by the membrane in the same working day; re-prime areas not covered by the membrane within 24-hours. Priming is not required where membrane will properly fully adhere to substrate and remain fully adhered.
- B. Comply with the manufacturer's instructions for handling and installation of the membrane material.
- C. Coordinate the installation of the membrane material and associated work to provide complete system complying with combined recommendations of the manufacturer and installer involved in work. Schedule the installation to minimize period of exposure of the membrane material.
- D. Apply membrane flashing to vertical surfaces as shown on the Drawings and as required to provide complete membrane flashing system. Seal projections through membrane and seal seams.
- E. Firmly press the membrane into place with a hand roller or the back of a utility knife as soon as possible, ensuring continuous and intimate contact with the substrate to prevent water from migrating under the membrane.

3.3 MEMBRANE REPAIRS

- A. Repairs must be made using detail membrane sized to extend 6" in all dimensions from the perimeter of the affected area. If repairs are required, carefully cut out affected areas and replace in similar procedure as outlined above.

3.4 PROTECTION

- A. Institute required procedures for protection of completed membrane during installation of work against the membrane and throughout remainder of construction period.

END OF SECTION

JOINT SEALANT (URETHANE)

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide complete sealant systems as indicated on Drawings and specified herein.
- B. Section includes building sealants for weatherproofing, including but not limited to, penetrations of mechanical and electrical exterior wall and miscellaneous sealant products used throughout job. Include interior sealing of joints prior to painting.

1.2 QUALITY ASSURANCE

- A. Guarantee: Furnish written guarantee at completion of work. Guarantee period shall be 2 years from date of substantial completion. Include repair and replacement of defective work, such as leaks, failure of material, loss of adhesion, running of compound, or staining of adjacent work.
- B. Provide manufacturer's standard warranties as follows:
 - 1. 20 year Structural Adhesion Warranty.
 - 2. 20 year Weatherseal Warranty (Silicone).
 - 3. 5 year Weatherseal Warranty (Urethane).
 - 4. 20 year Non-Staining Warranty.
- C. Installer must have five years of experience in the installation of sealants specified herein.
- D. Pre-installation Conferences:
 - 1. Notify the Architect, sealant manufacturer's representative, and sealant installer at least 2 weeks before starting sealant work. Arrange a mutually acceptable time for meeting at the job with all notified parties to review the sealant specifications and job conditions. Obtain acceptance and approval of all parties on materials, details, and methods before beginning sealant installation.
 - 2. Schedule 2 on-Site Pre-installation Meetings.
 - a. First Pre-installation Meeting: The sealant manufacturer shall perform field adhesion tests of each type of material to determine and reconfirm if primer is required. Install sealants (and primers, where recommended) at representative areas at the first Pre-installation Meeting preparatory to the pull tests. After applying sealant at test locations, allow a minimum of 7 days to 14 days for sealants to cure prior to performing pull tests. Refer to recommendations made by sealant manufacturer resulting from laboratory adhesion tests.
 - b. Second Pre-installation Meeting: Reconvene at the Site to perform pull tests. Allow at least 7 to 14 calendar days for test sealants to cure prior to second meeting.
- E. Sealant Manufacturer's Inspections: Arrange for required manufacturer's periodic and final field inspections.
- F. Test compatibility with existing coatings prior to application.

1.3 SUBMITTALS

- A. Product Data: Submit product data and MSDS sheets for all sealants to be used at interior locations indicating compliance with VOC limits of the Bay Area Air Resources Board Reg. 8, Rule 51.

JOINT SEALANT (URETHANE)

1.4 INDOOR AIR QUALITY

- A. Do not use sealants inside the building shell that exceed the maximum VOC limits of Bay Area Air Resources Board Reg. 8, Rule 51 (www.baaqmd.gov/reg8/rg0851.pdf, page 8).

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. General Electric Company.
- B. Pecora Corporation.
- C. Sika Corporation.
- D. Sonneborn Building Products Division, Contech, Inc.
- E. Tremco, Inc. / Mameco Vulkem.
- F. Bostik.
- G. Or accepted substitute.

2.2 MATERIALS

- A. Polyurethane Sealant: General exterior weather resistant application at porous materials such as concrete, masonry, and stone. Use single or multi-component products as appropriate.
- B. Silicone Sealant: General exterior weather resistant application at glass, plastic, or metal. General interior structural glazing sealant or in wet areas where painting is not specified. Use neutral cure silicones where possible. Use single or multi-component products as appropriate. Use acid cure silicones only where necessary and staining will not occur.
- C. Acrylic Latex Sealant: General interior application for finishing gaps between various materials where painting of sealant is specified. Use single or multi-component products as appropriate.
- D. Sealant Color: Color to match adjacent surfaces at exposed joints. At concealed joints, manufacturer's highest performance color.
- E. Joint Cleaner and Primer/Sealers: As recommended by sealant manufacturer for the joint surface to be cleaned, primed or sealed.
- F. Bond Breaker Tape: Polyethylene or other plastic self-adhesive tape, compatible with sealant, which will not bond to sealant.
- G. Sealant Backer Rod: Nonabsorptive closed cell compressible rod stock, compatible with sealant, which will not bond to sealant as recommended by the sealant manufacturer.

PART 3 - EXECUTION

3.1 JOINT SURFACE PREPARATION

- A. Clean, prime and seal joint surfaces as recommended by the sealant manufacturer.

JOINT SEALANT (URETHANE)

- B. Support sealant from back with construction indicated or with joint filler or backer rod where recommended by the sealant manufacturer.

3.2 INSTALLATION

- A. Comply with manufacturer's printed instructions. Sealant color selected by Architect to match adjacent surfaces.
- B. Skilled workmen shall install each type of material in locations as called for. All material struck neat to line and cleaned from adjacent surfaces.
- C. Apply sealants only to dry surfaces at correct temperatures, and with approved protection from adverse weather conditions and dust.
- D. Thoroughly clean and remove any non-compatible substances remaining on surfaces such as lacquers, curing compounds, form coatings, bond breakers and silicone water repellents. Clean out any dust and loose material by brushing, scraping and blowing with air jet as necessary. Clean metal and glass with solvents.
- E. Run full, continuous and uniform beads of sealant in joints to be sealed keeping faces of work clean. Dress face of sealant with approved skinning tools and solvent or lubricant.
- F. 1/2" maximum joint depth and 3/4" maximum width. Use backing rod to make approximately 1:2 joint section depth to width ratio. Use polyethylene bond breaker tape as required to prevent adhesion to back of joints.

3.3 ADJUSTING AND CLEANING

- A. Remove excess and spillage promptly.
- B. Replace materials improperly installed as directed by the Architect.
- C. Protect all horizontal sealants from dust and dirt until sealant is no longer tacky by covering the joint.

END OF SECTION

ACCESS DOORS AND PANELS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide access door panels for access to walls and ceilings to access valves, controls, filters, fire dampers, electrical junction boxes and equipment as required for ongoing lubrication and servicing and replacement of smaller equipment items without demolition. Door size is to be as required for servicing or replacing the item but not smaller than 12" x 12".
- B. Refer to Division 23, Heating, Ventilating, and Air Conditioning (HVAC), for mechanical equipment access requirements.

1.2 SUBMITTALS

- A. Submit shop drawings and manufacturer's detail sheets for review before ordering. Show installation details, list all required parts and accessories. Indicate required modifications to standard products required for this installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acudor Products Inc.
- B. CESCO Products.
- C. J.L. Industries.
- D. KARP Associates.
- E. Larsen's Manufacturing Company.
- F. Milcor Limited Partnership.
- G. Or accepted substitute.

2.2 MATERIALS

- A. Style and model as applicable to ceiling and wall finish.
- B. Provide fire rated assemblies where indicated on the Drawings or where required within rated wall assemblies.
- C. Provide sizes as noted on the Drawings. If no size is indicated, provide minimum size of 24" x 24" or as required for suitable maintenance access to concealed equipment and devices.
- D. Furnish screwdriver function latching on all non-rated doors. Door panels fastened to frames with continuous hinge. Supply with factory applied white rust inhibitive prime coat ready for painting.

ACCESS DOORS AND PANELS

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install all panels in accordance with the manufacturer's standard specifications and recommendations.
- B. Verify that reinforcing, backing and blocking required for solid anchorage is in place. Furnish with screw type fasteners long enough to anchor into supports.
- C. Furnish and install all units free from damage and to be in perfect operating condition.

END OF SECTION

GYPSUM PLASTERING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide gypsum plaster systems to patch existing interior surfaces as indicated on the Drawings and as specified herein. Match existing wall systems, thickness and texture. Verify locations where plaster is required to match existing.

1.2 REFERENCES

- A. American National Standards Institute: ANSI A42.1, Gypsum Plastering.
- B. ASTM International (ASTM):
 - 1. ASTM A641: Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 2. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM C28: Standard Specification for Gypsum Plasters.
 - 4. ASTM C35: Standard Specification for Inorganic Aggregates for Use in Gypsum Plaster.
 - 5. ASTM C61: Standard Specification for Gypsum Keenes Cement.
 - 6. ASTM C206: Standard Specification for Finishing Hydrated Lime.
 - 7. ASTM C645: Standard Specification for Nonstructural Steel Framing Members.
 - 8. ASTM C754: Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel.
 - 9. ASTM C842: Standard Specification for Application Interior Gypsum Plaster.
 - 10. ASTM C1396: Standard Specification for Gypsum Board.

1.3 SYSTEM DESCRIPTION

- A. Surface Tolerances: For flat surfaces, do not exceed 1/4" in 8'-0" from plumb or level surfaces.

1.4 SUBMITTALS

- A. Submit product preparation instructions and recommendations, storage and handling requirements and installation methods.

1.5 QUALITY ASSURANCE

- A. Regulatory Agency Requirements:
 - 1. Comply with local building code and governing authorities requirements for fire rated walls, ceilings and soffits. When requested, provide UL design numbers for fire rated assemblies.
 - 2. Comply with requirements for seismic movement of the structure without structural failure of the wall, ceiling and soffit system.
- B. Field Samples: Provide 48" x 48" minimum sample of plaster finishes for the Architect's review prior to starting work. Acceptable samples may be incorporated in the Work.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Except for water and sand, deliver plaster materials in sealed containers or waterproof bags, fully identified with product information.
- B. Coordinate the delivery of materials with the installation to minimize storage periods.

GYPSUM PLASTERING

- C. Storage: Store plaster and steel materials in dry, ventilated space, under cover and 3" minimum above the floor.

1.7 SITE CONDITIONS

- A. Temperature Requirements: Do not begin plastering until building is enclosed or ambient temperature remains above 55°F.
- B. Ventilation: Provide exhaust ventilation for plaster during the curing period.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Obtain all components and materials of the gypsum plaster system from a single manufacturer, or from producers recommended by the manufacturer, unless otherwise indicated.
- B. Fasteners: Screws and powder actuated fasteners as recommended by manufacturer and ASTM C754 for application required. Type "G" and Type "S", bugle head, in required length and to suit requirement of application to wood studs. Nails will not be allowed for attachment to wood studs.
- C. Lath: Provide lath to match existing systems.
 - 1. Metal Lath: Deformed expanded, self-furring, galvanized, 3.4 pounds per square yard. USG 3/8" Riblath or accepted substitute.
 - 2. Gypsum Plaster Base Panel: ASTM C1396, 3/8" or 1/2" thickness. Use fire resistant base materials where required.

2.2 PLASTER MATERIALS

- A. Base Coat Plaster: ASTM C28.
- B. Finish Coat Plaster: Gauging Plaster, ASTM C28 or Keenes Cement, ASTM C61.
- C. Hydrated Finishing Lime: ASTM C206, Type S with maximum of 8% unhydrated oxides.
- D. Base Coat Aggregates: Sand conforming to ASTM C28 for ready mixed base coats or ASTM C35 for site mixed base coats.
- E. Finish Coat Aggregates: Clean white silica sand sized to match office sample or existing plaster surfaces.

2.3 ACCESSORIES

- A. Acoustical Sealants: Non-setting, non-staining, acoustically tested sealant. USG Acoustical Sealant, Tremco Acoustical Sealant, A.C. Horn Vulcatex Thriftube, or accepted substitute.
- B. Plaster Metal Trim: Manufacturer's standard 26-gage galvanized steel. All trim to have expanded metal flanges. USG #66 square edge casing beads with expanded flange, #1-A expanded corner bead, #75 or #100 control joint, and others as detailed, or accepted substitute.

2.4 MIXING

- A. Quantity: Limit batch quantity to amount used before plaster starts to set.

GYPSUM PLASTERING

- B. Retempering: Do not retemper plaster. Remove any plaster from the site that starts to set prior to placing.
- C. Mixing Equipment: Conform to ANSI A42.1. Clean tools and equipment before mixing. Use mechanical mixing equipment, except when mixing less than 1 bag of plaster material, plaster may be hand mixed.
- D. Proportioning: Proportion finish coat for a medium hard finish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection: Provide temporary covering on adjacent surfaces to eliminate splattering of plaster.
- B. Cleaning: Clean and remove loose material and other substances that will interfere with plaster bond to substrate.

3.2 LATHING

- A. Select the type of lath from the following to match the existing conditions.
- B. Gypsum Base:
 - 1. In areas where gypsum base is scheduled for both walls and ceilings, install the ceiling first then the wall. Use base panels of maximum practical length to minimize end joints. Attach to framing with all edges over framing members using proper fasteners. Space fasteners at 12" on center in the field and 8" on center staggered on abutting edges. Drive flush with the surface of the panel for proper finishing. Fastener application below the surface of the panel, breaking of the surface of the paper, or too close to the edge of the board will not be acceptable.
 - 2. Cut panel neatly and fit around pipes, electrical outlets, mechanical work, etc. Remove any loose face paper at cuts and fill holes or openings with quick-setting plaster. Where panel appears loose from framing, install second fastener within 1-1/2" of the first.
 - 3. Finish in every location with metal edge and corner bead unless other finishing details are given and edge is covered with molding or trim. Install crack control joints to match existing wall.
- C. Metal Lath:
 - 1. Install metal lath with its long dimension across the supports and attach to framing at 6" on center. Wire tie lath at side laps not exceeding 9" on center. All fastenings, laps and installation shall conform to the Metal Lath Association Specifications and the recommendations of the Northwest Plaster Bureau.
 - 2. Use expanded flange type corner bead, complete with clips and accessories. Provide control joints as applicable and as approved by Architect. Provide casing beads at perimeters of plaster surfaces, exposed and not concealed by molding or other finish. Install crack control joints to provide areas of not over 100 square feet of surface. Cut lath at all expansion control joints.

3.3 INSTALLATION OF PLASTER OVER LATH MATERIALS

- A. Use skilled plasterers throughout the work. All surfaces rodged true to an even plane and free from humps and declivities, presenting a smooth and true surface. Protect all adjoining surfaces by covering as required. Neatness of the plasterer is of paramount importance.

GYPSUM PLASTERING

- B. Patch of Existing Surfaces: Check the Drawings and the building site to determine areas requiring patching. Wherever patching is necessary or called for, perform this work using materials as specified. Trim areas to be patched to a straight line, vertical or horizontal line. The same materials are to be used as the material of the adjoining surfaces and finished the same. Exercise care in the finishing of the patched area, to feather and blend to the adjoining surface producing as invisible a joint as possible.
- C. Minimum Thickness: Apply gypsum plaster with minimum thickness when measured from face of plaster base to face of finished plaster surface, as established by ASTM C842 for the types of bases occurring in the work unless otherwise required for fire resistance ratings.
 - 1. Application of Base Coat on Metal Lath: Apply first (scratch) coat and second (brown) coat in accordance with ASTM C842. Level without application of water. Finish thickness of approximately 1" including the lath (scratch, brown with finish coat of Keenes Cement over metal lath).
 - 2. Application of Base Coat on Masonry and Concrete: Apply the base coat to masonry and concrete and double back to bring the plaster out to the grounds in accordance with ASTM C842. Level without application of water. Finish thickness of approximately 1/2" (3/8" brown coating with 1/8" finish).
 - 3. Application of Base Coat on Gypsum Base: Apply base coat in accordance with ASTM C842. Level without application of water. Finish thickness of approximately 1/2" (3/8" brown coating with 1/8" finish).
- D. Apply base coats with sufficient materials and pressure to form good bond on the base or substrate material. Scratch the first coat to rough surface then the brown coat brought out to the ground, rodged to a true surface and left rough to receive the finish coat.
- E. When brown coat has set hard and firm and is partially dry, or a thoroughly dry base coat has been evenly wetted, apply finish coat to a 1/16" to 1/8" thickness. Allow the finish coat to draw a few minutes, then trowel or float to a true, even surface free from blemishes.
 - 1. Scratch Coat or Brown Coat: Composed of a minimum of 1 sack of gypsum plaster to 3 cubic feet of sand.
 - 2. Sand Finish Coat: Composed of 2 parts lime putty, 3 parts 30 mesh white sand, and 1-1/2 parts Keenes Cement.
 - 3. Smooth Trowel Coat: Composed of 50 pounds lime putty to 100 pounds Keenes Cement.
 - 4. Finish Coat to Match Existing Finish: Composed of parts of lime putty, sand, and Keenes Cement to match the existing finish.

3.4 PATCHING EXISTING SURFACES

- A. This subcontractor shall check the Drawings and building site to determine areas requiring patching in the area of the Work described on the Drawings. Wherever patching is necessary or indicated, perform this work using materials as specified. The same materials are to be used as the material of the adjoining surfaces and finished the same. Exercise care in the finishing of the patched area. Feather and blend to the adjoining surface to produce as invisible a joint as possible.
- B. In buildings requiring remodeling, patched materials and surfaces must be finished so that existing and new materials match one another, not only in color but also in patterns and surface texture. The intent is to not have a patched appearance. In areas where partitions must be removed to create new areas, careful planning is required to ensure that finishes of the existing and the newly created surfaces are homogenous. The existing materials should blend into the new so that the transitions form one material to the other cannot be readily observed. IF the desired level of finish cannot be achieved, arrange contrasting materials in a pleasing design.

GYPSUM PLASTERING

3.5 ADJUSTING AND CLEANING

- A. Defective Plaster: Plaster which is excessively cracked or crazed due to improper timing and curing will not be accepted. Remove and replace defective plaster, including plaster base materials, if damaged during removal of defective plaster.
- B. Cutting and Patching: Cut, patch, repair, and point-up plaster as required. Repair cracks and indented surfaces by moistening plaster and filling with new material, troweled or tamped flush with adjoining surfaces.
- C. Clean Up: Promptly remove plaster from floors and other surfaces which have been stained, marred or otherwise damaged during the plastering work. Restore damaged floors and surfaces as directed.

END OF SECTION

GYPSUM BOARD

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide gypsum drywall partitions on wood framing.
- B. Provide patching of gypsum drywall partitions, ceilings, and soffits on existing wall and ceiling framing and existing wall and ceiling furring. Include backing for applied finishes.
- C. Provide coordination with the mechanical and electrical subcontractors.
- D. Provide gypsum drywall as substrate for glue-up acoustic tile.
- E. Wall texture and finish shall match existing.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A641: Standard Specification for Zinc-Coated (Galvanized) Carbon Steel Wire.
 - 2. ASTM A653: Specification Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - 3. ASTM C473: Standard Test Methods for Physical Testing of Gypsum Panel Products.
 - 4. ASTM C475: Standard Specification for Joint Compound and Joint Tape for Finishing Gypsum Board.
 - 5. ASTM C557: Standard Specification for Adhesives for Fastening Gypsum Wallboard to Wood Framing.
 - 6. ASTM C645: Standard Specification for Nonstructural Steel Framing Members.
 - 7. ASTM C754: Standard Specification for Installation of Steel Framing Members to Receive Screw-Attached Gypsum Panel.
 - 8. ASTM C840: Standard Specification for Application and Finishing of Gypsum Board.
 - 9. ASTM C919: Standard Practice For Use of Sealants in Acoustical Applications.
 - 10. ASTM C1177: Standard Specification for Glass Mat Gypsum Substrate for Use as Sheathing.
 - 11. ASTM C1178: Standard Specification for Glass Mat Water-Resistant Gypsum Backing Panel.
 - 12. ASTM C1396: Standard Specification for Gypsum Board.
 - 13. ASTM D3273: Standard Test Method for Resistance to Growth of Mold on the Surface of Interior Coatings in an Environmental Chamber.
 - 14. ASTM E119: Standard Test Methods for Fire Tests of Building Construction and Materials.
- B. Gypsum Association:
 - 1. GA-214: Recommended Levels of Gypsum Board Finish.
 - 2. GA-216: Application and Finishing of Gypsum Panel Products.

1.3 SYSTEM DESCRIPTION

- A. System Tolerances: Do not exceed 1/4" variation in 8'-0" from plumb, level and true lines.

1.4 SUBMITTALS

- A. Product Data: Submit the manufacturer's specifications and installation instructions for each gypsum drywall product component, including other data as may be required to show compliance with these specifications.

GYPSUM BOARD

- B. Submit wall and ceiling texture sample on 24" x 24" gypsum board materials properly prepared to match specified wall finishing or on 10 square feet of prepared wall surface for the Architect's review. Acceptable texturing may be retained as finish surface. Remove all texturing that is not approved prior to drying on the wall surface. Texturing to be applied by the technician scheduled to do the texturing.
- C. Submit product preparation instructions and recommendations, storage and handling requirements and installation methods.

1.5 QUALITY ASSURANCE

- A. Regulatory Agency Requirements:
 - 1. Comply with building code and governing authorities requirements for fire-rated partitions and ceilings.
 - 2. Provide materials, accessories and use application procedures that have been listed and approved by UL, ICC, and tested in accordance with ASTM E119 for the type of construction scheduled. When requested, provide UL design numbers for fire-rated wall and ceiling assemblies.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Coordinate the delivery of materials with the installation to minimize storage periods. Deliver materials in original packages, containers or bundles bearing brand name and identification of manufacturer or supplier.
- B. Store gypsum and steel materials in dry, ventilated space, under cover protected from weather, direct sunlight, and above grade floor slabs. Neatly stack gypsum boards flat to prevent sagging.
- C. Protect structural members from excessive stress during delivery and erection.
- D. Handle gypsum boards to prevent damage to edges, ends or surfaces. Protect metal corner beads and trim from being bent or damaged.

1.7 SITE CONDITIONS

- A. Temperature Requirements: Do not begin installing gypsum board until building is enclosed or ambient temperature remains above 55°F.
- B. Cold Weather Protection: When ambient outdoor temperatures are below 55°F, maintain continuous, uniform, comfortable building working temperatures of not less than 55°F for a minimum period of 48 hours prior to, during, and following application of gypsum board and joint treatment materials or bonding of adhesives.
- C. Ventilation: Ventilate building spaces as required to remove water in excess of that required for drying of joint treatment material immediately after its application. Avoid drafts during dry, hot weather to prevent too rapid drying.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Obtain all components and materials of the gypsum drywall system from a single manufacturer, or from producers recommended by the manufacturer, unless otherwise indicated.

GYPSUM BOARD

2.2 FACE AND BACKING BOARDS

- A. Gypsum Face Panels: ASTM C1396. Long edges tapered. 5/8" thick, 48" wide, Type "X" gypsum core, UL classified.
- B. Gypsum Base Panels: ASTM C1396, Type "X" fire retardant type, UL classified, with long edges tapered.

2.3 GYPSUM ACCESSORIES

- A. Acoustical Sealants: U.S. Gypsum Acoustical sealant, Tremco Drywall Sealant, A.C. Horn Vulcatex Thriftube, non-setting, non-staining, acoustically tested caulking, or accepted substitute.
- B. Screw Fasteners: ASTM C645. No nailing of gypsum materials will be allowed.
- C. Fastening Adhesive for Wood Framing: ASTM C557. Supplement adhesive with permanent or temporary fasteners as recommended by the manufacturer.
- D. Laminating Adhesives: Product recommended by gypsum board manufacturer.
- E. Gypsum Board Metal Trim: Manufacturer's standard 26-gage galvanized steel. All trim to have fine mesh expanded metal flanges. Fine mesh corner beads: Mini-Bead 800/900 by ClarkDietrich Building Systems, Niles Mini-Bead 800/900, Mini Veneer Bead by Phillips Manufacturing Co., or accepted substitute.
- F. Interior Joint Reinforcing Tape: Fiber tape not less than 2-1/4" wide, ASTM C475.
- G. Exterior Joint Reinforcing Tape: Open weave glass fiber tape not less than 2-1/2" width, ASTM C475.
- H. Interior Joint Treatment Materials: ASTM C475, ready-mixed type as recommended by gypsum wallboard manufacturer. Provide 2 separate grades, 1 specifically for bedding tapes and filling depressions and 1 for topping and sanding. Use chemical-hardening type for bedding and filling where required.
- I. Skim Coat: "First Coat" by U.S. Gypsum, Georgia-Pacific "Ready-Mix All-Purpose Joint Compound", or accepted substitute.
- J. Paint Primer: Miller No. 6020 P.V.A. Primer, Acrylic Modified Drywall Primer (Rodda Scotseal), Parker 1841, Wall Board Primer, or accepted substitute.
- K. Wall Texture: ProRoc Wall and Ceiling Texture (Blue) by Certaineed Gypsum, Fine Wall Texture by Georgia-Pacific, Imperial QT or P-Regular by U.S. Gypsum, or accepted substitute.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection: Provide temporary covering to eliminate splattering of joint compound and spray texture on adjacent finished surfaces.

3.2 INSTALLATION OF WALL, SOFFIT, AND CEILING PANELS

- A. General and Fire Rating Requirements:
 - 1. Comply with Gypsum Association Specifications GA-216.

GYPSUM BOARD

2. Install panels of thickness indicated and as required meeting structural and fire rating requirements.
3. Glue and screw wallboard to wood framing members as recommended by the manufacturer. Nailing of gypsum panels will no be allowed.
4. For vertical partition wallboard installation, offset panel joints on opposite sides of stud framing.
5. In areas where gypsum wallboard is scheduled for wall and ceilings, install the ceiling first then the wallboard.
6. Cut board neatly and fit around pipes, electrical outlets, mechanical work, etc. Remove any loose face paper at cuts and fill holes or openings with quick setting plaster.
7. Use panels of maximum practical length to minimize end joints. Arrange joints on opposite sides of partition walls to occur on different studs and stagger butt joints on the same surface. Where partitions intersect exterior walls, start installation at exterior end to position butt joints as far away from exterior wall as possible. Board shall be brought into contact but not forced into place with all ends and edges neatly fitted. Bottom edge of gypsum board on walls shall be a maximum of 1/4" above floor.
8. Attach to framing with all edges over framing members using screw fasteners. Space screws at 12" on center on ceiling and 16" on center on walls, staggered on abutting edges. Power drive screws at least 1/32" deep. Space screws at not less than 3/8" from edge and ends of board. Where board may appear loose from framing, install second fastener within 1-1/2" for the first fastener.
9. While fasteners are being driven, hold the gypsum board in firm contact with underlying supports, fastening from the center of the board toward ends and edges. Drive fasteners home with heads slightly below surface, taking care to avoid breaking the paper face.
10. Install gypsum base panels as a substrate for face panels where 2 layers are required. Fasten both the base layer and face layer separately to framing members with screws.
11. Finish in every location with metal edge and corner bead unless other finishing details are given and edge is covered with molding or trim. Install control joints vertically at a maximum of 30 feet apart on unbroken wall surfaces whether shown on the Drawings or not. Extend control joint from head to ceiling and from window sill to floor. Verify all expansion joint locations with the Architect prior to installation of gypsum board.
12. Cover both faces of stud framing with gypsum board in concealed spaces (above ceilings, etc.), except in chase walls that are braced internally. Except where concealed application is required for sound, fire, air or smoke ratings, coverage may be accomplished with scraps of not less than 8 square feet area, and may be limited to not less than 75% of the full coverage.
13. Use water resistant type board on all wet and high moisture areas. Seal all cut ends and openings with recommended sealant.

3.3 SEALANT APPLICATIONS

- A. Partition Perimeter: Apply a 1/4" minimum bead of sealant on each side of plates, including those used at intersections with dissimilar wall construction. Immediately install gypsum board, squeezing sealant to form contact with adjacent surfaces. Fasten board as specified. Conform to ASTM C919 for sealant application.
- B. Partition Intersections: Seal edges of face layer of wallboard abutting intersection partitions, before taping and finishing.
- C. Openings: Apply a 1/4" bead of acoustical sealant around all cut outs to seal openings of electrical boxes, ducts, pipes and similar penetrations. Seal sides and backs of all electrical boxes.
- D. Control Joints: Before installing control joints, apply sealant in back of joint to reduce flanking sound path.
- E. Install acrylic latex sealant where required to fill exposed openings.

GYPSUM BOARD

3.4 PATCHING EXISTING SURFACES

- A. This subcontractor shall check the Drawings and building site to determine areas requiring patching in the area of the Work described on the Drawings. Wherever patching is necessary or indicated, perform this work using materials as specified. The same materials are to be used as the material of the adjoining surfaces and finished the same. Exercise care in the finishing of the patched area. Feather and blend to the adjoining surface to produce as invisible a joint as possible.
- B. In buildings requiring remodeling, patched materials and surfaces must be finished so that existing and new materials match one another, not only in color but also in patterns and surface texture. The intent is to not have a patched appearance. In areas where partitions must be removed to create new areas, careful planning is required to ensure that finishes of the existing and the newly created surfaces are homogenous. The existing materials should blend into the new so that the transitions form one material to the other cannot be readily observed. IF the desired level of finish cannot be achieved, arrange contrasting materials in a pleasing design.

3.5 FINISHING

- A. Levels of Finish:
 - 1. Level 3: All joints and interior angles shall have tape embedded in joint compound and one additional coat of joint compound applied over all joints and interior angles. Fastener heads and accessories shall be covered with two separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges. Mop down all walls after the final mud coat prior to priming. .Note: It is recommended that the prepared surface be coated with a drywall primer prior to the application of final finishes.
 - 2. Level 4: All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. All joint compound shall be smooth and free of tool marks and ridges. Mop down all walls after the final mud coat prior to priming.
 - 3. Level 5:
 - a. All joints and interior angles shall have tape embedded in joint compound and two separate coats of joint compound applied over all flat joints and one separate coat of joint compound applied over interior angles. Fastener heads and accessories shall be covered with three separate coats of joint compound. A thin skim coat shall be trowel applied to the entire surface. The surface shall be smooth and free of tool marks and ridges.
 - b. The skim coat is applied with a fine knap roller over the entire surface to fill imperfections in the joint work, smooth the paper texture, and provide a uniform surface. Goobers and smeared roller marks will not be accepted.
 - c. The skim coat is applied with a fine knap roller over the entire surface to fill imperfections in the joint work, smooth the paper texture, and provide a uniform surface. The entire surface is to be lightly sanded leaving a film of skim coating compound completely covering the paper. Smeared roller marks will not be accepted. Mop down all walls after the final mud coat prior to priming.
- B. Exposed Board in Finished Areas: Match adjacent existing finish level.
- C. Exposed Board in Unfinished Areas: Match adjacent existing finish level.
- D. Exposed Board Where Textured: Match adjacent existing finish level.
- E. Texturing:

GYPSUM BOARD

1. This subcontractor shall be responsible for the priming of the surface with a paint primer prior to the application of the texture material.
2. Apply sprayed texture where required to match existing wall surfaces.
3. Provide spray texture on exposed surfaces in finished ceiling areas.
4. Apply wall texture to gypsum board walls, soffits, and ceiling texture to gypsum board ceilings where scheduled.

3.6 CLEAN UP

- A. Do not dispose of or leave excess drywall materials or debris on the premises. Leave each area "broom clean" after completing drywall work. Clean spots and spills of taping and finishing compounds off of all adjacent surfaces and equipment.

END OF SECTION

ACOUSTICAL CEILING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide acoustical ceilings at locations indicated on the Drawings and as herein specified.
- B. Include the removal and reinstallation of existing panels and track system as required for work above the ceiling space. Reuse existing grid.

1.2 REFERENCES

- A. ASTM International (ASTM):
 - 1. ASTM A568: Standard Specification for Steel, Sheet, Carbon, Structural, and High-Strength, Low-Alloy, Hot-Rolled and Cold-Rolled, General Requirements for.
 - 2. ASTM C635: Standard Specification for the Manufacturer, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings.
 - 3. ASTM C636: Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels.

1.3 SUBMITTALS

- A. Office Samples: Submit sample of ceiling panels and tiles to the Architect prior to ordering materials.
- B. Submit product data for acoustical tiles.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All ratings in conformance with the Acoustical and Insulation Materials Association Bulletin, latest edition.
- B. Acoustical Tile: Mineral fiber, square edge tile 12" by 12" by 3/4", Class I flame spread rating. Minimum 2 coats factory applied washable white vinyl latex paint. NRC 0.60-0.70, STC range 35-39, light reflectance of LR-1, Armstrong Travertone Fissured, square edge K4C4 unless otherwise noted to match existing or accepted substitute.
- C. Ceiling Tile Adhesive: #137 by W. W. Henry, Ceiling Tile Adhesive by Miracle, or accepted substitute.
- D. Spare Materials: Furnish 1 full carton of acoustical panels and tiles or 5% overrun whichever is larger. Furnish from the same production run as that used in the installation. Deliver to the Owner for future repairs and maintenance.

PART 3 - EXECUTION

3.1 INSTALLATION OF ACOUSTICAL CEILING PANELS

- A. Room centerline to match the center of the tile or edge of the tile as indicated on the Drawings.
- B. Install ceiling panels in suspended grid system per the manufacturer's recommendations using clean hands or gloves.
- C. Install directional patterned tile with patterns running across the short direction of the room.
- D. Provide extra panels to protect recessed light fixtures as detailed for fire rated ceilings.

ACOUSTICAL CEILING

3.2 INSTALLATION OF ADHESIVE SYSTEM

- A. Room centerline to match center of tile or edge of tile or to match existing pattern as indicated on Drawings.
- B. Install ceiling tiles over wood stripping or gypsum board panels using fire rated adhesive. Apply in non-directional pattern with finished surface in flat smooth plane. Insert fiber splines in kerfs at corners of units where required.

3.3 ADJUSTING AND CLEANING

- A. Remove and replace panels and tile improperly placed, broken, or damaged prior to Substantial Completion.
- B. Clean surfaces of panels and tile or remove and replace as directed prior to Substantial Completion.

3.4 EXTRA STOCK

- A. Provide a quantity of each unique type or color equal to 5% of amount installed or at the minimum one full unopened carton.

END OF SECTION

PAINTING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Exterior Painting:
 - 1. Field finish:
 - a. Concrete walls.
 - b. Steel pipe bollards.
 - 2. Field paint exposed fire protection, plumbing, HVAC, and electrical equipment not factory finished except as may be noted on the Drawings.
- B. Interior Painting:
 - 1. Field finish:
 - a. Gypsum board walls and ceilings as scheduled on Drawings.
 - b. Patched plaster walls and ceilings as scheduled on Drawings.
 - 2. Field paint exposed fire protection, plumbing, HVAC, and electrical equipment not factory finished which is installed in areas scheduled for field finishing.
 - 3. Field paint all exposed factory finished HVAC ceiling and wall grilles to match the surrounding paint color and as indicated by the Architect.
- C. Do Not Paint:
 - 1. Prefinished items, such as light fixtures, plumbing fixtures and finished door hardware.
 - 2. Finished metal such as anodized aluminum, stainless steel, finished brass or bronze.
 - 3. Moving parts of operating units, equipment identification, performance rating, name plates or code-required labels.

1.2 REFERENCES

- A. Oregon Administrative Rules (OAR), Department of Human Services, Public Health Division: Chapter 333, Division 70 Renovation, Repair and Painting Activities Involving Lead-Based Paint.
- B. Code of Federal Regulations: 40 CFR: Protection of the Environment.

1.3 SUBMITTALS

- A. Product Data: Submit manufacturer's literature on each coating proposed for this Project. Obtain approval of coatings prior to ordering. Include the manufacturer's recommended minimum dry film thickness for each coating system. Indicate where the material is to be used.
 - 1. Provide manufacturer's data sheets on each product to be used, including:
 - a. Preparation instructions and recommendations.
 - b. Storage and handling requirements and recommendations.
 - c. Installation methods.
- B. Submit finish schedule including color information, gloss, and product number for each type, and color of finish specified. Provide two Verification Samples for each finish product specified, minimum size 6" square, representing actual product, color, sheen, and patterns.
- C. Office Samples:
 - 1. Submit Samples: For the Architect's review of color and gloss.
 - 2. Resubmit Samples: As requested until required color and gloss is achieved.
 - 3. Opaque Finish: Provide three 8" x 8" minimum size samples of each color and gloss.
 - 4. Transparent Finish: On actual wood surfaces provide three 4" x 8" minimum size samples for natural and stained wood finish.

PAINTING

- D. Submit product preparation instructions and recommendations, storage and handling requirements and installation methods.
- E. Contractor shall provide start date for painting in 3 week look ahead construction schedule. Contractor shall provide notice to BSD representative at least 24 hours before applying paint. If painting is being applied in stages, similar schedule notification will be required for the start of each stage. Notification is to allow Owner inspections of wall substrates prior to any primer being applied and to allow additional inspections between primer and finish coats.

1.4 QUALITY ASSURANCE

- A. Painter: Provide local subcontractor experienced in painting commercial buildings. Painting subcontractor must have 5 years experience in projects of similar size.
- B. Field Samples:
 - 1. On actual building components, duplicate finishes on acceptable office samples.
 - 2. Provide wall and ceiling colors and finishes on minimum 50 square feet of in-place surfaces.
 - 3. Provide trim and equipment colors and finishes on minimum 10 lineal feet of in-place surfaces.
 - 4. The Architect will approve for color, texture and sheen only.
- C. Fire Protection: Provide sufficient fire extinguishers of a type suitable for the control of fire originating in paint materials. Remove and dispose of, or safely store, all waste, empty containers and oily cloths off of the premises daily.
- D. Maintain environmental conditions (temperature, humidity and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- E. Coordinate work with other operations and installation of finish materials to avoid damage to installed materials. Do not apply coatings materials until moisture or dust producing work or other appearance or performance impairing construction activities have been completed.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to each site in new, original and unopened containers bearing manufacturer's name, trade name, and label analysis.
- B. Storage: Store coatings in ventilated spaces with containers closed.
- C. Handling: Keep dust and open flame from coating materials while mixing and painting.
- D. Contractor shall take special safety precautions against hazards from toxic and flammable materials. Keep open flame, electrical, and static spark, and other ignition sources away from flammable vapors and materials at all times. Place paint and solvent contaminated cloths and materials subject to spontaneous combustion in sealed non-flammable containers and remove from job site each day.

PAINTING

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Miller Paint Co.
- B. Rodda Paint Co. / Cloverdale Paint Co. (Specification Standard)
- C. Sherwin Williams Co., Professional Coatings Division.
- D. Kelly Moore.
- E. Or accepted substitute.

2.2 EXTERIOR MATERIALS

- A. Products listed below are approved for use in the Project. Other products may be used when approved by the Architect in writing.
- B. Galvanized Metals:
 - 1. Primer: Miller No. 310-2-10 Acrimetal DTM.
 - 2. Second and Third Coats: 310-5-10 Acrimetal DTM Semi Gloss
- C. Concrete:
 - 1. Primer: Miller No. 620-0-11 Kril Primer Sealer.
 - 2. First and Second Coats: Miller No. 520-1-xx Kril Coat Flat.

2.3 INTERIOR MATERIALS

- A. Products listed below are approved for use in the Project. Other products may be used when approved by the Architect in writing.
- B. Painted Wood and Trim - New and Existing:
 - 1. Primer: Miller No. 270-0-11 Miller-Prime Acrylic Enamel Undercoat.
 - 2. Second and Third Coats: Miller No. 320-5-01 Acrinamel Acrylic Semi-Gloss Enamel.
- C. Ferrous Metal:
 - 1. Primer: Zinsser All Prime Oil Based Universal Primer (AKA Cover Stain).
 - 2. Second and Third Coats: Miller No. 320-5-10 Acrimetal DTM Semi Gloss.
- D. Non Ferrous Metal:
 - 1. Primer: PPG Polyclutch Wash Primer 97-687/688.
 - 2. Second and Third Coats: Miller Premium Enamel Alkyd Semi Gloss 1705XX.
- E. Gypsum Drywall - Walls (Paint):
 - 1. Primer: Miller No. 220-0-11 P.V.A. Primer.
 - 2. Second and Third Coats: Miller No. 120-4-XX Premium Satin.;
- F. Gypsum Drywall - Ceilings:
 - 1. Primer: Miller No. 620-0-11 Kril Primer Sealer.
 - 2. First and Second Coats: Miller No. 120-4-XX Premium Satin; roller application for light eggshell finish.

PAINTING

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examination of Surfaces: Examine areas and conditions under which painting work is to be applied. Correct conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected.
- B. Contaminated Surfaces: Do not paint over dirt, rust, blistered paint, grease, wet substrates, or surface conditions detrimental to the formation of a durable paint film.
- C. Work Start: Start of painting work will be interpreted as the Applicator's acceptance of surfaces and conditions within any particular area.

3.2 PREPARATION

- A. Cleaning: Comply with coating the manufacturer's instructions for preparation and cleaning of each substrate.
- B. Protection:
 - 1. Cover and protect adjacent finished surfaces.
 - 2. Remove hardware, machined surfaces, cover plates, lighting fixtures and prefinished items in place and not scheduled for field finishing, or provide surface applied protection. Reinstall removed items after finishing adjacent surfaces.
 - 3. Post "WET PAINT" signs during application and curing of all coatings that may be accessed by other trades or the public.
- C. Priming:
 - 1. Seal wood required to be job painted. Prime edges, ends, face, undersides and backsides of millwork and exterior painted wood.
 - 2. Provide finish coats that are compatible with prime paints used. Provide barrier coats over incompatible primers where required. Notify the Architect in writing of anticipated problems using specified coatings with substrates primed by others.
 - 3. Apply prime coat or first coat to material that is scheduled or required to be painted or finished.
 - 4. Touch up shop primed surfaces scratched or chipped prior to field finishing.
 - 5. The primer applied under Section 09 29 00, Gypsum Board, under the wall texture is not to be considered as a prime coat for paint.
- D. Existing Lead Base Paint: For renovations, repairs and painting (RRP) in "Child-Occupied Facilities" (where kids under the age of 6 regularly spend time and built before 1978), the General Contractor shall follow all Federal, State and local rules (including OSHA and US EPA rules and Oregon Administrative Rules Chapter 333, Division 70) associated with lead-based paints (LBP).
 - 1. The Contractor is responsible for the identification of LBP hazards and providing engineering controls for trigger activities that disturb LBP.
 - 2. Any time painted surfaces are disturbed, the work must be performed by a certified firm with a trained and certified "renovator" in accordance with *40 CFR (including Part 745.82 Lead)*.
 - 3. Post the areas of the building that will be affected with appropriate signage warning of the potential hazard.

PAINTING

3.3 APPLICATION

- A. Methods and Coverage:
1. Apply painting and finishing materials in accordance with the manufacturer's directions. Use techniques best suited for the material and surfaces to which applied.
 2. For opaque finishes, apply additional coats when undercoats, stains or other conditions show through final paint coat, until paint film is of uniform finish, color and appearance.
 3. Where recommended by manufacturer, sand lightly between succeeding enamel or clear coats.
 4. Apply each material at not less than the manufacturer's recommended spreading rate, to provide a total dry film thickness of not less than amount recommended by coating manufacturer.
 5. Match approved office and field samples for color, texture and sheen.
 6. Paint exposed surfaces behind movable equipment and furniture same as adjacent surfaces.
 7. Paint surfaces behind permanently fixed equipment or furniture with prime coat only.
- B. Equipment Surfaces:
1. Paint interior surfaces of ducts where visible through registers or grilles, flat black.
 2. Except where accent colors are scheduled, paint mechanical and electrical work in finished areas including exposed ducts, piping, conduit, louvers, and grilles to match adjacent surfaces except when factory finished to color matching adjacent surface.
 3. Paint exterior exposed equipment where noted on the Drawings.
- C. Existing Surfaces: Existing walls to be repainted are to be cleaned, removing all scaled and loose paint. Wall areas that have been patched are to be primed and painted as specified for new work. The existing painted surfaces, after cleaning and spot priming as necessary, are to receive 2 finish coats of paint.
- D. Workmanship: Tint undercoats slightly darker than finish coat to aid Inspector in verifying coverage of each coat. Assume all responsibility for paint coats applied over surfaces and undercoats that have not been inspected and approved by Architect. Apply any additional coats of paint, as directed by Architect where surface preparation and undercoats have not been approved before painting. Make finished work match approved samples.
- E. Drywall and Plaster Surfaces: Paint shall not be applied to any surface until it is thoroughly dry and cured. Prime surfaces that show hot spots or alkali in order to prevent such blemishes from showing through the paint. Brush off all loose particles or crystals that may have formed.
- F. Colors: Refer to the Color Schedules included at the end of this Section. Job mixing and tinting will not be allowed.

3.4 ADJUSTING AND CLEANING

- A. Remove, refinish or repaint work not in compliance with specified requirements. Recoat work not meeting minimum dry film thickness.
- B. Correct any painting related damage by cleaning, repairing or replacing and refinishing as directed.
- C. Repaint lines between accent colors as directed to obtain clean straight lines.
- D. Remove paint splatters from plastic laminate, resilient flooring, anodized aluminum, glass and similar finished surfaced.
- E. Touch up factory finished surfaces damaged during construction.

3.5 EXTRA STOCK

PAINTING

- A. Verify all extra materials requirements with BSD Representative.
- B. In general, provide extra materials in full, unopened manufacturer's cartons (or containers) for storage at the school. The extra materials shall be from the same manufacturing lot as those installed during construction.
- C. At project closeout, provide to the Owner or Owner's Representative:
 - 1. One gallon of each finish coating materials in sealed, unopened original manufacturer's container. Clearly mark with color and finish identification. Remove all other opened containers and dispose of in compliance with all State and Federal regulations and guidelines.
- D. Contractor shall provide an As-Built Finish Schedule. Update Finish Schedule to include a list of product number, formula and location for each finish used. If Custom Finishes are used, include product number and color formula.

3.6 EXTERIOR COLOR SCHEDULE

- A. New steel pipe bollards: Match Miller Paint Company "Safety Yellow".
- B. Exterior concrete wall at Boiler Room: Match existing.

3.7 INTERIOR COLOR SCHEDULE

- A. General Interior Wall Color: Match existing.
- B. Interior Ceiling Color: Match existing.
- C. Access panels: Paint to match adjacent surface.
- D. Mechanical grilles: Paint to match adjacent surface.

END OF SECTION

HVAC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 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. The work shall include, but not be limited to, the following systems:
 - 1. Central heating and cooling equipment.
 - 2. Complete piping systems including insulation, valves, supports, etc.
 - 3. Air handling equipment including packaged equipment and exhaust fans.
 - 4. Air distribution systems including ductwork, terminal units, dampers, insulation, and air inlets and outlets.
 - 5. HVAC control system.
 - 6. Special systems as specified herein.
 - 7. System will be commissioned, see 23 08 00.
- E. Advise subcontractor, suppliers, and vendors involved in the work specified in this Section of the applicable requirements.

1.2 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. Commissioning shall be performed on this project. Commissioning agent is an agent of the owner. See Section 23 08 00 for systems to be commissioned.
- G. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both.
- H. 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.
- I. 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.

1.3 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.
- B. See 23 08 00 for commissioning.

1.4 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.

1.5 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 uploaded to e-Builder (Beaverton School Districts electronic project management software / system). 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.**

1.6 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.

1.7 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.

1.8 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.

1.9 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

2.1 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 90.1-2001 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.

2.2 MOTORS

- A. General: Motors shall conform to UL, CSA, and NEMA MG-1 and bear a permanently attached nameplate indicating compliance and motor characteristics. Provide motors meeting UL 507 standard where applicable.
- B. Manufacturers: General Electric, Lincoln, Baldor, Wagner, Westinghouse or accepted substitute. Where selection of motor manufacturer is within Contractor's control (independent of equipment selection), provide motors produced by a single manufacturer to the greatest extent possible.
- C. Temperature Rating: Class F insulation, except where otherwise indicated or required for service indicated.
- D. Starting Capability: As required for service indicated, but not less than 5 starts per hour.
- E. Phases and Current: 1/3 horsepower and smaller capacitor-start, capacitor-run single-phase; 1/2 horsepower and larger, squirrel-cage induction polyphase. Coordinate with actual current characteristics; specified in Division 26 and use no 230/460 voltage motors on 208 voltage power or vice versa.
- F. Service Factor: 1.15 for polyphase; 1.25 for single-phase.
- G. Construction: General purpose, continuous duty; NEMA design "B," except "C" for high starting torque applications.
- H. Frames: For single phase motor sizes NEMA No. 48, except 56 for heavy-duty applications. NEMA "T" frames for 1 horsepower and larger polyphase motors. Special frame types as required for close coupled pumps and similar applications.
- I. Bearings: Ball or roller, and design for thrust where applicable; double shielded and regreasable, except provide permanently sealed where not accessible for greasing. Sleeve-type bearings permitted only where indicated for fractional (1/6 hp or less) horsepower motors with direct drive loads. Minimum L-10 bearing life of 40,000 hours when used with minimum pitch sheaves per NEMA Table 14-1.
- J. Enclosure Type: Unless otherwise indicated, open drip-proof for normal concealed indoor use, guarded where exposed to employees or occupants. Type II for outdoor use, except weather-protected Type I where adequately housed. Totally enclosed where explosion proof motors are required.
- K. Overload Protection: Built-in thermal with internal sensing device for stopping motor, and for signaling where indicated on single phase motors.
- L. Speed: Not faster than synchronous speeds of 1,800 RPM except on some pumps as approved in each case.
- M. Efficiency: The manufacturer's highest (premium) efficiency motors tested under procedures recommended by NEMA MG-1 (IEEE Standard 112, Test Method B). Intermittent duty motors, operating less than 6 hours per day, shall comply with EPA standards. Submit manufacturer's data if motor nameplate does not indicate minimum efficiency. Nominal full load efficiencies for 460 volt, 1,800 rpm motors:

<u>HP</u>	<u>Efficiency %</u>
1-1/2	87.5
2	87.5
3	88.5
5	89.5
7-1/2	91.5
10	91.5
15	93.0
20	93.5
25 and larger	94.0

- N. Inverter Duty Motors: Where motors are controlled by an adjustable frequency drive, provide motors labeled "Inverter Duty," complying with NEMA MG1-31, and meeting the requirements of the adjustable frequency drive manufacturer.
- O. Provide shaft grounding on any motors 5 HP or larger operated by VFD. Micro fiber contact ring (solid or split case allowed) held in place with mechanical fasteners or conductive epoxy. Aegis Inc. SGR series or equal.

2.3 STARTERS AND SWITCHES

- A. Manufacturers: Cerus Industrial Model numbers are listed. General Electric, ABB, Allen Bradley, Schneider Electric, Eaton, are approved 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.
- 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. 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.
3. Provide factory start-up of devices to include trip adjustment per NEC.

2.4 GUARDS

- A. Provide guards in accordance with State Safety Code and OSHA requirements over all rotating equipment including belts, shafts and couplings. Drive guards over belts and sheaves shall include 2-1/2" diameter access opening at shaft ends for speed counter.

2.5 DRIVES

- A. Acceptable Manufacturers: Dayton, Gates, Browning.
- B. General: "V" section belt drives, multiple as required, sized on 1.5 times installed motor horsepower. Provide variable pitch motor sheaves on all one or two belt drives and standard slide rails or approved means of adjustment for each motor with belt drive. Use standard section belts and no sheave smaller than cataloged industry standard; provide countersunk center on shaft ends to receive speed counter tip.

2.6 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.
 - 11. See motor specification for shaft grounding.

- 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. Integral Main Disconnect: Circuit breaker connected to shut down all power to the controller. Interlock breaker with cabinet door.

- M. Acceptable Manufacturers: Subject to compliance with requirements:
1. ABB Power Distribution, Inc.
 2. Franklin

2.7 ACCESS PANELS

- A. Manufacturers: Inryco/Milcor, Bilco, Elmdor, Karp, Potter-Roemer or accepted substitute. Inryco/Milcor Style DW, K, or M panels as required by construction.
- B. Construction: Flush style, fire rated in fire rated partitions and ceilings. Provide flush key cylinder locks on all access panels less than 8' above the floor in public spaces. Turn keys over to Owner at project completion. Screwdriver latches on all others. Stainless steel construction when installed in locker area shower room ceilings or restroom walls.

2.8 METERS AND GAUGES

- A. General: Install meters and gauges where shown on the plans or specified elsewhere in these specifications.
- B. Pressure-Temperature Test Plugs:
1. 1/4" or 1/2" NPT fitting of solid brass capable of receiving either an 1/8" OD pressure or temperature probe and rated for zero leakage from vacuum to 1000 psig. Neoprene valve core for temperatures to 200 deg. F., Nordel to 350 deg. F.
 2. Provide for each test plug a pressure gauge adapter with 1/16" or 1/8" OD pressure probe.
 3. Furnish a test kit containing one 2-1/2" dial pressure test gauge of suitable range, one gauge adapter with 1/16" or 1/8" OD probe and two 5" stem pocket test thermometers – one 0 to 220 degrees F and one 50 to 550 degrees F. Turn the kit over to the Architect.
 4. Cisco "P/T Plugs," Peterson "Pete's Plug" or approved substitute.
- C. Thermometers: Dial Bi-metal with adjustable angle, separable sockets, plus 40 to 240 degrees F range (unless indicated otherwise). ASME B 40.3 Grade "A" Accuracy.
- D. Pressure Gauges: Install on suction and discharge of all pumps and where shown on Drawings 4-1/2" dial, 0-100 psig graduation pressure gauges with Ashcroft No. 1106 pulsation dampers and stop cocks. ASME B40.3 Grade "A" Accuracy.

2.9 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: See individual Division 23 sections for valve styles.
- D. Butterfly Valve Operators: Locking lever for shut-off service; "Memory Stop" for lever handle with 10-position throttling plate for throttling service; gear operator with babbitt sprocket rim for chain-operated valves and gear operators on all 8" or larger valves.
- E. Butterfly Valve Style: Lug-type with cap screws for all valves utilized for equipment isolation for servicing. Lug and grooved style valves shall be capable for use as isolation valves and recommended by manufacturer for dead-end service at full system pressure.

- F. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.
- G. Mechanical Actuators: Provide mechanical actuators with chain operators where indicated, where valves 4" and larger are mounted more than 7' above the floor, and where manual operation is difficult because of valve size, pressure differential or other operating conditions. Drop chains to 6'-6" above the floor.
- H. Selection of Valve Ends (Pipe Connections): Select and install valves with ends matching the types of pipe/tube connections.

2.10 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. Seismic pipe support details shall be designed and sized by a professional engineer licensed in the State of Oregon. Design shall comply with ISSC Chapter 16.
- 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 hangers and supports which are copper plated, plastic coated, or by other recognized industry methods.
- 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.

2.11 IDENTIFICATION MARKERS

- A. Pipe Markers:
 1. Adhesive pipe markers of width, letter size and background color conforming to ANSI A13.1.
 2. Acceptable Manufacturers: Brady B946 with arrow banding tape or similar Seaton, Zeston, MSI.
- B. Duct Markers:
 1. Adhesive duct markers 2¼"x14" with black text indicating contents on white background with directional flow arrow.
 2. Acceptable Manufacturers: Brady B946 or similar Seaton, Zeston, MSI.
- C. Nameplates:
 1. Engraved nameplates, 1/16" thick, laminated 3-ply plastic, bottom ply white, outer ply black, letters formed by exposing bottom ply.
 2. Size: 3" by 5" nameplates with 1/4" high letters.
 3. Tags on ceiling grid to be 1" tall with ¼" high letters.
- D. Valve Tags:
 1. 2" diameter, 18-gauge polished brass tags with 3/16" chain hole and 1/4" high stamped, black-filled service designation.
 2. Acceptable Manufacturers: Seaton, Brady, MSI.

2.12 HEAT TRACING

- A. Freeze Protection Heat Cable: Self-regulating tracing cable with braided tinned copper under TPR outer jacket and all necessary accessories including controls (operate whenever OSA temperature is below 32° F), bulb-stat with 3' capillary, junction/power connection kit, pipe straps, power termination kit, end seal caps, etc. Raychem HWAT with DigiTrace EC-TS Controller or equivalent Chromacox, Thermon, Nelson, or approved substitute. System to be powered by 277 voltage power source.

PART 3 - EXECUTION

3.1 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. Sleeves, Inserts, Cast-in-Place Work: Provide sleeves, inserts, anchoring devices, cast-in-place work, etc. which must be set in concrete sequenced at the proper time for the project schedule.
- D. 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. In areas where space is limited and coordination with other trades are required, 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.
 5. Coordinate the integration of the VRV control system into the BAS.
- E. 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.

3.2 UTILITY COORDINATION

- A. Utility Coordination: Coordinate all aspects of the incoming utility services indicated with the city engineer, serving utility, and the off-street improvements contractor. Requirements of the utility company which exceed the provisions made on the Drawings or covered by these Specifications shall take precedence. Provisions made on the Drawings or Specifications in excess of the utility company's requirements shall take precedence. No additional compensation will be allowed the contractor for connection fees or additional work or equipment not covered in the Drawings or Specifications which are a result of policies of the serving utilities.

3.3 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 which mechanical motor starters will be provided under the Electrical Specification Sections and provide all others.

3.4 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 above ceiling in-line pumps and cooling coils. 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. Access Panels: Provide access panels with proper backing reinforcement for all equipment, dielectric unions, valves and items requiring service and installed above ceilings, behind walls, or in furring, complete with correct frame for type of building construction involved. Exact size, number and location of access panels are not necessarily shown on Drawings. Use no panel smaller than 12" by 12" for simple manual access or smaller than 16" x 20" where personnel must pass through.
- E. Adjusting: Adjust and calibrate all automatic mechanical equipment, temperature controls, float devices, etc. Adjust flow rates at each piece of equipment or fixture.
- F. 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.
- G. Housekeeping Pads: Construct minimum 6" 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.

3.5 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.

3.6 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 hangers and supports which are copper plated or by other recognized industry methods.
3. Arrange supports to prevent eccentric loading of joists and joist girders. Locate supports at panel points only.
4. Only use hangers approved for acoustic deck application. See part 2 for specifics.
5. Do not support any devices from lower cord of trusses.

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. PEX Pipe: Maximum hanger spacing and minimum rod diameters as follows:
 - a. Continuous support 1/2" to 4" pipe size B-line B3106V channels with B-line

- B3106 hanger. Lay insulated pipe directly into the channel. For non-insulated CPVC delete channel at fittings or couplings. Insulate PEX and lay pipe and insulation in continuous channel. Secure piping to the channel at intervals between hangers with nylon zip ties. Supports for continuous channel shall match interval of copper pipe supports listed. Lap channels at least 24" to make rigid.
- b. Non-Continuous Support: For branch lines only where transition up or down are required. Support not required within 32" of supply to stop or transition to main.
 - c. Arrange supports to allow free movement, but restrict upward movement of lateral runs so as not to create reverse grade on drainage pipe. Use double bolt clamp or band hanger with restraint (Tolco fig. 25).
- 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 1613 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.

3.7 HVAC SYSTEM IDENTIFICATION

- A. Piping System: Indicate each pipe system by its generic name (abbreviated) as shown/scheduled/specified. Comply with ANSI A13.1 for marker locations, letter sizes, and colors. Include arrows to show direction of flow and "Electric Traced" signs to identify heat cable wrapped piping. Locate pipe labels in accessible areas as follows:
- 1. Near each valve, meter, gauge, or control device.
 - 2. Near equipment such as pumps, heat exchangers, water heaters, etc.
 - 3. At piping branch connections.
 - 4. At penetrations (each side) of walls, ceilings, and floors.
 - 5. At access panels and doors.
 - 6. At 25 foot maximum intervals. Provide a minimum of one label above each room where lift-out ceiling is installed. Reduce intervals in congested areas such as mechanical rooms.
- B. Valve Identification: Tag all valves with brass disc and chain. Prepare valve charts indicating valve number, size, location, function and normal position. Use no duplicate numbers in Plumbing and Heating systems. Mount glazed frames containing one set of valve charts in the building mechanical room.
- C. 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. Provide tags on ceiling grid to denote location of devices

above ceiling requiring service or access.

- D. Operation Tags: Where needed for proper and adequate information on operation and maintenance of mechanical systems, provide tags of plasticized card stock, either pre-printed or hand printed to convey the message; example: "DO NOT CLOSE THIS VALVE EXCEPT WHEN THE PUMP IS OFF."

3.8 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.

3.9 FREEZE PROTECTION ELECTRIC HEAT CABLE INSTALLATION

- A. Selection: Select cable watts/foot of pipe based upon maintaining 38 deg. F pipe temperatures with specified insulation thickness, pipe sizes and outside weather conditions of 20 degrees F and 20 mph wind.
- B. Installation: Install heat cable under the insulation with the recommended number of wraps per foot of pipe and with all necessary accessories and bulb-stat with 3' capillary. Also protect all fittings and valves. Secure cable to piping with cable ties or fiberglass tape. Provide OSA temperature sensor and controls to operate based on OSA temperature.
- C. Electrical: Connect to nearest available power source indicated on the Electrical Drawings. Verify electrical characteristics required.

3.10 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.

3.11 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.

3.12 DEMOLITION AND SALVAGE

- A. Owner shall have first right of refusal for all salvaged control devices and mechanical equipment.
- B. All existing digital control devices no longer used shall be set aside for Beaverton School District to inspect and take as they wish.

- C. All devices, pipes, and materials not desired by Beaverton School District are the property of the Contractor to recycle or dispose of properly off site.
- D. Owner may elect to salvage the refrigerant from the existing chiller to be removed. The Contractor will still be responsible for evacuation as required for demolition.

3.13 MECHANICAL PAINTING

- A. Refer to Section 09 900 Painting for reference to painting of HVAC work.

3.14 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. See Section 23 08 00 for commissioning.
- C. Record Drawings: Submit record set of drawings required in **Division 1** as previously specified in this Section.
- D. 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.
- E. 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

TESTING, ADJUSTING AND BALANCING

PART 1 - GENERAL

1.1 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. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.
- C. 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, Air Introduction & Regulation, Northwest Engineering Services, Neudorfer Engineers, Pacific Coast Air Balancing, or approved.
 - 3. Provide all necessary personnel, equipment, and services.

1.2 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.
- C. See section 23 08 00 for systems to be commissioned.

1.3 SUBMITTALS

- A. Balancing Data: Include the following minimum information in the Operation and Maintenance Data, as specified in Section 23 05 00.
 - 1. Names or initials of personnel performing the balancing.
 - 2. Dates balancing was performed.
 - 3. List of balancing instruments utilized.
 - 4. Weather conditions at the time of the test.
 - 5. Mechanical system descriptions.
 - 6. All motor rated voltages, amps, starter and overload protective device sizes.
 - 7. All motor operating data.
 - 8. Fan cfm, rpm, operating static pressures, driven and motor sheave data, and all drive changes necessitated to obtain design capacities. List actual minimum outside air volumes measured for each system.
 - 9. All supply, return and exhaust air outlet cfm readings.
 - 10. Heating section entering and leaving air temperatures.
 - 11. CO2 controller set points – minimum CO2 setpoint (ppm), maximum CO2 setpoint (ppm)(setting for min OSA at full occupancy).
 - 12. OSA intake damper settings at min CO2 and max CO2 set point.
 - 13. Building pressure at each area.
 - 14. Heat exchanger inlet and outlet conditions.
 - 15. Air side heat exchanger pressure drop.
 - 16. Operate fan systems with VFD's at maximum air flow and minimum air flow (or at airflow for when hood fans are on or off). Record speeds for control contractor and

- balancing.
17. Domestic hot water recirculating pump flow rate and branch balance valve flow rates.

PART 2 - PRODUCTS

-- NOT USED --

PART 3 - EXECUTION

3.1 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.
- C. Hydronic Systems: Adjust to within +/- 10 percent of design.

3.2 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.

3.3 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. For variable air volume system powered units, set volume controller to air flow setting indicated. Confirm connections are properly made and confirm proper operating for automatic variable air volume temperature control. Adjust drives to maximum airflow for highest static condition.

3.4 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities. Coordinate with control contractor to determine pressure setpoint for new differential pressure sensor in new construction.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.5 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. Plumbing pumps
 - 2. HVAC pumps
 - 3. Forced air furnaces
 - 4. Air coils
 - 5. Air handling units
 - 6. Fans
 - 7. Air filters
 - 8. Air terminal units
 - 9. 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. Refrigerant Cooling Coils:
1. Identification/number
 2. Location
 3. Service
 4. Manufacturer
 5. Air flow, design and actual
 6. Entering air DB temperature, design and tested
 7. Entering air WB temperature, design and tested
 8. Leaving air DB temperature, design and tested
 9. Leaving air WB temperature, design and tested
 10. Air pressure drop, design and tested
 11. Saturated suction temperature, design and tested
- F. Heating Section:
1. Identification/number
 2. Location
 3. Service
 4. Manufacturer
 5. Air flow, design and tested
 6. Entering water temperature, design and tested
 7. Leaving water temperature, design and tested
 8. Entering air temperature, design and tested
 9. Leaving air temperature, design and tested
 10. Air pressure drop, design and tested

- G. 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

- H. 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

- I. 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

- J. 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

- K. Terminal Device VRV Unit:
 - 1. Fan airflow
 - 2. Inlet and outlet static pressure
 - 3. See refrigerant coil for coil information required in both heating and cooling mode.

- L. 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

3.6 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. Allow Engineer to witness any tests (up to 25% of the systems). Coordinate when testing work is to be conducted with Engineer to allow scheduling of site visit. Allow two weeks prior to conducting work.
 3. If, in the judgment of the Architect, the discrepancies warrant additional adjustment, readjust and rebalance the systems at no additional project cost.
 4. Balancer to witness all duct quality tests and report results.
 5. Perform balancing work to the satisfaction of and in the presence of commissioning agent.

END OF SECTION

HVAC INSULATION

PART 1 - GENERAL

1.1 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.

1.2 QUALITY ASSURANCE

- A. Insulation Thickness and Thermal Performance: Comply with Chapter 13 provisions of the State of Oregon Structural Specialty Code (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.
- 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.

1.3 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.

1.4 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 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.

2.2 PIPING INSULATION

- A. Pipe Temperatures Minus 30 to 180 Deg. F: Flexible, preformed, pre-slit, self-sealing elastomeric pipe insulation up to 2-1/8" ID, thermal conductivity of 0.27 BTU/hr. sq. ft./in. at 75 deg. F and vapor transmission rating of 0.2 perms/inch. Apply in thickness necessary to prevent condensation on the surface at 85 deg. F and 70% RH. Armstrong "Armaflex 2000" or, in concealed locations, Imcoa or Nomaco also approved.
- B. Exterior Installations: Same as for interior installations except 0.016" aluminum finish jacket.

2.3 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."

2.4 EQUIPMENT INSULATION

- A. Equipment Temperatures Below 70 Deg. F: Flexible, closed cell, elastomeric sheet insulation of 5.5 #/cubic feet density and 0.27 thermal conductivity at 75 deg. F. Armstrong "Armaflex."
- B. Equipment Temperatures From 70 to 450 Deg. F: Glass fiber 3 pound density insulation with a 0.23 thermal conductivity at 75 deg. F. Johns Manville "814 Spin-Glas" with "FSK" jacket or finished as recommended by manufacturer.

2.5 INSULATION ACCESSORIES

- A. Insulation Compounds and Materials: Provide rivets, staples, bands, adhesives, cements, coatings, sealers, welded studs, etc., as recommended by the manufacturers for the insulation and conditions specified except staples not permitted on chilled water lines.
- B. Interior Tanks and Equipment Insulation Covering: Finished metal jacket or as recommended by the manufacturer for insulation material specified.
- C. PVC Protective Jacketing and Valve and Pipe Fitting Covers: Johns Manville Zeston 2000, Proto LoSmoke, or Ceel-Co Ceel-Tite 100 Series with precut fitting fiberglass insulation or approved.
- D. Jacket Lap Sealing Adhesives: Foster Drion 85-75 contact cement or approved substitute.
- E. Saddles and Shields: Unless otherwise indicated and except as specified in piping system specification sections, install the following types:
 - 1. Steel Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 - 2. Protection Shields (MSS Type 40): Of length recommended by manufacturer to prevent crushing insulation.
 - 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe, 360-degree insert of high-density, 100-psi (690-kPa) minimum compressive strength, water-repellent-treated calcium silicate or cellular-glass pipe insulation, same thickness as adjoining insulation with vapor barrier and encased in 360-degree sheet metal shield.

PART 3 - EXECUTION

3.1 PIPING INSULATION

- A. General: Do not insulate underground piping except at joints and fittings on preinsulated piping unless indicated otherwise.
- B. Refrigerant Piping Insulation: Insulate suction piping with minimum 1/2" thick foamed plastic or of thickness necessary to prevent condensation at 85 deg. F and 70% RH. Where possible, slip insulation over the piping as it is installed. Seal all joint and seams.
- C. Pipe Fittings:
 - 1. Insulate and finish all fittings including valve bodies, bonnets, unions, flanges and expansion joints with precut fiberglass insulation and preformed PVC covers sealed to adjacent insulation jacket for continuous vapor barrier covering over all fittings.
 - 2. Provide removable/reusable insulation covers on 4" and larger valves, unions, flanges, pump casings, strainers and similar fittings or equipment requiring periodic service.

- D. Protective Covering: Install continuous protective PVC or metal covering on all piping and fittings in mechanical rooms, accessible tunnels, attic spaces, accessible ceilings, etc., where insulation may be subject to damage. Install with rivets or cement seams and joints.
- E. Insulated Piping: Comply with the following.
 - 1. Maintain continuous insulation except at seismic support. Provide shield at insulation bearing point to support and allow minor thermal expansion.
 - 2. Install MSS SP-58, Type 39 or Type 40 protection saddles, if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN100) and larger if pipe is installed on rollers.
 - 3. Shield Dimensions for Pipe: Not less than the following.
 - a. NPS 1/4 to NPS 3-1/2 (DN8 to DN90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - b. NPS 4 (DN100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
 - c. NPS 5 and NPS 6 (DN125 and DN150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
 - d. NPS 8 and NPS 14 (DN200 and DN350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
 - e. NPS 16 and NPS 24 (DN400 and DN600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
 - 4. Insert Material: Length at least as long as protective shield.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.
- F. Piping Insulation Lap Seams and Butt Joints: Install insulation jacket in accordance with manufacturer's recommendation. Where jacket joint and lap seams have not adhered, remove affected section of insulation and reinstall or apply lap sealing adhesive in accordance with manufacturer's instructions.

3.2 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.
- 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-3.5.
 - 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.

3.3 EQUIPMENT ROOM ITEMS

A. Materials:

1. 1-1/2" calcium silicate blocks applied with wire or bands as required. Finish with 1/2" thick smoothing coat of insulating cement and with glass cloth.
2. For equipment and piping systems operating below 350 deg. F., a 3 pound per cubic foot, 1-1/2" thick spun glass fiber blanket with organic binders and aluminum sheet metal exterior jacket may be substituted for the above insulation.
3. Install tank head finish per manufacturer's recommendations.

END OF SECTION

DDC CONTROLS

PART 1 - GENERAL SYSTEM DESCRIPTION

1.1 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.

1.2 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. (Highland Park currently has an existing NAE 55 control device with both N2 and BACnet network capabilities.)
- E. Existing Johnson Control devices may be re-used if tested confirmed operational and compatible with the new system.

1.3 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 it 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.

1.4 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.

1.5 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.

1.6 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.

- C. Integrate VRV control system. See drawings for minimum points to be displayed on system graphic.

1.7 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.

1.8 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. Supply hard copy.
 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. A set of drawings showing the details of the valve and valve actuator installation for each valve, required for operation and maintenance manuals only. This should include:
- a. Action (normally open or closed)
 - b. Manufacturer make and model
 - c. Cv
 - d. Close off rating
 - e. Flow rate
 - f. Actuator spring range
 - g. Cavitation coefficient (where applicable)
 - h. Special construction features
21. 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 three copies of all 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 hard copy format and on a single Compact Disk (CD). The electronic files on the CD must be submitted in a user editable PDF format, scanned files are unacceptable. Copyrighted factory manuals may be in a PDF file.

1.9 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 pneumatic devices, tubing compressor, air dryer, and wire no longer used.
- B. Remove all digital control devices no longer used.
- C. Owner shall have first right of refusal of all digital control devices, and compressor and air dryer. Gather control devices and secure. Let Owner review devices. Those devices not desired by the Owner are to be recycled or disposed of by the Contractor off site.

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

2.1 BASIC MATERIALS, CONTROL DEVICES, SENSORS

- A. Installation of some of the equipment in this section may be the responsibility of other contractors (see 1.5).
- B. All sensors and equipment related to or connected to the DDC system shall be installed according to manufacturer's recommendations.

2.2 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 with out 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. Electrometalic 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 powder coated. This includes all junction boxes, splice boxes, connectors, etc. Rattle can painted/site painted conduit and devices are not allowed. Provide color sample for Owner approval.
- 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 1/2" 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 3/4" 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.

2.3 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.

2.4 CONTROL DAMPER ACTUATORS

- 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 manufacturers required shut-off torque to achieve the design leakage rate, which ever 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.
8. Actuators for VAV boxes to be provided to VAV manufacturer for installation at the factory.
- 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.
- C. Valve Sizing:
1. Modulating valve sizing shall be based on the following conditions.
 - a. Water Valves:
 - 1) Minimum pressure drop-2 psi or equal to the water side pressure drop of the coil it is associated with, whichever is greater.
 - 2) Maximum pressure drop-3 psi
 - b. Flow rates for valve sizing shall be based upon the flow rates indicated on the equipment schedules on the drawings.
 - c. Valve sizing shall consider the valve cavitation coefficient. In no case shall a valve be sized so that the pressure drop through the valve causes cavitation with fluid temperatures and pressures encountered in the system during start up or normal operation.
 - d. Valves on heating systems to be normally open.
- D. Valves:
1. Equip with custom flow control modulating ball valve.
 2. Two position valves shall be the full size of the pipe that they are associated with unless otherwise specified.
 3. Two-way valve actuators shall be sized to close off tight against the full pump shut off head on the system upon which they are installed.
 4. Three-way valve actuators shall be sized to close off tight in both directions against 2.5 times the valve pressure drop at full flow.
 5. Valves shall close against differential pressures. Water control valves, acting as pressure control or pressure relief valves, shall be capable of closing against a differential pressure equal to 150% of rated pump head of each application.
 6. Spring return is required at heating water valves.
 7. Screwed ends on valves 2-inches and smaller. Flanged ends on valves 2-21/2 inches and larger.
 8. Three-way valves where indicated on drawings, otherwise two-way valves.
- E. Valve Actuators:
1. Electronic actuators shall be manufactured by Belimo for all valves.
 2. Torque shall be rated at twice the required load.
 3. Modulated actuator shall be industry standard 0-10V, floating point is not allowed.

2.5 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 ₂ 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

2.6 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 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. Unless otherwise indicated or specified, provide one discharge and one space temperature sensor for each VAV Terminal Control Unit.
 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.

2.7 AIR PRESSURE SENSORS

- A. Static Pressure and Velocity Controllers:
1. Static pressure sensors shall be of either the diaphragm or rigid element bellows, electronic type, photo helix.
 2. Each sensor shall be provided with connections, i.e., stop cock and tubing, for attaching a portable pressure gauge.
 3. Sensors for mounting on insulated ducts or casings are to be equipped with brackets for mounting clear of the insulation.
 4. The transmitter shall be a two-wire type and provide a 4-20 mA signal which is proportional and linear over the calibrated pressure range.
 5. The transmitter shall be capable of operating from an unregulated 18-30 VDC power supply.
 6. The device housing shall provide 1/4" barbed brass fitting for the connection of the pressure lines. Pressure ranges shall suit the application so that normal operation will occur at mid range of the sensor span.
 7. The location of the indoor measurement shall be remote from doors and openings to the

outside, away from elevator lobbies, and shielded from air velocity effects. See Drawings for location.

2.8 WATER PRESSURE SENSORS

- A. The device shall be capable of withstanding an over pressure of two times its calibrated span without any damage to the sensing element.
- B. Typical ranges: 0-150 psig
- C. The device enclosure shall be a NEMA 4 type and provide rugged mounting feet. All wetted parts shall be stainless steel so that a wide variety of fluids may be measured.
- D. The transmitter shall be capable of operating from an unregulated 18-30 VDC power supply.
- E. Pressure sensors for liquid or pressurized applications shall be installed with shut off valve to that the system must not be shut down or drain to install or service the sensor.

2.9 FREEZE PROTECTION THERMOSTAT

- A. Length: one linear foot of sensing element per square foot of coil or duct area.
- B. Low temperature cutout control, snap acting, normally closed contacts.
- C. Sensing element contacts will open when any 16-inch portion of the element sensing at or lower than setpoint.
- D. Autoreset with manual alarm reset.
- E. Temperature sensing elements shall be thermally isolated from brackets and supports.
- F. Reset temperature 5°F above setpoint.

2.10 TRANSFORMERS

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

2.11 CO₂ 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 CO₂ 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. CO₂ 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.

2.12 WATER FLOW SENSOR

- A. Sensing Method: Electronic impedance sensing with single turbine.
- B. Accuracy: +/-0.5% of reading at calibrated velocity. +/-2% of reading from 0.4 to 20 ft/s.
- C. Pressure Drop: Less than 1 psi at 20 ft/s in 1-1/2" pipe, decreasing in larger pipes and lower

velocities.

- D. Maximum Operating Pressure: 400 psi.
- E. Maximum Liquid Operating Temperature: Standard is 180° F continuous, 200° F peak. Optional is 280° F continuous, 300° F peak. Onicon F-1100 series with analog output.

2.13 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 ration 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

2.14 TIMER SWITCH

- A. Spring wound timer switch with range of 0-12 hours. Intermatic FF Series or equal.

2.15 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.

2.16 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.

PART 3 - DIRECT DIGITAL CONTROLS – HARDWARE

3.1 SYSTEM ARCHITECTURE

- A. The system architecture shall consist of a multi-level Local Area Network (LAN) which supports

Control Units, networked Operator Workstations, and LAN Interface Devices. The following indicates the functional description of the system structure.

1. District Network: Used for communication between JCI Network Controller located in each building, and networked Building Level Controls located in selected building(s). This network will consist of using the World Wide Web with BACnet/IP protocol. BAS/DDC workstation(s) shall employ native BACnet /IP protocol. BACnet TCP/IP Protocol, and/or SNMP Protocol. BAS/DDC workstations shall not require third party routers, gateways or translators.
 2. Primary Controller LAN: Used to connect Primary Control Units (Primary Control Units-which generally control central plant equipment, air handler's boiler plants etc.) within a building. This LAN may be Ethernet 10BaseT (IEEE802.3) or a separate high speed peer-to-peer LAN used in conjunction with an Interbuilding LAN Interface Device. The LAN Interface Device shall employ native BACnet MS/TP on the Ethernet 10BaseT (IEEE802.3) physical layer for connection Building Controller.
 3. Secondary Controller LAN: polling or peer-to-peer LAN to support Terminal Control Units/application specific controllers and interfaces to other third party LANs is acceptable. The Secondary Controller LAN shall interconnect with the Primary Controller LAN using a LAN Interface Device which may or may not be an integral part of a Primary Control Unit.
- B. The Control Contractor shall provide set-up and software for the digital control system and web access on one owner provided rack mount server computer, and one owner provided lap top computer. Rack mounted computer to be located in the server room of the Hatfield Building. Coordinate with Metro IT personnel for access, wiring and standards of installation if more restrictive than these specifications.

3.2 NETWORK CONTROLLER/SUPERVISOR

- A. The Network Controller shall be a fully user-programmable supervisory controller. The Network Controller shall monitor and communicate the network of distributed primary, secondary, application-specific control units, provide global strategy and direction, and communicate on a peer-to-peer basis with other Network Controllers/Supervisors.
- B. Controllers shall be microprocessor-based with a maximum program scan rate of one (1) second. They shall be multi-tasking, multi-user, and real-time digital control processors. Controller size and capability shall be sufficient to fully meet the requirements of this Specification.
- C. Each Network Controller/Supervisor shall support/communicate with a minimum of 100 control units.
- D. Each controller shall have sufficient memory to support its own operating system, databases, and control programs, and to provide supervisory control for all control units. In addition, if memory for historical data trending is not on primary and/or secondary control units, then sufficient memory is required on the network controller to capture and record historical trending data. Memory size shall be at least 1 gigabyte.
- E. Network Controller/Supervisor speed shall be between 300 bps to 115K bps.
- F. Network Controller/Supervisor shall interact with printers, pagers, and host workstations.
- G. The controller shall have an integrated real-time clock.
- H. Error detection, correction, and re-transmission to guarantee data integrity. (Optional. Low cost is of greater importance.)
- I. The NC shall provide at least one Ethernet port 10/100 mdps, one RS-232/485 port. Controllers shall allow temporary use of portable devices without interrupting the normal operation.

- J. The NC shall support standard Web browser access via the Internet. It shall support a minimum of 15 simultaneous users.
- K. The NC shall provide alarm recognition, storage, routing, management and analysis to supplement distributed capabilities of equipment or application specific controllers.
- L. The NC shall be able to route any alarm condition to any defined user location whether connected to a local network or remote via dial-up, telephone connection, or wide-area network.
 - 1. Alarm generation shall be selectable for annunciation type and acknowledgement requirements including but not limited to:
 - a. Alarm,
 - b. Return to normal,
 - c. To default.
 - 2. Alarms shall be annunciated in any of the following manners as defined by the user:
 - a. Screen message text,
 - b. Email of complete alarm message to multiple recipients.
 - c. Pagers via paging services that initiate a page on receipt of email message.
 - d. Graphics with flashing alarm object(s).
 - 3. The following shall be recorded by the NC for each alarm (at a minimum):
 - a. Time and date
 - b. Equipment (air handler #, accessway, etc.)
 - c. Acknowledge time, date, and user who issued acknowledgement.
- M. Programming software and all controller "Setup Wizards" shall be embedded into the NC.
- N. 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.
- O. 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.
 - 1. During a loss of normal power, the control sequences shall go to the normal system shutdown conditions.
 - 2. 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.
 - 3. Should a controller memory be lost for any reason, the operator workstation shall automatically reload the program without any intervention by the system operators.

3.3 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.

3.4 SECONDARY CONTROL UNITS

- A. Secondary control units are able to control HVAC equipment per specified by the sequence of

operation.

1. Each controller shall be capable of performing specified control functions. The secondary control unit shall directly control all units, fans, dampers and control devices. All control software shall be implemented in the secondary control unit. The sequence of operation precisely identifies all points of monitoring and control.
2. Each controller shall monitor specific analog and digital inputs, process the data received, and produce analog or digital outputs to control the systems specified.

B. Minimum specifications include:

1. Microprocessor-based controllers, fully equipped with power supply, input and output terminals.
2. Modular multi tasking based direct digital controller with minimum of 2048 bytes of EEPROM and RAM memory.
3. Minimum 8 bit Analog-to-Digital (A/D) converter.
4. Minimum 10 bit Digital-to-Analog (D/A) converter.
5. Controllers shall have unused physical points available for future add-ons. The number of spare points shall equal 20% (20% AI, 20% AO, 20% BI, 20% BO) of all physical points or two spare points whichever is greater.
6. Shall include all control strategies listed in "Part 4: DDC Software."
7. Each control loop shall be fully definable in terms of inputs and outputs that are a part of the control strategy.
8. Each secondary control unit shall be equipped with a USB communication interface connection, minimum of 16 universal analog or digital inputs or outputs, and shall communicate via the LAN to the network front end. 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.
9. 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, in a ventilated control panel or as approved by the Engineer.

C. Secondary control unit. Secondary control units are microprocessor-based devices that are less programmable and will be used on:

1. Small unitary equipment (flow rate less than 2,000 CFM)
2. Fan coil units

3.5 APPLICATION SPECIFIC CONTROL UNITS

A. Pressure Independent VAV Terminal Unit Controller

1. General
 - a. Controls shall be microprocessor based Pressure Independent Variable Air Volume Terminal Unit Controllers (VTC). The VTC shall be based on a minimum 8-bit microprocessor working from software program memory that is physically located in the VTC. The VTC controller "intelligence" shall be resident within the same enclosure that translates sensor signals into digital information.
 - b. The VTC shall consist of microprocessor, power supply, enclosure, pressure transducer, field terminations, field adjustments, and operating/application system software in a single integrated package. Device shall operate remote Belimo damper actuator and valve actuator.
 - c. All input/output signals shall be directly hardwired to the VTC. Troubleshooting of input/output signals shall be easily executed with a volt/ohm meter (VOM) or hand-held operator interface device or laptop.
2. Non-Volatile Memory
 - a. All control sequences programmed in the VTC shall be stored in non-volatile memory which is not dependent upon the presence of a battery to be retained.
 - b. Power failures shall, therefore, not cause the VTC memory to be lost, nor shall there be any need for batteries to be recharged or replaced.

3. Controller Location: To simplify controls, mechanical service and troubleshooting, all components of the VTC shall be mounted directly at the Variable Air Volume terminal box. This shall allow all controls maintenance and troubleshooting to be made while at the VTC zone location. Enclosure assembly shall be mounted and positioned so that it is easily accessible to operational personnel.
 - a. The VTC shall be powered by a 24 VAC power source and shall comply with Class 2 wiring requirements.
 - b. For compatibility with the environment of a VAV terminal box, the VTC shall have wide ambient ratings for specified controls, sequences, and performance. VTC shall be rated for service from 40°F to 140°F.
 - c. Contractor shall submit description of location of VTC on VAV terminal box.
 - d. For compatibility of use in the supply or return air plenum, the VTC enclosure shall be constructed to comply with the requirements of UL-465.
4. Transducer
 - a. Each VTC shall contain an integral flow transducer capable of measuring and controlling over a 0.05 to 2.00 WC range with an accuracy of +6% at full rated flow.
 - b. Flow transducer shall contain an automatic recalibration circuit that eliminates transducer error due to temperature variations and long-term sensor drift.
 - c. VAV box controllers not meeting this specification shall include their bid price the cost of sensor recalibration to factory tolerance on a quarterly basis for a minimum period of three years.
5. Actuator Operation
 - a. Each VTC shall be capable of operating on VAV terminal boxes that require clockwise or counterclockwise primary damper operation.
 - b. All actuators shall provide a proportional signal over the entire control range.
 - c. Actuators shall stop automatically at end of travel and shall include a permanently lubricated gear train.
 - d. Interface to the VAV terminal box shall be directly to the damper shaft or through electrical connection to an existing 24 VAC bi-directional motor operator.
 - e. All actuators shall be Belimo. None others will be accepted.
6. Operational Features
 - a. Each VTC shall have a discharge temperature sensor that provides data to the BAS.
 - b. Each VTC shall support the setup of the minimum and maximum flow setpoints, the cooling setpoint as well as the heating or parallel fan start point setpoints without the need for a separate hand-held communications device. In addition, the configuration modes described earlier in this specification must also be definable at the VTC without requiring an external hand-held communications device.
 - c. The set-up of the above parameters shall be permanent in the VTC, a power failure shall not require the reconfiguration of the VTC operating parameters.
7. BAS Communication/Control With VTC application control unit: BAS shall be in continual direct communication with the VTCs implemented in the facility. VTCs shall perform all control as specified in control functions for the respective VAV terminal box.

PART 4 - DIRECT DIGITAL CONTROLS – SOFTWARE

4.1 SYSTEM SOFTWARE

- A. Stand-alone Digital Controller (SDC) Software:
 1. All Stand-alone controllers shall have as a standard feature, a complete library of control algorithms for DDC, Energy Management, and Facilities Management functions. These resident libraries of algorithms shall be drawn from for the creation of the application programming of each individual controller.
 2. Contractor shall provide a blueprint documentation of the software application program for each controller. Documentation provided shall include block software flowchart

- showing the interconnection between each of the control algorithms and sequences.
3. For systems utilizing program listings: A program listing shall be printed onto the same blueprint, along with the program flowchart, and description of the sequence of operation. This blueprint shall be stored and maintained in each controller.
 4. System acceptance shall not be completed until this documentation is provided.
 5. The stand-alone software library shall include as a minimum, the following programs:
 - a. Direct Digital Control Functions:
 - 1) Setpoint Reset
 - 2) Ramp
 - 3) Floating ON/OFF
 - 4) 2-Position ON/OFF
 - 5) PID Loop
 - 6) Self-tune PID Loop
 - 7) Linear Sequencer
 - 8) Rotating Sequencer
 - 9) Binary Sequencer
 - 10) High/Low Select
 - 11) Energy Dead Band
 - 12) Thermostat
 - b. Energy Management Control Functions:
 - 1) Duty Cycle
 - 2) Temperature Compensated Duty Cycling
 - 3) Optimum Start/Stop
 - 4) Electric Demand Limiting
 - 5) Weekly Scheduling
 - 6) Calendar Scheduling
 - 7) Enthalpy Changeover
 - c. Math and Logic Functions:
 - 1) Add
 - 2) Subtract
 - 3) Multiply
 - 4) Divide
 - 5) Square root
 - 6) and, or, xor, nand, nor
 - 7) Invert
 - 8) Averaging
 - 9) Summation
 - 10) Totalize
 - 11) Pulse Count Conversion
 - 12) Time Delay
 - 13) Sensor Curve Fit
 - 14) CFM Calculation
 - 15) BTUH Calculation
 - d. Facilities Management Functions:
 - 1) Analog High/Low Alarm
 - 2) Digital Alarm
 - 3) Trend Log Reporting
 - 4) Daily EMS Report
 - 5) Monthly EMS Report
 - 6) Maintenance Time Reminders
 - 7) BTUH Trend
 - e. HVAC Application Functions:
 - 1) Constant Volume Single Zone
 - 2) Heat Pump
 - 3) Multizone
 - 4) Variable Air Volume (Dual & Single Fan VAV Systems)
 - 5) Fan Tracking VAV
 - 6) Boiler Optimization

- 7) Chiller Optimization
 - 8) MICROFLO /TM/ Interface
 - 9) MICROZONE /TM/ Interface
 - 10) Supply Air Optimization
 - 11) Hot Deck Optimization
 - 12) Cold Deck Optimization
6. Stand-alone controllers not capable of performing the above listed software programs without the host computer will not be acceptable. Programs must be maintained regardless of communication with the host computer.
 7. Programs shall be provided as required to meet the sequence of operation as specified.
 8. All programming resident to the stand-alone controller, including but not limited to, application programs and point database, shall be protected from loss due to power failure for a minimum of six months. Systems not providing nonvolatile memory shall provide battery backup sufficient to provide protection for six months.

4.2 SYSTEM OVERVIEW

- A. The BAS Contractor shall provide system software based on server/thin-client Engineer, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP/IP. Server shall be accessed using a web browser over Owner network and remotely over the Internet.
- B. The intent of the thin-client Engineer is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support Microsoft and Netscape Navigator browsers (6.0 or later versions), and Windows as well as non-Windows operating systems. No special software, other than free public domain programs such as "JAVA VIRTUAL MACHINE" shall be required to be installed on PC's used to access the BAS via a web browser.
- C. The BAS server software must support at least the following server platforms (Windows, and/or Linux). The BAS server software shall be developed and tested by the manufacturer of the system stand-alone controllers and network controllers/routers.
- D. The web browser GUI shall provide a completely interactive user interface and must offer and be configured with the following features as a minimum:
 1. Trending
 2. Scheduling
 3. Electrical demand limiting
 4. Duty Cycling
 5. Downloading Memory to field devices
 6. Real time 'live' Graphic Programs
 7. Tree Navigation
 8. Parameter change of properties
 9. Setpoint Adjustments
 10. Alarm / Event information
 11. Configuration of operators
 12. Execution of global commands
 13. Add, delete, and modify graphics and displayed data
- E. Software Components: All software shall be the most current version. All software components of the BAS system software shall be provided and installed as part of this project. BAS software components shall include:
 1. Server Software, Database and Web Browser Graphical User Interface
 2. System Configuration Utilities for future modifications to the system, and controllers.
 3. Graphical Programming Tools
 4. Direct Digital Control software
 5. Application Software
 6. Any required third party software

7. If licensing credits are required provide a minimum of 10% additional to as built control system requires.
- F. BAS Server Database: The BAS server software shall utilize a Java DataBase Connectivity (JDBC) compatible database such as: MS SQL 8.0, Oracle 8i or IBM DB2. BAS systems written to Non -Standard and/or Proprietary databases are NOT acceptable.
- G. Database Open Connectivity: The BAS server database shall allow real time access of data via the following standard mechanisms:
 1. Open protocol standard like SOAP
 2. OLE/OPC (for Microsoft Client's/Server platform only)
 3. Import/Export of the database from or to XML (eXtensible Mark-up Language)
- H. Communication Protocol(s): The native protocol for the BAS server software shall be TCP/IP over Ethernet. Proprietary protocols over TCP/IP are NOT acceptable.
- I. Thin Client – Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
 1. Web Browser's for PC's: Only a 5.5 or later browser (Explorer/Navigator) will be required as the GUI, and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.
 2. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).

4.3 WEB BROWSER GRAPHICAL USER INTERFACE

- A. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic setpoint controls, configuration menus for operator access, reports, and reporting actions for events.
- B. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and password. Navigation in the system shall be dependent on the operator's role privileges, and geographic area of responsibility.
- C. Navigation: Navigation through the GUI shall be accomplished by clicking on appropriate level of a navigation tree (consisting of expandable and collapsible tree control like Microsoft's Explorer program), and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment, and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
- D. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
- E. Groups View shall display Scheduled Groups and custom reports.
- F. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).
- G. Action Pane: The Action Pane shall provide several functional views for each HVAC or mechanical/electrical subsystem specified. A functional view shall be accessed by clicking on the

corresponding button:

1. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic setpoint controls, web content, and other valid HTML elements. The data on each graphic page shall automatically refresh.
 2. Graphic pages for viewing at workstations and smart devices shall differ. Smart device graphics shall be more condensed for viewing on these types of devices. Provide an option upon entering the system from a smart device for viewing full graphics version or just the smart version.
 3. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
 4. Schedules: Shall be used to create, modify/edit and view schedules based on the systems geographical hierarchy (using the navigation tree).
 5. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
 6. Trends: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling
 7. Logic - Live Graphic Programs: Shall be used to display 'live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
 8. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.
- H. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to setpoints and comfort. Animated .gifs or .jpg, vector scalable, active setpoint graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:
1. Display Size: The GUI workstation software shall graphically display in 1024 by 768 pixels 24 bit True Color.
 2. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
 3. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective setpoints. The colors shall be updated dynamically as a zone's actual comfort condition changes.
 4. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
 5. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
 - a. Each piece of equipment monitored or controlled including each terminal unit
 - b. Each building
 - c. Each floor and zone controlled
- I. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with password access) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day 'Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the 'Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.
1. Schedules: Schedules shall comply with the LonWorks standards, (Schedule Object,

- Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
- a. Types of schedule shall be Normal, Holiday or Override
 - b. A specific date,
 - c. A range of dates,
 - d. Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any)
 - e. Wildcard (example, allow combinations like second Tuesday of every month).
2. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of “things” to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
 3. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ‘individual tenant’ group – who may occupy different areas within a building or buildings. Schedules applied to the ‘tenant group’ shall automatically be downloaded to control modules affecting spaces occupied by the ‘tenant group’
 4. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler, and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
 5. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
 6. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules, and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.
- J. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ‘Alarms’ view. Alarms, and reporting actions shall have the following capabilities:
1. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report, and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
 2. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
 3. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
 4. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
 5. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
 6. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A ‘network’ view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type

- of Acknowledgement and notification for return to normal or fault status.
7. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement, and total number of Alarms in the BAS Server database.
 8. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
 9. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
 - a. Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
 - b. Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
 - c. File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
 - d. Write Property: The write property reporting action updates a property value in a hardware module.
 - e. SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
 - f. Run External Program: The Run External Program reporting action launches specified program in response to an event.
- K. Trends: Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.
1. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
 2. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
 3. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
 4. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
 5. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and 'pan through' historical data by simply scrolling the mouse.
 6. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
 7. Copy/Paste. The operator must have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).
- L. Security Access: Systems that Security access from the web browser GUI to BAS server shall require a Login Name and Password. Access to different areas of the BAS system shall be defined in terms of Roles, Privileges and geographic area of responsibility as specified:
1. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of 'easily understood English language' privileges. Roles shall be defined

in terms of View, Edit and Function Privileges.

- a. View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
 - b. Edit Privileges shall comprise: Setpoint, Tuning and Logic, Manual Override, and Point Assignment Parameters.
 - c. Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print, and Alarm/Event Maintenance.
2. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

4.4 GRAPHICAL PROGRAMMING

- A. The system software shall include a Graphic Programming Language (GPL) for all DDC control algorithms resident in all control modules. Any system that does not use a drag and drop method of graphical icon programming shall not be accepted. All systems shall use a GPL is a method used to create a sequence of operations by assembling graphic microblocks that represent each of the commands or functions necessary to complete a control sequence. Microblocks represent common logical control devices used in conventional control systems, such as relays, switches, high signal selectors, etc., in addition to the more complex DDC and energy management strategies such as PID loops and optimum start. Each microblock shall be interactive and contain the programming necessary to execute the function of the device it represents.
- B. Graphic programming shall be performed while on screen and using a mouse; each microblock shall be selected from a microblock library and assembled with other microblocks necessary to complete the specified sequence. Microblocks are then interconnected on screen using graphic "wires," each forming a logical connection. Once assembled, each logical grouping of microblocks and their interconnecting wires then forms a graphic function block which may be used to control any piece of equipment with a similar point configuration and sequence of operation.
- C. Graphic Sequence: The clarity of the graphic sequence must be such that the operator has the ability to verify that system programming meets the specifications, without having to learn or interpret a manufacturer's unique programming language. The graphic programming must be self-documenting and provide the operator with an understandable and exact representation of each sequence of operation.
- D. GPL Capabilities: The following is a minimum definition of the capabilities of the Graphic Programming software:
 1. Function Block (FB): Shall be a collection of points, microblocks and wires which have been connected together for the specific purpose of controlling a piece of HVAC equipment or a single mechanical system.
 2. Logical I/O: Input/Output points shall interface with the control modules in order to read various signals and/or values or to transmit signal or values to controlled devices.
 3. Microblocks: Shall be software devices that are represented graphically and may be connected together to perform a specified sequence. A library of microblocks shall be submitted with the control contractors bid.
 4. Wires: Shall be Graphical elements used to form logical connections between microblocks and between logical I/O.
 5. Reference Labels: Labels shall be similar to wires in that they are used to form logical connections between two points. Labels shall form a connection by reference instead of a visual connection, i.e. two points labeled 'A' on a drawing are logically connected even though there is no wire between them.
 6. Parameter: A parameter shall be a value that may be tied to the input of a microblock.
 7. Properties: Dialog boxes shall appear after a microblock has been inserted which has editable parameters associated with it. Default parameter dialog boxes shall contain various editable and non-editable fields, and shall contain 'push buttons' for the purpose

- of selecting default parameter settings.
8. Icon: An icon shall be graphic representation of a software program. Each graphic microblock has an icon associated with it that graphically describes its function.
 9. Menu-bar Icon: Shall be an icon that is displayed on the menu bar on the GPL screen, which represents its associated graphic microblock.
 10. Live Graphical Programs: The Graphic Programming software must support a 'live' mode, where all input/output data, calculated data, and setpoints shall be displayed in a 'live' real-time mode.

PART 5 - SYSTEM SETUP

5.1 RESPONSIBILITIES OF INSTALLER AND PROGRAMMER

- A. This section further defines the responsibilities of the installer and programmer.
- B. The following features shall be incorporated into the final delivered product.
- C. System shall allow up to five (5) different remote (wet base) viewers to access and modify data (level 1 access) at the same time.

5.2 PASSWORDS

- A. Provide four password levels:
 1. Level 1: Full access to change programming code and all variables.
 2. Level 2: Access limited to changing any adjustable parameter (e.g., fan status). Level 2 access shall allow the operator to perform the following commands including, but not limited to:
 - a. Start-up or shutdown selected equipment
 - b. Adjust setpoints
 - c. Add/Modify/Delete time programming
 - d. Enable/Disable process execution
 - e. Lock/Unlock alarm reporting for each point
 - f. Enable/Disable Totalization for each point
 - g. Enable/Disable Trending for each point
 - h. Enter temporary override schedules
 - i. Define Holiday Schedules
 - j. Change time/date
 - k. Enter/Modify analog alarm limits
 - l. Enter/Modify analog warning limits
 3. Level 3: Access limited to changing room temperature setpoints and override operation.
 4. Level 4: User is only able to view data on screen.
- B. Programmer will not provide owner level 1 high clearance passwords until job has been accepted.

5.3 POINTS

- A. All points (DI, DO, AI, and AO) will have unique alphanumeric names and addresses. Installer and programmer will determine: scanning frequency (rate), units, scaling factors, high and low alarm values, alarm differentials, default values, and ranges in coordination with engineer and Owner staff.
- B. Provide the following minimum programming for each analog input:
 1. Name
 2. Address
 3. Scanning frequency
 4. Engineering units
 5. Offset calibration and scaling factor for engineering units
 6. High and low alarm values and alarm differentials for return to normal condition

7. High and low value reporting limits (reasonableness values) which shall prevent control logic from using shorted or open circuit values.
 8. Default value to be used when the actual measured value is not reporting. This is required only for points that are transferred across the primary and/or secondary networks and used in control programs residing in control units other than the one in which the point resides. Events causing the default value to be used shall include failure of the control unit in which the point resides, or failure of any network over which the point value is transferred.
 9. Selectable averaging function which shall average the measured value over a user selected number of scans for reporting.
- C. Provide the following minimum programming for each analog output:
1. Name
 2. Address
 3. Output updating frequency
 4. Engineering units
 5. Offset calibration and scaling factor for engineering units
 6. Output Range
 7. Default value to be used when the normal controlling value is not reporting.
- D. Provide the following minimum programming for each digital input:
1. Name
 2. Address
 3. Scanning frequency
 4. Engineering units (on/off, open/closed, freeze/normal, etc.)
 5. Debounce time delay
 6. Message and alarm reporting as specified.
 7. Reporting of each change of state and memory storage of the time of the last change of state.
 8. Totalization of on time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
- E. Provide the following minimum programming for each digital output:
1. Name
 2. Address
 3. Output updating frequency
 4. Engineering units (on/off, open/closed, freeze/normal, etc.)
 5. Direct or Reverse action selection
 6. Minimum on time
 7. Minimum off time
 8. Status association with a DI and failure alarming (as applicable)
 9. Reporting of each change of state and
 10. Reporting of memory storage of the time of the last change of state.
 11. Totalization of on time (for all motorized equipment status points), and accumulated number of off-to-on transitions.
 12. Default value to be used when the normal controlling value is not reporting.

5.4 ALARM MANAGEMENT

- A. Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, to minimize network traffic, and to prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.
- B. Point Change Report Description
1. All alarm or point change reports shall include the point's English language description,

and the time and date of occurrence.

- C. Prioritization
 - 1. The installer shall set up all system analog points with high and low alarm limits. All digital system points shall be associated with a status feedback point and all exceptions shall be reported as alarms. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized and filtered to minimize nuisance reporting and to speed operator response to critical alarms.
 - 2. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.
- D. Critical and Non-Critical Alarm Routing
 - 1. Critical alarms shall be defined as major equipment failure such as chiller, boiler, large air-handler, critical space temperature or others requested by the owner. Critical alarms shall be displayed at the workstation.
 - 2. All other alarms shall be considered non-critical and shall be auto acknowledged and then sent to the alarm log.
- E. Report Routing
 - 1. Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.
- F. Alarm Messages
 - 1. In addition to the point's descriptor and the time and date, the user shall be able to print, display, or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.
 - 2. Each standalone DDC panel shall be capable of storing a library of at least 250 Alarm Messages. Each message may be assignable to any number of points in the panel.
 - 3. Alarm state for individual points shall be displayed on operator workstations as "NORMAL" or "ALARM".

5.5 DATA TRENDING

- A. Data trending will be set for the start-up period and after system acceptance.
- B. Date trended during system start-up and before system acceptance shall include all real and virtual data points. Data will be collected and stored every one minute unless otherwise noted on blueprints or in appendices.
- C. Establish data trended (every 15 minutes) of the following points after system acceptance:
 - 1. Outside Air Temperature
 - 2. Outside Air Enthalpy
 - 3. Occupancy schedule
 - 4. For each air handler
 - a. On/Off status
 - b. Damper position (as determined by BAS)
 - c. Damper Output Signal
 - d. Damper position (as determined from actuator output)
 - e. Cooling Setpoint
 - f. Heating Setpoint
 - g. Discharge Air Temperature for each zone
 - h. Discharge Air Temperature setpoint for each zone
 - i. Mixed Air Temperature
 - j. Mixed Air Temperature setpoint
 - k. Return Air Temperature
 - l. Return Air Enthalpy

- m. Heating valve
- n. DX status or cooling value
- o. DX stages if applicable
- 5. Space Temperatures and temperature setpoints
- 6. Percent heating and Cooling Load for each zone

D. All data will be saved on the hard drive for at least one year.

5.6 SCHEDULES

A. Schedule will be installed using time parameters provided by owner or obtained on drawings.

5.7 DYNAMIC ANIMATED COLOR GRAPHIC DISPLAYS

A. Color graphic floor plan display's and system schematic's for each piece of mechanical equipment (including air handling units, variable air volume boxes, fan coils, unit ventilators, cabinet heaters, exhaust fans, fin tube radiation, chilled water systems, hot water boiler systems, and so forth) shall be provided as specified in the point list portion of this Specification. The Controls Contractor shall fully configure the color graphics and plot all associated control/monitoring points on the screen. Samples of all color graphics screens shall be provided to the Owner for approval.

B. System Selection/Penetration

- 1. The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or test-based commands. Floor plans shall display room numbers and each zone shall be color-coded. The operator shall be able to point and click on a room or zone of rooms (in the case of an air handler that serves more than one zone). The room or zone will display an animated flow diagram of the mechanical equipment that serves that zone, with all control and monitoring points associated with that piece of equipment, including setpoints. Operator shall be able to override or modify setpoints from this screen.

C. Dynamic Animated Data Displays

- 1. Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention. Damper and valve positions, air and water flow shall be animated and shall represent actual, current conditions.

D. System Performance Analysis Screens

- 1. System performance analysis screens shall be provided for the major mechanical systems (such as air handlers, chillers, boilers, and so forth.). For each of these systems, the screen shall be split into quadrants, simultaneously displaying the following data:
 - a. Quadrant 1. – Dynamic animated flow diagrams.
 - b. Quadrant 2. – All analog values associated with the mechanical system shall be graphed on an X-Y axis graph. Five-minute samples for the last twenty-four hour period shall plotted. Scaling shall be automatic.
 - c. Quadrant 3. – Text sequence of operations from engineering as-built submittals.
 - d. Quadrant 4. – Space temperature summaries from each zone being served by mechanical system.

E. Windowing

- 1. The windowing environment of the PC Operator Workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

F. Alarm Annunciation

- 1. Any point in a state of alarm shall change the color of its symbol to red until it is no longer in alarm. This alarm shall be carried up each level of graphics to the main screen

you see after log in.

- G. On each system graphic provide a button to open the associated sequence as a PDF file.

5.8 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 ₂ sensors	20 PPM
Current Sensor	0.1 kW

5.9 OVERRIDES

- A. The DDC system should recognize the override and report to the screen and the printer.
- B. The manual overrides for all system shall be in one location as specified by the Engineer.
- C. Software shall have adjustable time limits for each override.
- D. Provide override switches (see drawings for location of panel for each unit). Each momentary switch with lockout and light (green for “on,” red for “off”) to activate an override of unit(s) as programmed through software. Each override to have adjustable time setting and revert to previous mode of operation at time’s end.

5.10 SAFETY CIRCUITS

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

5.11 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 6th, 7th, and 8th grade level facilities that do not serve the lower grades. **BSD-HS** will be the reference used for all facilities serving 9th 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)

5.12 REPORTS

- A. At a minimum, the system shall allow the user to easily print the following types of reports.
 - 1. General listing of all points in the network
 - 2. List of user accounts and access levels
 - 3. List of all points currently in alarm
 - 4. List of all off-line points
 - 5. List of all points currently in override status
 - 6. List of all disabled points
 - 7. List of all points currently locked out
 - 8. List of all Weekly Schedules
 - 9. List of all Holiday Programming
 - 10. List of Limits and Deadbands, throttling ranges, gains, etc.
 - 11. List of all adjustable and virtual points.

5.13 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 that 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.

6.1 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.

6.2 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 +/-0.5% accurate, test equipment shall be +/-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: ± 0.5 degrees F
 - b. Water temperature: ± 1 degrees F
 - c. Duct pressure: ± 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.

6.3 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 dampers unless waived by owner. Failure or delays on engineers / owners part shall not be included in 120 day count.

6.4 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.

6.5 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.

6.6 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.
 - 4. Maintenance Training: The system maintenance course shall be taught at the project site within one month after the completion of the operators training. The course shall last for one 8-hour training day. The course shall include answering questions from the last training session, trouble shooting and diagnostics, repair instructions, preventive maintenance procedures and schedules, and calibration procedures.
 - 5. Include this section at Owner's discretion. Modify as appropriate to project size.
 - a. Formal Institute Training: This project includes all costs associated with training for 2 students at the manufacturers formal training institute. The training

shall extend for a 40-hour work week and be conducted by professional instructors. The instructors shall submit a report to the supervisor of the attendee on the performance at the training institute. The Owner shall have the right to choose the appropriate course for their employees as long as they meet prerequisite qualifications.

END OF SECTION

SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 - GENERAL

1.1 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

2.1 NO PRODUCTS LISTED FOR THIS SECTION

PART 3 - EXECUTION

3.1 SEQUENCE OF OPERATIONS

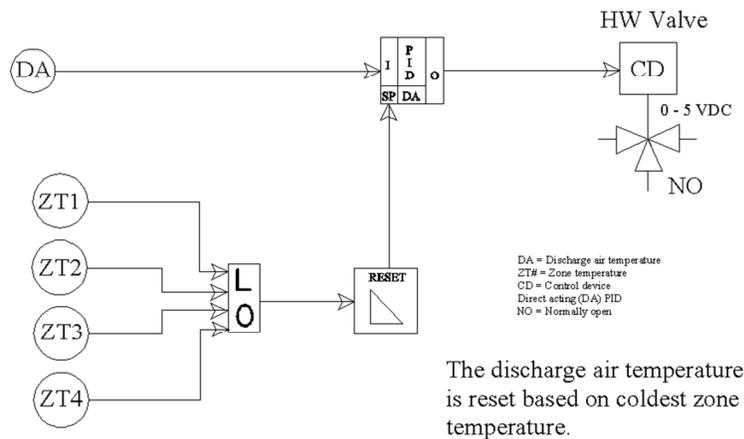
- A. Provide a complete and operational temperature control and building automation system based on the following points and sequence of operation, complete as to sequences and standard control practices. The determined point list is the minimum amount of points that are to be provided. Provide any additional 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

4.1 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



STANDARDIZATION

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

4.3 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.

4.4 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 re-cooled.
- 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 CO₂ 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.

4.5 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.

4.6 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.

4.7 EXISTING SEQUENCES

- A. Modify existing heating and ventilation sequences at constant volume air handlers to include operation of the new chilled water coil or split system DX cooling system. Include sequences for cooling operation with economizer.
- B. During OSS cooling valve to be closed or system to be disabled.
- C. Cooling Operation:
 - 1. During occupied mode (and night high limit and cool-down modes), cooling valve shall modulate in sequence with economizer dampers to maintain discharge temperature setpoint.
 - 2. Mechanical cooling shall remain off when heating section is operating and during warm-up, night low limit, as well as during night purge mode.
 - 3. Mechanical cooling shall operate only after discharge air temperature cannot be maintained for two [2] minutes when discharge air temperature is 1°F (adjustable) above setpoint and economizer has been operational.
 - 4. Mechanical Cooling shall not operate when outside air temperature is below 50° F (adjustable).
- D. Night High Limit:
 - 1. During the unoccupied mode, the night high limit will be enabled if:
 - a. Any space temperature rises above the high limit setpoint (initial, 85°F, adjustable).
 - 2. Once enabled, the night high limit will:
 - a. Start system supply and exhaust fans.
 - b. Initiate Night purge mode (independent of actual clocktime)
 - c. If night purge fails (either initially or within three hours of initiation or within 1 hour of occupancy period), initiate mechanical cooling with economizer (and set mixed air temperature to minimum value of 48°F, initial, adjustable).
 - 3. When all spaces served by the system are below setpoint minus differential (initial 3°F, adjustable), the system will revert to the unoccupied mode.
- E. At Fan coil units without condensate drainage and Air handlers serving spaces with split system DX cooling systems close coil valve to prevent chilled water from entering the heating only coils and condensing.
- F. Where multiple combination heating and cooling function duct mounted zone coils take the place of a single air handler mounted coil operate duct coils to maintain space temperature or discharge air temperature set-point per current sequence.
- G. Kitchen Operation:
 - 1. EF-16 (kitchen exhaust fan) shall be disabled when EF-2 (grease exhaust fan) is enabled.
 - 2. CO₂ control (if present) at AH-2 to be overridden. Operate outside air damper to 100% open to provide make-up air for EF-2 operation.

4.8 SEQUENCE OF OPERATION – CONSTANT VOLUME MULTI-ZONE AIR SUPPLY UNIT WITH HOT AND CHILLED WATER COILS

- A. Space Temperature Setpoints: Existing Sequence to remain.
- B. Hot Deck Discharge Air Temperature Setpoint Reset: Existing Sequence to remain.
- C. Cold Deck Discharge Air Temperature Setpoint Reset: Setpoint shall reset based on the maximum

zone cooling demand proportional/integral (PI) control value. Setpoint reset is based on the following schedule.

Cold Deck Reset Schedule	
Maximum Zone Cooling Demand (%)	Cold Deck Temperature Setpoint (F)
100	55
0-10	65

- D. Mixed Air Temperature Setpoint Reset (Occupied Mode Only): Mixed air temperature set point shall reset based on the cold deck discharge air temperature setpoint. Reset mixed air temperature 2°F below the cold deck temperature setpoint.
- E. Supply Fan Control: Existing Sequence to remain.
- F. Return Fan Control: Existing Sequence to remain.
- G. Heating Valve Control: Existing Sequence to remain.
- H. Cooling Valve Control:
 - 1. Occupied Mode: Cooling valve shall modulate to maintain cold deck temperature setpoint.
 - 2. Unoccupied, Night Low Limit, Night High Limit, Optimal Start, Night Purge and Low Limit Freeze Modes: Cooling valve to modulate fully closed.
 - 3. Cooling Valve Lockout: Cooling valve shall not modulate when the outside air temperature is below 55 °F (Adjustable) or the maximum zone cooling demand is less than 10% (adjustable). When ambient conditions allow for economizing, cooling valve operation shall be locked out until the economizer damper position maintains 100% for five (5) minutes (adjustable) or economizer operation is disabled as described in the economizer damper control sequences.
 - 4. Low Limit Control: If the minimum hourly outside air temperature is less than 32°F (adjustable) and the system is unoccupied, modulate cooling valve fully open. Also see cooling system sequences regarding this sequence.
- I. Economizer Control: Existing Sequence to remain.
- J. Zone Damper Control: Existing Sequence to remain.
- K. Optimal Start Control (Heating Mode): Existing Sequence to remain.
- L. Night Low Limit Mode: Existing Sequence to remain.
- M. Night High Limit Mode:
 - 1. Night high limit mode is initiated during unoccupied times (mode), when the space temperature rises above the unoccupied cooling setpoint and the outside air temperature is 10°F (adjustable) less than the average space temperature.
 - 2. When all spaces served by the system are below the unoccupied heating setpoint minus the dead band setpoint (initial 5°F, adjustable), the system will revert to the unoccupied mode.
- N. Night Purge: Existing Sequence to remain.

4.9 MISCELLANEOUS

- A. Split System: Operate units on their own controls. Enable/disable from BAS occupancy schedule.

Enable only when economizer can no longer maintain space or discharge air temperature set-point for a period of 5 (Adj.) minutes.

- B. When momentary alarm switch in Principals office is pushed, disable all HVAC systems, close outside air dampers, and send general alarm.

4.10 UNIT VENTILATOR

- A. Operate from DDC time signal.
- B. Heating and Cooling: Modulate combination heating and cooling valve to maintain space at setpoint and discharge temperatures per reset schedule. When outside temperatures are below 60 deg. F. (adjustable on a school wide basis) discharge temperature shall be maintained at 75 deg. F. When outside temperatures are above 70 deg. F. (adjustable on a school wide basis) discharge temperature shall be maintained at 60 deg. F. At OSA temperatures between heating and cooling reset temperatures the discharge temperature set-point shall be that of the economizer sequence.
- C. Economizers (air-side):
 1. Outside air dampers will remain closed when the unit ventilator supply fan is off and during morning warm-up and night low limit when the unit is on.
 2. Open to minimum position during occupied mode and if space has reached at least set point -2° F.
 3. The economizer shall modulate closed to prevent the mixed air temperature from dropping below 55 F (user adjustable) or rising above 85 F (user adjustable)
 4. The economizer shall modulate, to maintain the economizer space temperature setpoint, using proportional only control with a 1.5 deg. F proportional band (user adjustable).
 5. The economizer space temperature setpoint is equal to one half the sum of the occupied space cooling setpoint and the occupied space heating setpoint.
 6. Operate to maintain space between 70° F and 75° F.
 7. See drawings for CO₂ Sequence.
- D. Night Low Limit:
 1. During the unoccupied mode, when any space temperature falls below the low limit setpoint (initial, 55°F, adjustable), the system fan will start, outside air dampers will close, and heating will stage on as required.
 2. When all spaces served by the system are above setpoint plus differential (initial 5°F, adjustable), the system will revert to the unoccupied mode by turning fans off and closing all heating valves.
- E. Night High Limit Operation:
 1. Night High Limit Enable: During unoccupied mode, the night high limit will be enabled if space temperature rises above 84° F (adjustable).
 2. System Operation:
 - a. System initially operations as if in night purge mode.
 - b. If night purge mode fails to maintain space set point (within three hours of initiation, or within one hour of occupancy period), initiate mechanical cooling with economizer (mixed air temperature not to fall below 48° F, adjustable).
 - c. When all spaces serviced by the system are below set point minus differential (3° F), the system shall return to unoccupied mode.
- F. Night Purge Operation (Night High Limit Only):
 1. Night Purge Requirements: Night purge shall operate under the following conditions:
 - a. Space temperature is above 70° F and,
 - b. Outside air temperature is greater than 50° F (adjustable) and,
 - c. Outside air temperature is at least 10° F (adjustable) less than average space temperature and,
 - d. Occupancy period occurs within three hours (adjustable).
 2. Night Purge Enable:

- a. Outside air damper shall modulate to fully open.
- b. Supply fan shall be enabled.
- c. Heating coil is closed.
3. Night Purge Disable:
 - a. Deviation from space heating temperature and space temperature is less than 3° F (adjustable).
4. Night Purge Limitations/Conditions:
 - a. Space shall be cooled below its heating set point.
 - b. Heating is disabled.

4.11 SEQUENCE OF OPERATION - CHILLER

- A. Disable on signal outside air temperature is below 53° F.
- B. Enable on building time signal.
- C. Start and operate chilled water pump on signal that any chilled water valve is open more than 5%.
- D. Start and verify pump operation prior to starting chiller.
- E. Operate Pump VFD to Maintain:
 1. Minimum pressure at remote differential pressure sensor.
 2. Minimum flow through chiller.
- F. Operate Chiller to Maintain Discharge Temperature Per Schedule: On any (adjustable) valve open 100% for 5 minutes reduce chilled water setpoint by 2° F. On all valves open less than 75% (adjustable) increase chilled water setpoint by 2° F. Reset between 44° F and 48° F.
- G. Operate chilled water pipe heat trace freeze protection on outside air temperature below 38° F.

4.12 BOILER ROOM HEATING WATER/CHILLED WATER CHANGE-OVER VALVE SEQUENCE.

END OF SECTION

HYDRONIC PIPING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this section apply to the HVAC heating and cooling water systems. Provide pipe, pipe fittings, pumps, and related items required for complete piping system.
- B. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

1.2 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, manufacturers identification marking, wall thickness designation, and applicable standards and approvals. Fittings shall be labeled as required by the referenced standard.
- C. Concealed Plastic Piping: No concealed plastic piping inside the building unless approved by Code or Governing Authorities.
- D. Definitions: Where piping fluid is not indicated in the following paragraphs, provide similar piping materials for similar fluids.
- E. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied from the same manufacturer as the grooved components.
 - 1. All castings used for coupling housings, fittings, and valve bodies shall be date stamped for quality assurance and traceability.
- F. See Commissioning specification for additional requirements.

1.3 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.

1.4 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Black Steel Pipe:
 - 1. Applications:
 - a. Heating water
 - 2. Pipe: Schedule 40, standard black steel pipe ASTM A-106 or A-53.

3. Threaded Fittings: For above ground installations only.
 - a. Banded class 120 cast iron fittings, ANSI B16.4 to 125 psi.
 4. Welding Fittings: Beveled ends, seamless fittings of the same type and class of piping above.
 5. Flanged Fittings: For above ground installations only.
 - a. Class 125 cast iron fittings, ANSI B16.2 including bolting to 125 psi.
 - b. Facing and Gasketing: Selected for service pressures and temperatures. Full-faced for cast iron and raised face for steel flanges.
- B. Black Steel Pipe:
1. Applications:
 - a. Heating water above grade
 2. Pipe: Schedule 40, standard black steel pipe ASTM A-106 or A-53.
 3. Fittings: Cold Press Mechanical Joint Fitting shall conform to material requirements of ASTM A420 or ASME B16.3 and performance criteria of IAPMO PS117. Sealing elements for press fittings shall be EPDM. Sealing elements shall be factory installed or an alternative supplied by fitting manufacturer. Press ends shall have Smart Connect® feature design (leakage path). MegaPress fittings with the Smart Connect feature assure leakage of liquids and/or gases from inside the system past the sealing element of an unpressed connection. The function of this feature is to provide the installer quick and easy identification of connections which have not been pressed prior to putting the system into operation.
 4. Pipe Thread: Pipe Threads shall conform to ASTM B16.3.
 5. Hangers and supports: Hangers and supports shall conform to MSS SP 58.
 6. Hanger spacing: In accordance with ASME B 31.1, NFPA54, UPC, IMC other National or local codes.
 7. Source Quality Control:
 - a. Fittings shall be listed and approved for their intended application.
 - b. Manufacture shall be Viega MegaPress or approved.
- C. Black Steel Pipe:
1. Applications:
 - a. Heating water
 2. Pipe: Schedule 40, standard black steel pipe ASTM A-106 or A-53.
 3. Mechanical Couplings for Joining Carbon Steel Pipe
 - a. Standard Mechanical Couplings, 2 inch (DN50) through 12 inch (DN300): Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. (Gaskets used for potable water applications shall be UL classified in accordance with ANSI/NSF-61 for potable water service.) Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and ASTM A-183, minimum tensile strength 110,000 psi (758450 kPa).
 - 1) Rigid Type: Coupling housings with offsetting, angle-pattern bolt pads shall be used to provide system rigidity and support and hanging in accordance with ANSI B31.1, B31.9 and NFPA 13. Basis of Design: Victaulic Style 07.
 - a) 2" (DN50) through 8" (DN200): Installation ready rigid coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C). Basis of Design: Victaulic Style 107H.
 - 2) Flexible Type: Use in locations where vibration attenuation and stress relief are required. Flexible couplings may be used in lieu of flexible connectors at equipment connections. Three couplings, for each connector, shall be placed in close proximity to the vibration source. Basis of Design: Victaulic Style 77.

- a) 2" (DN50) through 8" (DN0200): Installation ready flexible coupling for direct stab installation without field disassembly. Gasket shall be Grade "EHP" EPDM compound with red color code designed for operating temperatures from -30 deg F (-34 deg C) to +250 deg F (+120 deg C). Basis of Design: Victaulic Style 177.
 - b. Flange Adapters: For use with grooved end pipe and fittings, flat faced, for mating to ANSI Class 125 / 150 flanges. Basis of Design: Victaulic Style 741.
 - c. Grooved couplings shall meet the requirements of ASTM F-1476.
 - d. Gasket: Synthetic rubber conforming to steel pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.
 4. Grooved End Fittings:
 - a. Standard fittings shall be cast of ductile iron conforming to ASTM A-536, Grade 65-45-12, forged steel conforming to ASTM A-234, Grade WPB 0.375" wall (9.53 mm wall), or factory-fabricated from Std. Wt. Carbon Steel pipe conforming to ASTM A-53, Type F, E or S, Grade B. Fittings provided with an alkyd enamel finish or hot dip galvanized to ASTM A-153. Zinc electroplated fittings and couplings conform to ASTM B633.
 - b. Fittings shall be manufactured of ductile iron conforming to ASTM A-536, forged carbon steel conforming to ASTM A-234, or factory fabricated from carbon steel pipe conforming to ASTM A-53. Fittings shall be manufactured to the dimensional standards ASME B16.9. Orange enamel coated or galvanized.
 5. Tooling: Tools shall be manufactured and supplied by pipe fitting manufacturer. Use roll sets or cut groovers compatible with the pipe material and wall thickness per installation instructions.
 6. Approved Manufacturers: Victaulic. For alternate manufacturers, see other end treatments listed above.
- D. Copper Pipe and Tube:
1. Application:
 - a. Heating water.
 - b. Cooling coil condensate drain
 2. Sizes 2-1/2" and Larger: Rolled groove fittings with UPC approval. Victaulic CTS or approved. For Pipe see "F".
- E. Copper Pipe and Tube:
1. Application:
 - a. Heating water in boiler room or mechanical rooms.
 - b. Cooling coil condensate drain
 2. UPC approved copper fitting with EPDM o-ring. For Pipe see "E".
 3. Press fit connection.
 4. Viega Pro Press approved.
- F. Copper Pipe and Tube:
1. Application:
 - a. Heating water
 - b. Cooling coil condensate drain
 2. Pipe: Type L hard temper copper with brazed or soldered joints, ASTM B88. Brazing required for 2" and larger lines.
 3. Fittings: Wrought copper solder-joint fittings, ANSI B16.22.
- G. Plastic Pipe:
1. Application:
 - a. Indoor heating water above grade where supported per specifications with manufacturers support channel and concealed.
 - b. Size shall be one nominal pipe size greater than the size on the drawings.
 2. Pipe:
 - a. Cross-linked polyethylene (PEX) tubing manufactured by PEX-a or Engel

Method for closed loop heating service (with oxygen barrier): Tested/listed to ASTM E84, ASTM F876 and F877, and CSA B137.5 listed certified to NSF standards 14 and 61. Rated for 100 PSI at 180° F. Wirsbo AQUAPEX or approved.

3. Fittings: ASTM F1960 cold expansion fittings. Provide fittings of the type matching piping manufacture and recommended by the piping manufacturer for the service indicated. EP fittings are not allowed. Fitting shall be manufactured in the U.S.A.
4. Insulate per specification - pre-insulated pipe is not allowed.

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Insulating (Dielectric) Fittings: Not allowed. See Section 3.
- B. Welding Materials: Provide welding materials as determined by the installer to comply with installation requirements.
- C. Soldering and Brazing Materials: Provide soldering materials as determined by the installer to comply with installation requirements.
 1. Tin-Antimony Solder: ASTM B32, Grade 95TA.
 2. Lead-Free Solder: ASTM B32, Grade HB. Harris "Bridgit" approved.
 3. Silver Solder: ASTM B32, Grade 96.5TS.
- D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges. Pressure and temperature rating required for the service indicated.
- E. Sleeve Seal: Rubber-link pipe wall and casing closure. Thunderline Link-Seal. For fire rated wall, floor or ceiling penetrations, 3-M "CP-25" caulk, "No. 303" putty and/or "PSS 7904" sealing system.
- F. Strainers: "Y-pattern," ductile iron or bronze body (depending on pipe system) rated for pressures indicated with blow-off connection and 20 mesh stainless steel screen or perforated metal basket with 1/16" or 1/8" openings. Basis of Design: Victaulic Style 732.
- G. Valves up to 12": Model #'s listed are Nibco unless noted otherwise. Approved equal are Watts, Hammond, Apollo, and Victualic.
 1. Ball (to 2"):
 - a. Two-piece, cast bronze body, full port, 600 psi WOG, T/S 585-70.
 2. Butterfly: Ductile iron body, electroless-nickel coated ductile iron aluminum bronze disc, 300 psi WOG, pressure responsive elastomer seat, and stainless steel stem that is offset from the disc centerline to provide complete 360-degree circumferential seating, suitable for water temperatures to +250 degrees F. Lugged body – LD-2000, Wafer body – WD-2000, Grooved body – Victaulic Vic300 MasterSeal.
 3. Check: Bronze or ductile iron body, spring-assisted swing check, 300 psi WOG, T/S-413B and F-918B, Grooved body – Victaulic Series 716.
 4. Gate valves only allowed at boiler connection as required by Oregon Boiler Code. Rising stem with adjustable gland 125 working pressure bronze mounted wedge disk. Watts F-503 Series or equal.

2.3 HEATING WATER SPECIALTIES

- A. Pressurized Precharged Expansion Tank: Precharged diaphragm type hydropneumatic tank with all necessary air elimination fittings. Install with ball valve on piping connection. Amtrol, Taco, Bell & Gossett, Armstrong, Wheatley, Wessels, ELBI or approved substitute.
- B. Air Vents: Install at all system high points whether shown or not;
 1. At all locations not in mechanical rooms use manual air vents.
 2. At mechanical rooms fabricate of 2" diameter or larger pipe at least 12" long. At the high point of each main install an Armstrong No. 1AV autovent, or equivalent

- Bell & Gossett, Dunham-Bush approved substitute. Route discharge line to over floor sink.
3. As an option to 2 above install a Spirotop VTP dry design vent at the high point of each main.
- C. Triple Duty Valve: Combination spring loaded vertical check, calibrated balancing and shut off valve with balance point memory in angle or straight pattern as required or as shown on the Drawings. Bell & Gossett, Taco, Armstrong, Thrush, Victaulic, Wheatley, Patterson or approved substitute.
- D. Air Separators: Coalescing or centrifugal separation operation. Fabricated steel rated for 125 psi pressure with threaded, grooved, or flanged connections. Unit pressure drop shall not exceed one foot at design flow rate. Unit shall include internal air coalescing medium or galvanized steel strainer and perforated air collecting tube. Submittals shall include unit air and dirt elimination efficiencies at design flow. Include sediment collection area and bottom blowdown valve with hose connection. Install with high capacity float operated air vent. Spirovent, Bell & Gossett, Thrush, Taco, Armstrong, ELBI or approved.
- E. Suction Diffusers: Where indicated on Drawings provide a suction diffuser with stainless steel inlet vanes, combination diffuser-strainer orifice cylinder 20-mesh stainless steel and temporary start-up strainer on the inlet of base mounted pumps. Bell & Gossett, Taco, Armstrong, Thrush, Victaulic, Wheatley, Patterson or approved substitute.
- F. Circuit Setter and Balancing Valves: Globe style with calibrated handle style balancing fitting with differential pressure taps, brass or bronze body and trim. TA Hydraulics STAD series, or equal Nexus, Wheatley or approved substitute. Valves shall only be used where specifically called out for balance valve, otherwise use flow control valve.
- G. Chemical Shot Feeder: 2 gallon feeder rated for 125 psi working pressure complete with fill funnel and valve or cap, drain valve, air vent, and inlet and outlet connections. Griswold FB series, Vector Industries or approved
- H. Differential Pressure Control Valves 1/2" through 2": Maximum differential pressure is 51 psi, maximum temperature is 248°F for use in heating and cooling systems only. NPT threaded valve body and bonnet shall be manufactured of dezincification resistant copper alloy, O-rings, seat seal, and membrane manufactured of HBNR. Shall have adjustable differential control, single pressure temperature port, dead end service shut off capabilities, stainless steel spring, and polyimide handle. Shall be capable of stabilizing ΔP_v ranges of 2.9-11.6 psi for heating water devices and 5.8-23.2 psi for chilled water valves sizes shall be determined by factory representative based on system flows listed on drawings. Supply side valve shall be Tour and Andersson style STAD (or approved equal) with capillary tube, drain kit, and all connection fittings to match.
- I. Water Meter: Multi-jet principle gear drive meter. Cast bronze body with reed switch. OMEGA FTB8000B-PT or equal. Calibrate to flow rates that would dilute treatment system.
- J. Coil Connection Hoses: Not allowed. Use Union. Dielectric Unions not allowed.

2.4 EXPANSION JOINT

- A. Stainless steel bellows type with flanged ends, controlled flexing, internal liner rated at a minimum of 28,000 average life cycles. Provide amount of expansion indicated at each joint as shown on Drawings. Carefully align joint and make proper allowance for temperature of pipe at time of installation. Flexonics, Hyspan, or approved substitute.
- B. At pumps multiple grooved flexible fittings per 2.01 C-3a-2 are allowed if installed per manufacture guidelines. See Section 23 05 48 for Flex Connection at Seismic Joints.

2.5 HYDRONIC PUMPS

- A. In-Line Circulators: For application smaller than 300 GPM, pipe mounted, in-line arrangement with mechanical seals with ceramic seal seats, suitable for continuous operation at 225 deg. F at head and capacity stated on Drawings. Cast iron impeller casing, oil lubricated bronze journal and thrust bearings or regreasable ball bearings (manufacturer's standard), 1750 rpm standard frame VFD compatible motor. Provide pressure gauge tapings on suction and discharge flanges. Impeller size not to exceed 90% of largest diameter impeller which will fit pump casing. Minimum horsepower and efficiency as indicated on Drawings and not less than will be required at any point of the impeller curve. B&G or Taco.
- B. Pumps Larger Than 300 GPM: End Suction, base mounted, flexible coupling, mechanical seals, suitable for hot or cold water service at head and capacity stated on Drawings. Cast iron casing, bronze fitted, roller bearing, 1750 rpm standard frame motor. Impeller size not to exceed 90% of largest diameter impeller which will fit pump casing. Minimum horsepower and efficiency as indicated on Drawings and not less than will be required at any point of the impeller curve. Provide pressure gauge tapings on suction and discharge flanges. Bell & Gossett, or Taco. Provide coupling and shaft guard to meet requirements of State Safety Code. See 230500 for motor requirements.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. General: Install pipe, tube and fittings in accordance with recognized industry practices. 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.
 - 1. Unions and flanges for disassembly, maintenance and/or replacement of valves and equipment are not required in installations using grooved joint couplings. (The couplings shall serve as disconnect points.)
- B. Piping Runs: Route piping close to and parallel with walls, overhead construction, columns and other structural and permanent-enclosure elements of the building (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 partitions.

3.2 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. 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 or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave no more than 3 threads exposed.
- C. Solder Copper Tube and Fitting Joints for 2" and Smaller: In accordance with recognized industry practice. Cut tube ends squarely, ream to full inside diameter, and clean outside of tube ends and inside of fittings. Apply solder flux to joint areas of both tubes and fittings. Insert tube full depth into fitting, and solder in a manner which will draw solder full depth and circumference of joint. Wipe excess solder from joint before it hardens. "T-Drill" field formed tees may be utilized where the main is at least two pipe sizes larger than the branch.
- D. Braze Copper Tube and Fitting Joints: Where indicated, in accordance with ANSI/ASME B31.5. Pass a slow stream of dry nitrogen gas through the tubing at all times while brazing to eliminate formation of copper oxide.

- E. Weld Pipe Joints: In accordance with recognized industry practice and as follows:
 - 1. Weld pipe joints only when ambient temperature is above 0 degrees F.
 - 2. Bevel pipe ends at a 37.5 degree angle, smooth rough cuts, and clean to remove slag, metal particles and dirt.
 - 3. Use pipe clamps or tack-weld joints with 1" long welds; 4 welds for pipe sizes to 10"; 8 welds for pipe sizes up to 20".
 - 4. Build up welds with a stringer-bead pass, followed by a hot pass, followed by a cover of filler pass. Eliminate valleys at center and edges of each weld. Weld by procedures which will ensure elimination of unsound or unfused metal, cracks, oxidation, blow-holes and non-metallic inclusion.
 - 5. Do not weld out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
 - 6. Install forged branch-connection fittings wherever branch pipe is indicated, or install regular "T" fitting at Contractor's option.

- F. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gasket.

- G. Insulating (Dielectric) Fittings: Where the "joining of ferrous and non-ferrous piping". Use brass valve or brass nipple with length/nominal dramatic ratio of 8 or greater rather than dielectric fitting.

- H. Changes in Direction: Use fittings for all changes in direction. Run lines parallel with building surfaces.

- I. Line Grades: Pitch hydronic piping 1" to 40' minimum to low point drips or drains.

- J. Unions and Flanges: At all equipment to permit dismantling and elsewhere as consistent with good installation practice.

- K. Expansion:
 - 1. Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment. Flexible hoses are not allowed.

- L. Press Fittings: MegaPress Cold Press Mechanical Joint Fittings shall be installed in accordance with the manufacturer's installation instructions. The protective corrosion coating shall be removed from the outside of the pipe end. The pipe shall be fully inserted into the fitting and the pipe marked at the shoulder of the fitting. The fitting alignment shall be checked against the mark on the pipe to assure the pipe is fully engaged (inserted) in the fitting. The joints shall be pressed using the tool(s) approved by the manufacturer.

- M. Fusion Welding of Joints:
 - 1. Install fittings and joints using socket-fusion, electrofusion, or butt-fusion as applicable for the fitting or joint type. All fusion-weld joints shall be made in accordance with the pipe and fitting manufacturer's specifications and product standards.
 - 2. Fusion-weld tooling, welding machines, and electrofusion devices shall be as specified by the pipe and fittings manufacturer.
 - 3. Prior to joining, the pipe and fittings shall be prepared in accordance with ASTM F 2389 and the manufacturer's specifications.
 - 4. Joint preparation, setting and alignment, fusion process, cooling times and working pressure shall be in accordance with the pipe and fitting manufacturer's specifications.

3.3 MISCELLANEOUS PIPING EQUIPMENT

- A. Floor, Wall and Ceiling Plates: Chrome plated pressed steel or brass screw locked split plates on all pipe penetrations in finished spaces.

- B. Strainers: Install in a manner to permit access for cleaning and screen removal and with blow-off valve.
- C. Sleeves: At all penetrations of concrete or masonry construction. PVC, 24 gauge galvanized steel or Schedule 40 galvanized steel pipe. Use steel pipe sleeves through beams, footings, girders or columns and for all penetrations of walls or floors below grade. Where floor finish is ceramic tile, terrazzo, or similar material extend standard steel pipe sleeves 1-1/2" above finished floor. Fabricate sleeves 1" diameter larger than pipe or insulation. PVC and sheet metal sleeves at non-structural penetrations only.
- D. Sleeve Caulking: Grout uninsulated pipe with cement mortar or approved waterproof mastic. All caulking or grouting shall extend full depth of sleeve. Install UL sealing caulk, putty and/or system at all penetrations of fire rated walls, floors and ceiling.
- E. Valves: Install valves in accordance with Section 23 05 00. Install control valves specified in other Division 23 sections.

3.4 EQUIPMENT INSTALLATION

- A. Installation and Arrangement: Install and arrange as shown on the Drawings. Comply with manufacturer's recommendations for installation connections and start-up.
- B. Lubrication: Lubricate all moving and rotating parts in accordance with the manufacturer's recommendations prior to start-up.
- C. Expansion Joint and Compensator Installation: Carefully align joint or compensator and make proper allowance for temperature of pipe at time of installation.
- D. Air Vents: Conduct 1/4" copper tubing from high end of air chambers to accessible locations and terminate with screwdriver cock. Conduct 1/4" copper tubing from outlets of automatic air vents to floor drains indicated or to the outside when approved by Governing Authorities.
- E. Pumps: Mount in a manner to allow disassembly of pump and motor without disturbing piping.
- F. Mechanical contractor and balancing contractor shall be trained on installation, connection, and balancing procedures by certified representative of differential pressure control valves.

3.5 CLEANING

- A. General: Clean all dirt and construction dust and debris from all mechanical piping systems and equipment and leave in a new condition. Touch up paint where necessary.
- B. Heating Water Piping Systems:
 - 1. Add cleaning chemical in proper concentration to clean system of manufacturing and installation contamination and residue.
 - 2. Fill, vent and circulate the system with this solution at design operating temperature. After circulating for four hours, bleed out cleaning solution by the addition of fresh water to the system.
 - 3. Test for pH and add sufficient amount of the cleaning chemical to obtain a pH between 7 and 8.
 - 4. Clean all strainers and remove start-up strainers (from suction diffusers) after the system has operated for one week.

3.6 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. 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. Heating Water Piping: 75 psig hydrostatic for 30 psig systems without loss for four hours.
- D. Tanks and Equipment: Hydrostatic pressure to 1.5 times operating pressure.

END OF SECTION

REFRIGERANT PIPING SYSTEM

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The requirements of this section apply to the refrigerant piping system connecting refrigeration and HVAC equipment specified in other sections of these specifications. Provide pipe, pipe fittings and related items required for complete piping system.
- B. Related Work: The requirements of Sections 23 05 00 - Common HVAC Materials and Methods, 23 80 50 – VRV Heat Recovery System also apply to this section.

1.2 QUALITY ASSURANCE

- A. General: ASTM, and ANSI Standards are indicated. In addition, special standards are referenced where neither ASTM nor ANSI Standards are applicable. Comply with federal and local regulations regarding the handling of refrigerant.
- 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. Air Conditioning and Refrigeration Equipment Rating: Rated in accordance with ARI certified rating procedures and bear the ARI label.
- D. Installation Contractor: Manufacturer's authorized installation and start-up agency normally engaged and experienced in air conditioning/refrigeration work and certified in the handling of refrigerant.

1.3 SUBMITTALS

- A. Submit catalog data, construction details, and performance characteristics for each type and size of refrigeration equipment.
- B. Submit refrigeration piping drawings for split system cooling units (condensing units and air handlers) terminal duct-less split systems and VRV systems. Show piping devices (dryers, filters, service valves), routing, and sizes. Pipe routing noted on drawings is intended to coordinate with building construction. Modification of routing is allowed but is to comply with specification relative to concealment, support, workmanship and manufactures recommendation. Sizes for VRV piping is based on system basis of design (LG) and routing is only provided as a guide. Provide submittal for entire VRV system refrigerant piping system regardless of manufacture.
- C. Submit operating and maintenance data.

1.4 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.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Copper Pipe and Tube:
 - 1. Application: Refrigerant.
 - 2. Pipe: ASTM B88. Type ACR hard temper copper with brazed joints. Cleaned and sealed at the factory.
 - 3. Refrigerant Fittings: ANSI/ASME B31.5 or SAE J 513-F, "Refrigeration Tube Fittings." Where conflicts occur, B31.5 shall govern.
 - 4. Soft drawn is allowed at connection to VRV unit (limited to 72" from unit).

2.2 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

- A. Brazing Materials: Provide brazing filler rod and flux materials as determined by the installer to comply with installation requirements.

2.3 REFRIGERATION SPECIALTIES

- A. General: Provide the following equipment where they are not a part of the factory installed equipment accessories. Select equipment for operation with the refrigerant being utilized and for the pressure and temperature conditions indicated. Sporlan, Alco, Henry, Detroit, or as listed for each equipment.
- B. Thermostatic Expansion Valve: Capacity matched for the system, angle or straight through pattern external equalizer, brass body complete with capillary and remote sensing bulb.
- C. Solenoid Valves: For installation in liquid, suction and/or hot gas circuit as indicated. Brass body, replaceable coil of voltage indicated.
- D. Liquid and Moisture Indicators: Moisture and liquid indicator installed after the liquid line filter dryer.
- E. Liquid Line Filter Dryer: Sealed container up to approximately 10 tons of capacity and replaceable desiccant dryer core and strainer on larger capacity systems.
- F. Charging Valves: Quick coupling type connection with removable valve core.
- G. Service Valves: Install liquid, suction and discharge line valves, all suitable for refrigerant used and location in the system, designed so as to be easily packed with pressure on the line and with wing caps that completely enclose valve stem. Install all purge valves, relief valves or other valves required for safe and proper operation of the system and as may be required by State or local codes. Detroit, Alco, Sporlan or Automatic Products approved substitute.

PART 3 - EXECUTION

3.1 PIPE INSTALLATION

- A. See section 1 for submittal requirements.
- B. Piping Runs: Route piping close to and parallel with walls, overhead construction, columns and other structural and permanent-enclosure elements of the building. 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 partitions.
- C. Refrigerant Piping:
 - 1. Use hard drawn copper tubing and make all changes in direction with specified fittings for copper.
 - 2. Lay out the refrigerant piping system in a manner to prevent liquid refrigerant from entering the compressor and so that oil will return to the compressor. Slope all horizontal suction lines toward the compressor. Take special care to keep all tubing clean and dry.

3. Install all refrigerant piping straight and free from kinks and restrictions, properly supported to minimize vibration. Provide hangers at 5' spacing for 1/2" lines, 6' spacing for 1" lines and 8' spacing for 1-1/2" and larger lines. Submit complete diagram for approval.
4. Comply with the refrigerant piping installation instructions of the refrigeration equipment manufacturer.

3.2 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. Braze Copper Tube and Fitting Joints: Where indicated, in accordance with ANSI/ASME B31.5. Pass a slow stream of dry nitrogen gas through the tubing at all times while brazing to eliminate formation of copper oxide.
- 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.

3.3 MISCELLANEOUS PIPING EQUIPMENT

- A. Floor, Wall and Ceiling Plates: Chrome-plated pressed steel or brass screw locked split plates on all pipe penetrations in finished spaces.
- B. Filters: Install in a manner to permit access for removal and replacement of filter cartridge.
- C. Sleeves: At all penetrations of concrete or masonry construction. PVC, 24 gauge galvanized steel or Schedule 40 galvanized steel pipe. Fabricate sleeves 1" diameter larger than pipe or insulation. PVC and sheet metal sleeves at non-structural penetrations only.
- D. Sleeve Caulking: Grout insulated pipe with cement mortar or approved waterproof mastic. All caulking or grouting shall extend full depth of sleeve. Install UL sealing caulk, putty and/or system at all penetrations of fire rated walls, floors and ceiling.
- E. Support: See section 23 05 00.
- F. Expansion Joints or Loops: Provide with ends required for installation. Bronze fabricated corrugated hose with working pressure of 1300 psi and temperature of 450° F. Flexonics or approved.

3.4 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. Refrigeration System Piping: If, for any reason, sanitized and sealed-at-the-mill tubing is not used, clean the tubing as follows:
 1. Wipe each tube internally with a dry, lintless cloth followed with a clean lintless cloth saturated with recommended refrigerant.
 2. Repeat until the saturated cloth is not discolored by dirt.
 3. Wipe with a clean cloth saturated with compressor oil and squeezed dry.
 4. Wipe with a dry, lintless cloth.

3.5 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: 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.

C. Refrigerant System:

1. When the refrigerant connections have been completed, close the compressor suction and discharge valves (or receiver outlet valve in the case of condensing unit) and test the balance of the system to near operating pressure with a dry nitrogen.
2. Carefully test all joints, using soap and water or other sudsing solution. After all joints are tested, discharge the gas and repair all leaks, then repeat the test with a mixture of nitrogen and R-410A and a halide torch or an electronic leak detector.
3. Evacuate the system to remove moisture and non-condensables. Lower the absolute pressure with a vacuum pump to 1000 microns of mercury. Apply external heat as required to vaporize moisture.
4. Dehydrate each refrigerant circuit by satisfactory use of a vacuum pump before charging with refrigerant. Furnish all necessary refrigerant and oil for complete operating charge of the system. Upon completion of the work of construction, test all refrigeration equipment under normal operating conditions and leave in operating order. Adjust automatic temperature controls.
5. After the first 24 hours of operation, measure the pressure drop across the suction filter. If the pressure drop exceeds 5 pounds per square inch, replace the cartridge with a new one, retesting and replacing the cartridge and/or adjusting the system as necessary to achieve a pressure drop of less than 5 pounds per square inch in 24 hours.

END OF SECTION

AIR DISTRIBUTION

PART 1 - GENERAL

1.1 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.

1.2 QUALITY ASSURANCE

- A. Air Distribution Equipment Rating: In accordance with AMCA certified rating procedures and bearing the AMCA label.
- B. See section 23 08 00 for commissioning requirements.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 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: 1" negative.
 - 2. Supply ducts from fan discharge: 3" positive.
- 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. Schuller "Linacoustic," Owens Corning "Aeroflex" Type 150, and Certainteed "ToughGard" Type 150 approved, 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.
- 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: Round and flat oval spiral seam duct shall be manufactured of galvanized steel sheet metal with spiral lock seam. Sizes up to 36" diameter or 36" wide shall be 22 gauge; sizes over 36" shall be 20 gauge. Reinforcement or bracing shall be as detailed on the Drawings. Matching fittings shall be manufactured of galvanized steel with continuous welded seams. Fittings up to 36" diameter or width shall be 20 gauge, fittings larger than 36" shall be 18 gauge.
- F. Fittings for exposed to view spiral duct:
1. Galvanized construction in accordance with ASTM A643 and A924.
 2. Fittings shall be rated to 10" WC pressure.
 3. Shall be equipped with EPDM gasket hemmed by 180° edge around entire fitting connection.
 4. Rated and tested for SMACNA Class 3 leakage.
- G. 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.
- H. Kitchen Dishwasher Exhaust Duct:
1. Fabricate dishwasher exhaust ducts of 18 gauge type 304 stainless steel with smooth welded joints and No. 4 finish as detailed on the Drawings.
- I. 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.

2.2 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. Exterior Wall Louvers: Prefabricated extruded aluminum stormproof blades with frame to suit building construction. 1/2", 16 gauge aluminum wire mesh on back side of all intake louvers and insect screen on exhaust/relief louvers. 4" deep, 45 degree fixed drainable type blade, AMCA 500 tested for 800 fpm without water penetration, and maximum of 1.1" wg intake pressure loss and

0.09" wg exhaust pressure loss. Color of each louver shall be selected to match adjacent metal panel. Color is a custom color. Ruskin Greenheck ESD-403 as basic pattern on blade and frame, Ruskin, Cesco, American Warming, or approved.

- C. Gravity Exhaust Head/Outside Air Intake :
1. Aluminum cap with backdraft or automatic dampers, curb connection, flashing, 1/2" mesh galvanized bird screen and hinged access. Greenheck, Exitaire, Carnes, Acme, Powerline, Penn or accepted substitute. Allowed only where detailed on drawings.
 2. Gravity Exhaust Head / Outside Air Intake Housing: Extruded aluminum (0.0081) louvered tiered style with curb connection, flashing, 1/2" mesh bird screen and hinged access. 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. Acme, Greenheck, Cook, Carnes or approved.
 3. Install with automatic relief / outside air intake damper in curb as indicated on the Drawings.
- D. Locking Connection Straps: 1/2" wide positive locking steel straps or nylon self-locking straps. Panduit or accepted substitute.
- E. Connection Fittings: Connections to non-metallic ducts manufactured sheet metal "spin-in" fittings. Genflex, Wiremold, Thermaflex, Glassflex, Clevepak, Schuller, or accepted substitute.
- F. 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.
- G. 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.
- H. 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.
- I. Flexible Connections: Neoprene impregnated fiberglass connection. Ventglass, Duro-Dyne, or accepted substitute.

2.3 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, and Tuttle & Bailey are accepted substitutes where only Titus or Price 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. Modular Code Diffuser: Steel construction, fixed louver direction modules which can be field changed for adjustable discharge patten (1, 2, 3, or 4-way). Titus MCD.
- E. Ceiling Filter Return Air Grilles: For VRV systems, steel construction with white finish, boarder type for installation in ceiling (hard ceiling or tee bar). Tee bar to fit in 24" grid designed to accept 2" filter media with hinged face and 1/4 turn metal hardware. Price 530 FF-TB.
- F. Side Wall Filter Grilles: Heavy Duty, Bars Return Grille: For low return where not located in gyms. All welded construction with heavy 14 gauge, fixed steel horizontal face bars at 1/2" on centers and reinforced every 6" to 8". Titus 33RFL or 33RFS.
- G. Ventilation System 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. Price PDDR.
- H. 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. Grilles installed at walls (not installed on exposed ducts) shall be factory primed for field painting.
- I. Sidewall or Ceiling Return or Exhaust Register (for Ventilation System Only): Face bars parallel to long dimension on ceiling type and horizontal on wall type; bars set at 35 degrees to 45 degrees, spaced on 0.66" to 0.75" centers; key operated opposed blade volume damper. Titus 350RL series. Grilles installed at walls (not installed on exposed ducts) shall be factory primed for field painting.
- J. Heavy Duty, Low Return Grille: For ventilation system low return where not located in gyms. All welded construction with heavy 14 gauge, steel horizontal face bars at 1/2" on centers and reinforced every 6" to 8". Titus 33 series.
- K. Steel Door Transfer Grilles and Sidewall Transfer grilles: All welded construction with 20 gauge, fixed inverted V-blades with a deflection angle of 77° so as to provide a sight proof design. Provide with frame for wall or door mounting as required. Titus T-700L.
- L. 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.

PART 3 - EXECUTION

3.1 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.

3.2 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.

3.3 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.
- 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 1.5 times 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 'battered' 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. Install dampers in fiberglass ductwork (where fiberglass ductwork is allowed) with galvanized sheet metal sleeves of sheet metal gauges required for metal duct systems of the same dimensions.
- 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. Exposed duct shall not be sealed. See Section 23 30 00, 2.01 E and F for exposed duct.

3.4 NEW DUCTWORK CLEANING

- A. Store all ductwork materials on pallets or above grade, protected from weather, dirt/mud and other construction dust. Protect per SMACNA Duct Cleanliness Guidelines Level B (Intermediate).
- B. Remove all accumulated dust, dirt, etc. from each duct section as it is being installed.
- C. See Earth Advantage requirements for temporary filters and air flush requirements. Temporary filters at unit shall match quality of devices specified.
- 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.

3.5 EXISTING DUCT CLEANING

- A. Return and Outside Air Duct System Cleaning.
 - 1. Clean all main trunk lines.
 - 2. Clean all ductwork of return air grills.
 - 3. Install additional entry points as needed to provide thorough cleaning.
 - 4. Seal access points after cleaning.
 - 5. Mark location of manually operated dampers and air-direction devices before cleaning and return to marked position upon completion.
 - 6. Protect all furniture and equipment during cleaning.
 - 7. Replace filters if provided by the school district.
 - 8. Return all ceiling tiles, access panels, and any furniture or equipment moved to original position.
 - 9. Clean up all debris created by cleaning.
 - 10. Provide before and after pictures of ductwork to owner upon completion.
 - 11. See section B for details.
- B. Detailed Duct and Equipment Cleaning.
 - 1. The ACR NADCA Standard 2013 will be referenced in this procedure. References made to that standard by default include the supporting information (definitions, terms, etc.) of that document. References to NADCA reference the standard.
Comply with sections 2 and 3 of NADCA
Procedure:
 - 2. Service Openings: Service openings may be needed to perform assessment, cleaning and restoration (ACR) procedures. Below are the minimum requirements for service

- openings.
- a. Service openings installed into the system shall not degrade the structural, thermal, or functional integrity of the system.
 - b. Service openings shall be created in a manner that allows for proper closure.
 - c. Service openings shall not hinder, restrict, or alter the airflow within the air duct.
 - d. Service opening construction materials and methods shall be in compliance with industry standards and local codes, using materials acceptable under those standards and codes.
3. Materials used in the fabrication of duct access doors and permanent panels shall be those classified for flammability and smoke spread if the material is exposed to the internal airstream. These materials are classified as having a flame-spread rating of not over 25 without evidence of continued progressive combustion and a smoke-developed rating of not over 50, as determined by UL 723.
 4. All tapes used in the installation and closure of service openings shall meet the requirements of UL 181A.
 5. All service openings shall comply with applicable UL, SMACNA and NFPA standards, as well as local, regional, and state codes.
 6. Service Panels:
 - a. Service panels used for closing service openings in the HVAC system shall be of an equivalent gauge or heavier so as to not compromise the structural integrity of the duct.
 - b. Service panels used for closing service openings shall be mechanically fastened (screwed or riveted) at minimum every 4" on center. The panel shall overlap the ductwork surfaces by a minimum of 1" on all sides.
 - c. It is recommended that service panels used for closing service openings be sealed with gaskets, duct sealants, mastic, or tape.
 7. Prefabricated Duct Access Doors: The gauge of the duct access door shall be based on the pressure class of the duct system and shall be installed according to manufacturer's specifications.
 8. Drilled 1" Service Openings: Drilled 1" service openings shall be closed with materials meeting UL 181 for smoke generation and flame spread.
 9. Flexible Duct Systems: Service openings shall not be made in flexible ductwork.
 10. Cleaning and Restoration of HVAC Systems: HVAC systems shall be cleaned by using a suitable agitation device to dislodge contaminants from the HVAC component surface and then capturing the contaminants with a vacuum collection device.
 11. Wet Cleaning, Power Washing, and Steam Cleaning: Wet cleaning, power washing, steam cleaning and any other form of wet process cleaning of HVAC system components shall not damage or result in subsequent damage to the components. Cleaning agents or water shall never be applied to electrical, fibrous glass or other porous HVAC system components.
 12. Vacuum Collection Equipment: Vacuum collection equipment shall be operated continuously during cleaning. The collection equipment shall be used in conjunction with agitation tools and other equipment to convey and collect debris and prevent cross-contamination of dislodged particulate during the mechanical cleaning process. Maintain capture velocities per NADCA 4.5.
 13. Confined Space Cleaning: When working inside a confined space, health and safety concerns shall be a priority. The duct support system, internal components, configuration and confined space concerns shall be evaluated for safety prior to entry. It is recommended that a Certified Safety Professional be consulted as needed.
 14. Air-Handling Unit (AHU) Cleaning: It is recommended that air-handling coils, fans, condensate pans, drains and similar non-porous surfaces be wet cleaned in conjunction with mechanical methods.
 - a. Efforts to control water extraction shall be sufficient to collect debris and prevent water damage to the HVAC components and surrounding equipment and structure.
 - b. The capture, containment, testing and disposal of waste water generated while performing wet cleaning shall be in accordance with applicable local, regional, state, and federal regulations.

15. Air Duct Cleaning: Air ducts shall be cleaned to remove all non-adhered substances and shall be capable of passing NADCA cleanliness verification tests.
 - a. Air ducts shall be accessed through service openings in the system that are large enough to accommodate mechanical cleaning procedures and allow for cleanliness verification.
 - b. Air ducts shall be cleaned using mechanical agitation methods to remove particulate, debris, and surface contamination.
 - c. Dislodge substances shall be captured with a vacuum collection device.
 - d. Cleaning activities shall not damage any HVAC components.
16. Dampers: Dampers and any air-directional mechanical devices shall have their position marked prior to cleaning and shall be restored to their marked position after cleaning.
17. Registers, Grilles, Diffusers: It is recommended that all registers, grilles, diffusers, and other air distribution devices be removed if possible, properly cleaned, and shall be restored to their previous position.
18. Smoke and/or Fire Detection Equipment: Cleaning activities shall not impair, alter or damage any smoke and fire detection equipment located within the facility, or attached to and serving the HVAC system.
19. Post-Cleaning Inspection: If debris still remains on the coil after cleaning, the process shall be repeated.
20. Control of Odors and Product Emissions: All products used shall comply with any local, regional, state, and federal regulations and/or other laws regulating the use of such agents.
21. Remediation of Mold Contamination: Remediating mold shall be performed in accordance with the IICRC S520 Standard for Professional Mold Remediation and the cleaning/restoration of the HVAC system provisions as outlined within this Standard.
22. Surface Treatments: Surface treatments may be used to restore the integrity of material surfaces as an alternative to replacement. Surface treatments shall only be applied after confirming the system has been cleaned and has passed the specified level of cleanliness verification.
23. Removal of Mold Contaminated Porous Materials: It is recommended that porous materials with mold growth (Condition 3) be properly removed and replaced. This task shall be followed by surface cleaning using mechanical cleaning methods.
 - a. The mechanical cleaning methods selected for duct liner or fibrous glass duct board shall not create abrasions, breaks, or tears to fibrous glass liner or duct board surfaces.
24. Resurfacing Fibrous Glass Surfaces: Resurfacing may be considered when thermal acoustic fibrous glass components, including air duct liner or duct board in the HVAC system, are considered friable, or exhibit visual signs of abrasion, degradation, or other undesirable conditions. Resurfacing may also be considered when the project work plan requests smoothing fiber glass surfaces to reduce future particulate collections within the HVAC system.
 - a. If resurfacing is to be performed, an assessment shall be made to determine whether the surface of the component will provide a strong, bondable surface for the coating material after undergoing proper mechanical cleaning.
 - b. If fibrous glass materials are beyond restoration and deemed unsuitable to support the proper application of a surfacing product or unable to provide a long-term bondable surface, resurfacing shall not be performed.
25. Damaged Fibrous Glass Material: When there is evidence of damage, deterioration, delaminating, friable material, such that cleaning or resurfacing cannot restore fibrous glass materials, replacement is recommended. Call to the attention of the Engineer.
26. HVAC System Repair: HVAC components found to have pre-existing damage during the cleaning process shall be documented and brought to the attention of the Engineer.
27. After return air and exhaust air ducts have been cleaned operate the fan system at full speed for a minimum of 8 hours. Then proceed to cleaning air handler unit and supply air ductwork.
28. Allow a one week window scheduled at least 7 days prior with engineer to inspect final cleaning of ducts and fans systems. Systems shall be selected randomly by the engineer. Provide a technician to assist with air handler or duct access. For ductwork cleaning

provide photo evidence per reference standard with reference markers as to location showing before and after conditions. If inspection of air handlers at that time is not possible provide photo documentation per referenced standard.

29. In the event that engineer does not agree that the fan is clean method 2 from the referenced standard shall be implemented using cleaning and test equipment furnished by the duct cleaning contractor.

END OF SECTION

HVAC FANS

PART 1 - GENERAL

1.1 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.

1.2 QUALITY ASSURANCE

- A. Air Handling Equipment: Rated in accordance with AMCA certified rating procedures and AMCA labeled.
- B. See section 23 08 00 for commissioning requirements.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 EXHAUST FANS AND UNITS

- A. Roof Mounted Exhaust Fan (Direct Drive): Curb mounted on roof; vertical shaft, direct driven, open BI wheel as shown on Drawings with permanently lubricated sealed ball bearings; fan duty motor; bird screen; weatherproof aluminum housing for mounting on square base; capacity as indicated on Drawings. Motor located outside the air stream. Casing to be easily removed for service. Motor and fan assembly to be mounted on rubber vibration isolators. Where indicated on the Drawings, provide backdraft damper in curb. Provide factory mounted disconnect and curb. Provide with EC motor with speed selection equipment at fan for balancing. Greenheck, Carnes, Cook, Twin City, or approved.
- B. Inline Cabinet Exhaust Fan: Direct drive, forward curved centrifugal wheel, sleeve bearings, motor and wheel isolated from unit on vibration isolators; provide grille on inlet and duct connection with backdraft dampers on discharge. Where noted on drawings, provide with EC motor to accept external signal to vary operation air flow. Size and capacity as indicated on Drawings. Carnes, Greenheck, Cook, Twin City, or approved.
- C. Grease Hood Exhaust Fan: Curb mounted on roof; vertical shaft, belt driven, enclosed BI wheel as shown on Drawings with pressure lubricated ball bearings; ball bearing fan duty motor isolated from exhaust air stream. Low silhouette vertical discharge housing for mounting on square base. Capacity as indicated on Drawings. Provide cleanout access (hinged top), grease capture device and factory curb mounting base. Carnes, Greenheck Cook, Twin City or approved. Motor shall be inverter rated.

2.2 FAN COIL UNIT OPTION 1: JAGA BRIZA 22 OR APPROVED

- A. Quality Assurance:
1. Each unit shall be fully tested at the factory.
 2. Insulation and adhesives shall meet NFPA-90A requirements for flame spread and smoke generation.
 3. All aluminum components shall be certified to meet ASTM G53 UV-resistance.
 4. Surface temperature remains safe at all times based on DHSS DN 4 1992 regulation and subsequent revision.
 5. The water source heating and cooling equipment shall be certified for outputs based on EN442 standards and EN16430 standards.
- B. Cabinets for wall mounting:
1. Unit shall be wall mounted and less than 10" deep.
 2. The Cabinet shall be fabricated with 16 gauge electrolytic galvanized steel and will be coated epoxy polyester baked at 392°F. Sandblast Grey metallic lacquer color.
 3. The Top or front grille shall provide supply air, top outlet is only allowed when provided with pencil proof grille. Front bottom shall provide return.
 4. The Cabinet front face shall be constructed of a single uniform piece seamless in construction.
 5. The Cabinet shall be fabricated with heat exchanger support bracket. Standard configuration will be center mounted.
 6. All Valve connections shall be made inside of the cabinet unless separate enclosures are supplied.
 7. The Cabinet shall be fabricated such that there are no exposed corners or gaps. All corners shall be joined to form one solid piece – gaps are not permitted.
 8. The unit shall come with support structure.
 9. The Cabinet shall be factory Parts Warranted for 10 Years.
- C. Heat Exchanger:
1. The Heat exchanger shall be of copper and aluminum construction, composed of round, seamless circulation tubes pure red copper, and two brass collector manifolds.
 2. The Fins shall be connected to the heat exchanger by expansion method only.
 3. The Heat exchanger shall be factory pressure tested to 300 PSI and rated to 150 PSI.
 4. The Heat exchanger shall have ASTM G53 certification.
 5. Heating and cooling by means of one single coil for the 2 pipe application.
 6. The Heat Exchanger fins shall be corrugated by design for greater heat transfer.
 7. The Heat Exchanger shall be factory Parts Warranted for 10 Years.
- D. The Support Frame:
1. The unit is equipped with a PVC condensation collecting tray and drain.
 2. Insulation to avoid the formation of condensation and to reduce the noise.
- E. Fan and Motor:
1. Static and dynamically balanced aluminum or ABS fan units. An electronic brushless synchronous motor with permanent magnets, controlled by a frequency and amplitude modulated inverter which generates a sinus-shaped voltage. The inverter is driven by a single-phase 120Vac 60Hz. Source is allowed, external speed control of the fans is not provided. Fixed speed motors are allowed. The motor is provided with internal protection. Provide with filter rack for installation of 1" thick 30% filter. Supply Voltage 120V.
 2. ECM fans warranted for standard 2 years.
 3. ECM fans may include 0-10V analog controls with OPTIONAL ON/OFF fan control based on water temperature through the coil (no DDC connection needed when this option is selected).

- A. Unit Performance:
 - 1. Units shall carry the ARI compliance label.
 - 2. Units shall be safety certified in accordance with UL Standard UL1995, and ANSI Standard Z21.47.
- B. Unit Construction:
 - 1. Unit shall be completely factory assembled, piped, wired and shipped in one piece.
 - 2. Cabinet shall be constructed entirely of G90 galvanized metal with the exterior constructed of 20 gauge or heavier material.
 - 3. Access to compressor(s), controls, filters, blower, heating section, and other items needing periodic checking or maintenance shall be through hinged access doors.
 - 4. The interior airside of the cabinet shall be entirely insulated on all exterior panels with 1" thick, fiberglass insulation.
- C. Blowers:
 - 1. Blower(s) shall be entirely self-contained on rubber-in-shear rail.
 - 2. All supply air blowers shall be direct drive.
- D. Heating Coil: Hydronic coils shall be constructed with copper tubes and mechanically bonded aluminum corrugated plate fins. All coils shall have aluminum individual unshared fin surfaces. An air brake shall exist between coils. Hydronic coils shall be furnished with a threaded drain plug at the lowest point. A manual air vent shall be provided at the high point of the coil. Unit shall contain a single hydronic coil for both heating water and chilled water. Provide with condensate pan.
- E. Filters:
 - 1. Unless otherwise noted, unit to be furnished with 1" pleated throw away supply air filters, see previous specification section.
 - 2. Provide one complete extra set of filters for replacement once building flush out or construction is complete.
- F. Provide with factory relay for fan operation and transform for low voltage control power. Provide with factory extended end for pipe connection.
- G. Approved Manufacturers: Trane, Daikin, Johnson Controls, Carrier, Enviro Tech, or Modine.

2.3 UNIT VENTILATOR

- A. General:
 - 1. Unit ventilators shall be constructed of 16-gauge furniture quality steel, with exposed edges rounded and metal top.
 - 2. Front panels shall be retained by a minimum of three Allen wrench operated camlocks. The camlock heads shall be surrounded by a plastic inset to prevent paint damage.
 - 3. All steel unit ventilator surfaces shall be cleaned, phosphatized, polished, rinsed and dried before application of final finish coat. The final finish shall be applied by an electrocoat paint system. Paint film shall be at a dry film thickness of 7/10 mil with no visible run marks. Units shall be supplied in one of eight decorator colors as selected by the architect.
 - 4. Unit ventilator discharge grilles shall be constructed of heavy steel bars welded in place as an integral part of the unit structure. Easily cleaned sight blockoffs shall be installed below the grille in the end pockets.
 - 5. Unit inlet grilles shall be easily removable for easy filter access by loosening two camlocks.
- B. Installation: Unit ventilator end pockets shall be at least 13" wide and provided with removable outside ends to allow fullest access for easy field installation of valves and piping. The unit shall

have large pipe access openings in the bottom of both end pockets and large knockouts for piping and electrical connection in the back of both ends. Pipe chase across the back of the unit for field installation of crossover piping or running of electrical wiring as required.

- C. Dampers:
1. Unit ventilators shall be equipped with dual blade type mixing dampers to ensure proper modulation and mixing of return and outdoor air. A continuous divider shall be placed between the damper blades to separate the fresh air and return air compartments and positively prevent blow-thru.
- D. Fan Board Assembly:
1. The unit ventilator fan board assembly shall be a single, rigid assembly and include the fans, fan housings, bearings, fan shaft and motor. The fan motor shall be mounted on the fan board.
 2. The wrap around portion of the fan housings shall be constructed of six-pound density molded fiberglass, at least 3/4" thick, and vinyl coated on the exterior surface.
- E. Motors: Motors shall be EC type. Unit shall have 3 fan speeds. Motor speed shall not be affected by damper positions or filter loading. The motor shall be easily removable without removing the fan board.
- F. Coils: Hydronic coils shall be constructed with copper tubes and mechanically bonded aluminum corrugated plate fins. All coils shall have aluminum individual unshared fin surfaces. An air brake shall exist between coils. Hydronic coils shall be furnished with a threaded drain plug at the lowest point. A manual air vent shall be provided at the high point of the coil. Unit shall contain a single hydronic coil for both heating water and chilled water. Provide with condensate pan.
- G. Filters: Each unit shall be equipped with a single 1" thick replaceable media filter frame with MERV 8 polyester media. Filter shall be accessible without removal of the unit front panel.
- H. Sound:
1. Sound data for the unit shall be based on tests in a sound laboratory reverberant room strictly conforming to ANSI S1.32-82. The test procedures for determining the unit sound level shall be in accordance with ARI Standard 350-86. Sound data must be accurate to within +3 db in the first and second octave bands and +2 db in the third through eighth octave bands.
 2. Where the manufacturer's sound data is not published, the company must certify that sound data conforms with the above requirements. If the manufacturer cannot provide acoustical data in accordance with the requirements given above, the contractor must submit certified data that the specified units have been tested in an independent acoustics laboratory, capable of testing equipment at specified operating conditions, to determine sound power level by octave band.
 3. Where units do not meet the specified maximum sound power level given, they must operate at reduced rpm so as to comply. In this case, the units will be sized so as to provide the specified cfm at the reduced rpm.
- I. Controls:
1. Controls shall be field installed. See control specification section and drawings for more information.
- J. Approved Manufacturers: Daikin, Johnson Controls, or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

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

3.2 ROOF MOUNTED EQUIPMENT INSTALLATION

- A. All roof mounted mechanical equipment shall be supported and seismically anchored on leveled, flashed and counterflashed 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 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.

3.3 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. Lubrication: All moving and rotating parts shall be lubricated in accordance with the manufacturer's recommendations prior to start-up.
- C. 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.

3.4 CONTROLS

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

3.5 RESTORATION OF EXISTING HVAC EQUIPMENT

- A. General: Where restoration, refurbish, or rebuild type of work is indicated, include the following as minimum required work.
 1. Replace motors as noted, belts (matched set on multiple belt systems), sheaves, and bearings. Motors shall be per 23 05 00 with shaft grounding at VFD driven motors. Belts and sheaves per 23 05 00. Replace backdraft dampers not integral to exhaust fans.
 2. Bearings shall be manufactured by SKF, Fafnir or Dodge. Provide submittal. Bearings shall have zone harden path for bearing surface and 120° set screws. Do not use eccentric collar bearings. Provide with new housing (pillow block, side casing flange) etc. Match bearing housing style currently installed. Prior to any replacement work at air handlers complete a vibration analysis of fan, drive, bearing and shaft. Firm completing the analysis shall specialize in this service. (OTS Precision Balancing or approved). Technician completing the bearing replacement shall specialize in this service. If after the bearing replacement is complete fan operation is noisy, or vibrates to a level determined by Engineer to be unacceptable, replacement of all rotating devices shall be at the Contractors expense.
 3. Replace flex connectors and supply and return, OSA, relief duct connections.
 4. Replace magnetic starter(s) and overload protective devices. See Section 23 05 00 for VFD or starter. See drawings for where VFD's are required.
 5. Replace filters media. See Section 23 40 00.
 6. Where missing, provide filter close off panels to bridge the gap between air handler wall and nominal filter sizes. Close off panels shall be no wider than 2".
 7. Clean unit casing(s), plenum(s), fan scroll(s) and damper blades.

8. Vacuum clean entire air handler enclosure.
9. At air handlers clean fan wheels from low pressure and high pressure side with same method as coil above. Ensure fans are installed correctly if removed for cleaning.
10. Clean damper surfaces and adjust linkage to ensure dampers close/open properly.
11. Clean existing return air and outside air ductwork re-used, see Section 23 30 00 for more information.

3.6 UNIT VENTILATOR INSTALLATION

- A. Leveling legs may be necessary at both ends of the unit to facilitate alignment and leveling. Units are built into existing casework and/or elevated in case work. Modify existing base or provide new as required.

END OF SECTION

HVAC AIR CLEANING DEVICES

PART 1 - GENERAL

1.1 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, and 21 13 00, Fire Protection also apply to this section.

1.2 QUALITY ASSURANCE

- A. Air Equipment Rating: In accordance with ASHRAE certified rating procedures.
- B. See section 23 08 00 for commissioning requirements.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 AIR FILTERS

- A. Disposable Media, 30% Efficient Filters:
 - 1. Disposable, preformed media, pleated 2" thick cartridge type with minimum 16 gauge steel holding frames. Average ASHRAE test efficiency of 30% or greater with initial pressure drop across the clean filter bank not exceeding 0.3" wg when operating at full rated filter capacity. The filter media shall have an Underwriters Laboratories Class II 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. Farr 30/30, Airguard DP2-40, Eco-Air C35 and American Air Filter Type AM-AIR 300X or approved substitute.

PART 3 - EXECUTION

3.1 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.

END OF SECTION

HEAT EXCHANGERS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide HVAC 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.

1.2 QUALITY ASSURANCE

- A. Air Handling Equipment: Rated in accordance with AMCA certified rating procedures and AMCA labeled.
- B. Air Conditioning and Refrigeration Equipment Rating: Rated in accordance with ARI certified rating procedures and ARI labeled.

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 HEATING WATER COILS

- A. Non-ferrous extended surface, counterflow serpentine type with heavy gauge galvanized steel casing suitable for mounting required. Assembled with 5/8" OD x 0.020" thick copper tubes brazed to copper headers with drain and vent tapings. Copper or aluminum fins mechanically bonded to tubes and spaced a maximum of 12 fins per inch. Construction shall allow for expansion and contraction without developing leaks. Permanently label each coil in accessible location with all operating parameters.

2.2 CHILLED WATER COOLING COIL

- A. Non-ferrous extended surface, counterflow serpentine type with heavy gauge galvanized steel casing with double sloped, non-ferrous drain pan suitable for mounting required. Assembled with 5/8" OD x 0.020" thick copper tubes brazed to copper headers with one complete circuit distributor for each capacity step of the compressor. Provide interlaced coils for 2 circuit condensing units. Aluminum fins mechanically bonded to tube and spaced a maximum of 12 fins per inch. Construction shall allow for expansion and contraction without developing leaks. Permanently label each coil in accessible location with all operating parameters.

PART 3 - EXECUTION

3.1 INSTALLATION

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

- B. Piping: Refer to applicable sections for piping, valves, insulation, painting, etc.

END OF SECTION

AIR-COOLED LIQUID CHILLER

PART 1 - GENERAL

1.1 SYSTEM DESCRIPTION

- A. Microprocessor controlled, air-cooled liquid chiller utilizing scroll compressors, low sound fans, electronic expansion valve, hydronic pump system.

1.2 QUALITY ASSURANCE

- A. Unit shall be rated in accordance with AHRI Standard 550/590, latest edition (U.S.A.) and all units shall be ASHRAE 90.1 compliant.
- B. Unit construction shall comply with ASHRAE 15 Safety Code, UL latest edition, and ASME applicable codes (U.S.A. codes).
- C. Unit shall be manufactured in a facility registered to ISO 9001 Manufacturing Quality Standard.
- D. Unit shall be full load run tested at the factory.

1.3 DELIVERY, STORAGE AND HANDLING

- A. Unit controls shall be capable of withstanding 150 F (66 C) storage temperatures in the control compartment.
- B. Unit shall be stored and handled per unit manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 EQUIPMENT

- A. Manufacturer: Carrier, York (Johnson Controls), Trane, or Daikin.
- B. General: Factory assembled, single-piece chassis, air-cooled liquid chiller. Contained within the unit cabinet shall be all factory wiring, piping, controls, refrigerant charge (R-410A), and special features required prior to field start-up.
- C. Unit Cabinet:
 - 1. Frame shall be of heavy-gage, galvanized steel.
 - 2. Exterior panels shall be galvanized steel with a baked enamel powder or pre-painted finish.
 - 3. Cabinet shall be capable of withstanding 500-hour salt spray test in accordance with the ASTM (U.S.A.) B-117 standard.
- D. Fans:
 - 1. Standard condenser fans shall be direct-driven, 9-blade airfoil cross-section, reinforced polymer construction, shrouded-axial type, and shall be statically and dynamically balanced with inherent corrosion resistance.
 - 2. Fan operation shall allow reduced sound levels during scheduled unoccupied operating periods. Manufacturers without unoccupied reduced sound capability shall submit 1/3 octave band data and sound power data as measured according to AHRI 370 as confirmation of unit sound characteristics.
 - 3. Air shall be discharged vertically upward.
 - 4. Fans shall be protected by coated steel wire safety guards.
- E. Compressor/Compressor Assembly:
 - 1. Fully hermetic, direct-drive, scroll type compressors.

2. Compressor motors shall be cooled by refrigerant gas passing through motor windings and shall have either internal line break thermal and current overload protection or external current overload modules with compressor temperature sensors.
 3. Compressors shall be mounted on rubber in shear vibration isolators.
 4. Each compressor shall be equipped with crankcase heaters to minimize oil dilution.
 5. Chillers with less than 6 stages of operation are not allowed.
- F. Cooler:
1. Cooler shall be rated for a refrigerant working-side pressure of 450 psig (3103 kPa) and shall be tested for a maximum waterside pressure of 150 psig (1034 kPa) when optional hydronic package is installed.
 2. Shall be single-pass, ANSI type 316 stainless steel, brazed plate construction.
 3. Shell shall be insulated with 3/4-in. (19 mm) closed-cell, polyvinyl-chloride foam with a maximum K factor of 0.28.
 4. Shall incorporate 2 independent refrigerant circuits.
 5. Cooler shall have optional factory-installed heater, to protect cooler from ambient temperature freeze down to 0° F.
 6. Unit shall be provided with a factory-installed flow switch.
 7. All connections internal to the unit shall use standard Victaulic-type fittings.
 8. Cooler fluid inlet line shall have a 40 mesh strainer just ahead of the cooler.
 9. Include factory freeze protection (heat trace) of water carrying components to factory pipe terminations. Provide power to devices through unit power connection.
- G. Condenser:
1. Coil shall be air-cooled heat exchanger with microchannel coils and shall have a series of flat tubes containing a series of multiple, parallel flow microchannels layered between the refrigerant manifolds.
 2. Coils shall consist of a two-pass arrangement. Coil construction shall consist of aluminum alloys for fins, tubes, and manifolds in combination with a corrosion-resistant coating.
 3. Tubes shall be cleaned, dehydrated, and sealed.
 4. Assembled condenser coils shall be leak tested and pressure tested at 656 psig (4522 kPa).
- H. Refrigeration Components:
1. Refrigerant circuit components shall include filter drier, moisture indicating sight glass, electronic expansion device, discharge and liquid service valves and complete operating charge of sides both refrigerant R-410A and compressor oil.
- I. Controls, Safeties, and Diagnostics:
1. Unit controls shall include the following minimum components:
 - a. Microprocessor with non-volatile memory. Battery backup system shall not be accepted.
 - b. Separate terminal block for power and controls.
 - c. Control transformer to serve all controllers, relays, and control components.
 - d. ON/OFF control switch.
 - e. Replaceable solid-state controllers.
 - f. Pressure sensors shall be installed to measure suction and discharge pressure for each circuit. Thermistors shall be installed to measure cooler entering and leaving fluid temperatures, outdoor ambient temperature, and suction temperature. Provision for field installation of accessory sensor to measure compressor return gas temperature.
 2. Unit controls shall include the following functions:
 - a. Automatic circuit lead/lag for dual circuit chillers.
 - b. Hermetic scroll compressors are maintenance free and protected by an auto-adaptive control that minimizes compressor wear.
 - c. Capacity control based on leaving chilled fluid temperature and compensated by rate of change of return-fluid temperature with temperature set point accuracy to

- 0.1° F (0.06° C).
- d. Limiting the chilled fluid temperature pulldown rate at start-up to an adjustable range of 0.2° F to 2° F (0.11° C to 1.1° C) per minute to prevent excessive demand spikes at start-up.
 - e. Seven-day time schedule.
 - f. Leaving chilled fluid temperature reset from return fluid and outside air temperature.
 - g. Timed maintenance scheduling to signal maintenance activities for pump, condenser coil cleanings, strainer maintenance and user-defined maintenance activities.
 - h. Low ambient protection to energize cooler and hydronic system heaters.
 - i. Periodic pump start to ensure pump seals are properly maintained during off-season periods.
 - j. Single step demand limit control activated by remote contact closure.
 - k. Nighttime sound mode to reduce the sound of the machine by a user-defined schedule.
3. Diagnostics:
- a. The control panel shall include, as standard, a scrolling marquee display capable of indicating the safety lockout condition by displaying a code for which an explanation may be scrolled at the display.
 - b. Information included for display shall be:
 - 1) Compressor lockout.
 - 2) Loss of charge.
 - 3) Low fluid flow.
 - 4) Cooler freeze protection.
 - 5) Cooler set point.
 - 6) Chilled water reset parameters.
 - 7) Thermistor and transducer malfunction.
 - 8) Entering and leaving-fluid temperature.
 - 9) Compressor suction temperature.
 - 10) Evaporator and condenser pressure.
 - 11) System refrigerant temperatures.
 - 12) Chiller run hours.
 - 13) Compressor run hours.
 - 14) Compressor number of starts.
 - 15) Low superheat.
 - 16) Time of day:
 - a) Display module, in conjunction with the microprocessor, must also be capable of displaying the output (results) of a service test. Service test shall verify operation of every switch, thermistor, fan, and compressor before chiller is started.
 - b) Diagnostics shall include the ability to review a list of the 20 most recent alarms with clear language descriptions of the alarm event. Display of alarm codes without the ability for clear language descriptions shall be prohibited.
 - c) An alarm history buffer shall allow the user to store no less than 20 alarm events with clear language descriptions, time and date stamp event entry.
 - d) The chiller controller shall include multiple connection ports for communicating with the local equipment network.
 - e) The control system shall allow software upgrade without the need for new hardware modules.
4. Safeties:
- a. Unit shall be equipped with thermistors and all necessary components in conjunction with the control system to provide the unit with the following protections:
 - 1) Loss of refrigerant charge.
 - 2) Reverse rotation.

- 3) Low chilled fluid temperature.
 - 4) Thermal overload.
 - 5) High pressure.
 - 6) Electrical overload.
- b. Factory pump motor shall have external overcurrent protection.
- J. Operating Characteristics:
1. Unit shall be capable of operating down to 45 F.
 2. Unit shall be capable of starting and running at outdoor ambient temperatures up to 120 F (50 C) for all sizes. Unit shall additionally be able to stay online when running with a 125 F (52 C) ambient temperature.
 3. Unit shall be capable of starting up with 95 F (35 C) entering fluid temperature to the cooler.
- K. Fan Motors:
1. Condenser fans shall be direct-drive Aero-Acoustic™ type, discharging air vertically upward.
 2. All condenser fan motors shall be totally enclosed 3-phase type with permanently lubricated ball bearings, class F insulation and internal, automatic reset thermal overload protection or manual reset calibrated circuit breakers.
 3. Shafts shall have inherent corrosion resistance.
 4. Fan blades shall be statically and dynamically balanced.
 5. Condenser fan openings shall be equipped with PVC coated steel wire safety guards.
- L. Electrical Requirements:
1. Unit/module primary electrical power supply shall enter the unit at a single electrical box.
 2. Unit shall operate on 3-phase power at the voltage shown in the equipment schedule.
 3. Control points shall be accessed through terminal block.
 4. Unit shall be shipped with factory control and power wiring installed.
 5. Provide with factory circuit breaker with exterior locking handle.
- M. Chilled Water Circuit:
1. Chilled water circuit shall be rated for 300 psig (2068 kPa).
 2. Solid-state flow monitor with integral relay shall be factory installed and wired.
 3. Brass body strainer with 40 mesh screen and ball type blow down.
- N. Special Features:
1. Security Grilles/Hail Guards: Unit shall be supplied with factory or field-installed, louvered, sheet metal panels which securely fasten to the chiller and provide condenser coil protection against hail and other physical damage. Provide wire guards entirely covering the sides of the chiller below the coil section.
 2. Vibration Isolation: Vibration isolation pads shall be supplied for field installation at unit mounting points. Pads shall help to reduce vibration transmission into the occupied space.
 3. BACnet Communication Option: Shall allow the integration with a BACnet MS/TP network.
 4. Freeze Protection Cooler Heaters: Cooler heaters shall provide protection from cooler freeze-up to 0°.
 5. Low Sound Package: Low-sound Condenser fans to provide chiller sound reduction.
 6. High SCCR (Short Circuit Current Rating): 10 KAIC Minimum.
 7. Compressor Suction Service Valves: Shall provide a suction service valve per circuit, which is in addition to the standard discharge service valve.
 8. Controls: Operation shall be from BACnet Integration. See specification for sequence.
- O. Warranty:
1. Standard Warranty (Domestic): The refrigeration equipment manufacturer's guarantee shall be for a period of one year from date of equipment start-up but not more than 18 months from shipment. The guarantee shall provide for repair or replacement due to

- failure by material and workmanship that prove defective within the above period, excluding refrigerant.
2. 1st Year Labor Warranty: Entire unit
 3. Extended Compressor Warranty: 5 years parts and labor.
 4. Refrigerant Warranty: None.
 5. Delay Warranty Start: None.
- P. 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.
- Q. 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.
- R. Engage a factory authorized service representative to train Owner's maintenance personnel to adjust, operate and maintain the entire Make-Up Air unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

END OF SECTION

TERMINAL HVAC EQUIPMENT

PART 1 - GENERAL

1.1 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.

1.2 QUALITY ASSURANCE

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

1.3 SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SMALL PACKAGED HVAC UNITS

- A. Non-Ducted, Split System Cooling Unit with One Indoor and One Outdoor Unit:
 - 1. Indoor Section: Non-ducted, compact fan coil unit designed for wall mounting.
 - 2. Outdoor Section: Capacity matched with indoor section, steel cabinet with hermetically sealed compressor, accumulator, crankcase heater, high and low pressure switches, restart delay relay, and propeller fans.
 - 3. Refrigerant Piping: See Section 23 23 00.
 - 4. Unit shall be R-410A
 - 5. Power for indoor unit shall be derived from outdoor unit for systems smaller than 2-1/2 tons.
 - 6. Provide with integral pump for location where gravity drain is not indicated on drawings.
 - 7. Acceptable Manufacturers: Carrier, Daikin or approved.
 - 8. Minimum efficiency shall be 18 SEER per AHRI 210/240 test procedure.
 - 9. Provide with wired wall thermostat.
 - 10. Daikin or LG only.

2.2 NON-DUCTED, SPLIT SYSTEM COOLING UNIT WITH MULTIPLE INDOOR UNITS TO ONE OUTDOOR UNIT

- A. Outdoor Unit:
 - 1. General: The outdoor unit shall be used specifically with indoor components manufactured by the same manufacturer. The outdoor units shall be equipped with multiple circuit boards that interface to the controls system and shall perform all functions necessary for operation. Each outdoor unit module shall be completely factory

assembled, piped and wired and run tested at the factory.

- a. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s).
 - b. Outdoor unit shall have a sound pressure rating no higher than 60 dB(A).
 - c. The outdoor unit shall have an accumulator with refrigerant level sensors and controls.
 - d. The outdoor unit shall have a high pressure safety switch, over-current protection, crankcase heater and DC bus protection.
 - e. The outdoor unit shall be capable of operating in heating mode down to -4°F ambient temperature or cooling mode down to 23°F ambient temperature, without additional low ambient controls.
 - f. The outdoor unit shall not cease operation in any mode based solely on outdoor ambient temperature.
 - g. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained.
 - h. Control system shall include hardware to integrate to BACnet BAS.
2. Unit Cabinet: The casing(s) shall be fabricated of galvanized steel, bonderized and finished. Units cabinets shall be able to withstand 960 hours per ASTM B 117 criteria for seacoast protected models.
3. Fan:
- a. Each outdoor unit module shall be furnished with one direct drive, variable speed propeller type fan. The fan shall be factory set for operation under 0 in. WG external static pressure, but capable of normal operation under a maximum of 0.24 in. WG external static pressure via dipswitch.
 - b. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
 - c. All fan motors shall be mounted for quiet operation.
 - d. All fans shall be provided with a raised guard to prevent contact with moving parts.
 - e. The outdoor unit shall have vertical discharge airflow.
4. Refrigerant R410A refrigerant shall be required.
5. Coil:
- a. The outdoor coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
 - b. The coil fins shall have a factory applied corrosion resistant blue-fin finish.
 - c. The coil shall be protected with an integral metal guard.
 - d. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.
6. Compressor:
- a. Each outdoor unit module shall be equipped with one inverter driven scroll hermetic compressor. Non inverter-driven compressors shall not be allowed.
 - b. A crankcase heater(s) shall be factory mounted on the compressor(s).
 - c. The outdoor unit compressor shall have an inverter to modulate capacity. The capacity shall be completely variable with a turndown of at least 29% of rated capacity, depending upon unit size.
 - d. The compressor will be equipped with an internal thermal overload.
 - e. The compressor shall be mounted to avoid the transmission of vibration.
7. Electrical:
- a. See electrical drawings for power requirement.
 - b. The outdoor unit shall be controlled by integral microprocessors.
 - c. The control circuit between the indoor units, branch controller and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

B. Wall-mounted Indoor Unit:

1. General: Wall-mounted indoor unit section and shall have a modulating linear expansion device.
2. Indoor Unit: The indoor unit shall be factory assembled, wired and run tested.

Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, an auto restart function, and a test run switch. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory.

3. Unit Cabinet:
 - a. The casing shall have a white finish.
 - b. Multi directional drain and refrigerant piping offering four (4) directions for refrigerant piping and two (2) directions for draining shall be standard.
 - c. There shall be a separate back plate which secures the unit firmly to the wall.
 4. Fan:
 - a. The indoor fan shall be an assembly with one or two line-flow fan(s) direct driven by a single motor.
 - b. The indoor fan shall be statically and dynamically balanced to run on a motor with permanently lubricated bearings.
 - c. A manual adjustable guide vane shall be provided with the ability to change the airflow from side to side (left to right).
 - d. A motorized air sweep louver shall provide an automatic change in airflow by directing the air up and down to provide uniform air distribution.
 5. Filter: Return air shall be filtered by means of an easily removable, washable filter. Provide two sets to allow owner change-out without washing filter in unit.
 6. Coil:
 - a. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing.
 - b. The tubing shall have inner grooves for high efficiency heat exchange.
 - c. All tube joints shall be brazed with phos-copper or silver alloy.
 - d. The coils shall be pressure tested at the factory.
 - e. A condensate pan and drain shall be provided under the coil.
 - f. Both refrigerant lines to indoor unit shall be insulated.
 7. Electrical: See electrical drawings for power requirements.
 8. Controls: This unit shall use controls provided by manufacturer of indoor/outdoor equipment to perform functions necessary to operate the system.
 9. Provide each indoor unit with wired wall thermostat.
- C. Electrical Characteristics:
1. General: The control shall operate at 24VDC. Controller power and communications shall be via a common non-polar communications bus.
 2. Wiring: 1. Control wiring shall be installed in a system daisy chain configuration from indoor unit to ME remote controller to indoor unit, to the BC controller (main and subs, if applicable) and to the outdoor unit. Control wiring to remote controllers shall be run from the indoor unit terminal block to the controller associated with that unit.
 3. Control wiring for schedule timers, system controllers, and centralized controllers shall be installed in a daisy chain configuration from outdoor unit to outdoor unit, to system controllers, to the power supply.
 4. Wiring type: Wiring shall be 2-conductor (16 AWG), twisted shielded pair, stranded wire.
- D. Approved Manufacturers: Daikin as basis of design. LG is approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION OF SPLIT SYSTEMS

- 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.

- C. 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.
- D. Engage a factory authorized service representative to perform startup service. Clean entire unit, comb coil fins as necessary and clean filters. Measure and record electrical values for voltage and amperage. Refer to Division 23 "Testing, Adjusting and Balancing" and comply with provisions therein.
- E. Engage a factory authorized service representative to train owner's maintenance personnel to adjust, operate and maintain the unit. Refer to Division 01 Section Closeout Procedures and Demonstration and Training.

3.2 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. 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.

3.3 CONTROLS

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

END OF SECTION

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 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. Electric distribution equipment.
 - 2. Complete power systems, including panelboards, branch circuits, devices, etc.
 - 3. Connection of electrical equipment furnished under other Divisions of this Specification.
 - 4. Wiring to and connection of electrical equipment or appliances furnished outside of these Specifications and Contract but described on the Electrical Drawings.
 - 5. Special systems as specified herein.
 - 6. 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.

1.2 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.

1.3 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."

1.4 WORK OF OTHER DIVISIONS

- A. Work under this Division shall be conducted in a manner to cooperate with the installation of work of other Divisions.
- B. Control devices (i.e. magnetic starters) and control wiring relating to the heating, ventilating and air conditioning systems and plumbing 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.

1.5 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 cover 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.

1.6 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.
- B. The Architect reserves the right to require the submission of an actual sample of the specific item before the review and acceptance of any product as an equal to that specified.

1.7 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.

1.8 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.

1.9 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 of bid alternates 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

2.1 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.

2.2 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.

2.3 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.

2.4 FIRE RATINGS

- A. Electrical items (light fixtures, boxes, etc.) 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

3.1 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, lighting fixtures, 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.

3.2 EXCAVATING AND BACKFILL

- A. Provide trenching, backfilling, compaction, repaving or other site restoration as required by the work done in this Division. Minimum trench depth shall be 36" unless otherwise noted. Install 6" wide red vinyl tape with lettering "Caution: Buried Electric Line Below" 18" above all buried electric lines in this contract.
- B. Excavating and backfilling required for installation of electrical work shall be performed in accordance with requirements specified in Division 31. Backfill in excavations outside of building may be excavated material from site containing no rocks over 3/4" in diameter.
- C. Provide all necessary backfill materials, whether from site excavations or from off-site borrows, to completely fill excavations. Coordinate patching of all asphalt or concrete surfaces disturbed by this work with the Owner.
- D. Bored Crossings: Casing shall be smooth steel pipe fabricated in sections for welded joints, of size sufficiently large to provide adequate working space to properly install conduits, continuous butt welded at joints for rigid, watertight encasement, minimum thickness of 0.188" for casing under 14" diameter, and 0.281" for casings 14" and larger diameter.

3.3 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, light fixtures 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.

3.4 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 and lighting 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. Lighting dimensions are to the bottom of suspended fixtures; mount panelboards 72" to top handle; mount devices above counters, 12" above counter or 4-1/2" above backsplash, whichever is greater; and receptacles in unfinished areas 48".
- G. All raceways and wiring shall be concealed where possible. All wiring devices, recessed light fixtures, etc., 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.

3.5 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.

3.6 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.

3.7 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.

3.8 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.

3.9 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.

3.10 DEMOLITION AND REMODELING NOTES

- A. Keep all systems functioning with minimum system interruptions. Power, telephone, and life-safety system interruptions shall be coordinated with the Owner.
- B. The Contractor shall have the option to reuse existing raceways as far as practical, provided it remains code accessible, concealed by new work, and not in conflict with demolition.
- C. The Electrical Drawings are not wiring diagrams but schematic plans prepared to aid the Contractor in bidding the electrical revisions and additions shown. It is intended that the Contractor shall visit the job site prior to bidding to verify all existing conditions which will be affected by or will have affect upon the required revisions and additions, prepare a wiring diagram, secure all permits and accomplish the work, securing approval from the Architect for deviations from the schematic plan.
- D. Remove all unused lighting fixtures from remodel area prior to completion of the work.
- E. All removed lighting fixtures and other electrical devices accumulated during the demolition process shall become the property of the Owner and shall be transported by the Contractor to the Owner's designated storage prior to job completion.
- F. Remove all existing fixtures, clocks, horns, switches, receptacles, and other wiring devices from surfaces scheduled for remodeling. Replace devices as required following application of remodeling finishes, installing box extensions where required.
- G. All lighting fixtures in the project area scheduled to be relocated shall be relamped, repaired as required, and cleaned.
- H. All relocated grid fixtures must be equipped with class "P" ballast protection. Those fixtures without class "P" ballasts shall be retrofitted with new external ballast fusing, complying with NEC 410. The contractor shall have the option to furnish new fixtures, matching the existing as approved by the Engineer or other new fixtures as approved by the Engineer.
- I. Unless shown otherwise, every attempt shall be made to retain existing 120 volt receptacle outlets in use (whether shown on the plan or not). Replace all existing non-grounded receptacles with grounded type. Prove existing conduit ground or provide green ground conductor which proves to the service entrance ground. New and existing 120 volt receptacle (re)wiring shall typically not exceed 6 duplex receptacles per 20 ampere circuit.
- J. If abandoned outlets serve as feed-through boxes for other existing electrical equipment which is being retained, new conduit and wire shall be provided to bypass the abandoned outlets. If existing conduits pass through partitions, floors, or ceilings which are being removed or remodeled, new conduit and wire shall be provided to route around the removed area and maintain service to the existing load.
- K. Where devices are removed from a wall to remain, provide blank cover plate similar to other cover plates in that area.
- L. The contractor shall trace the remaining load on existing branch circuits, remove all unused wiring, make code approved circuit consolidations (where possible) to conserve and update use of existing capacity, and provide new updated panel schedules. Provide copies of resulting panel schedules and transmit with the electrical record drawing set, on which the contractor shall also note "as-built" circuit number assignments.
- M. Where existing electrical items are scheduled for removal, also remove associated raceways,

boxes, conduits, etc. as far as practical.

- N. Where replacement boxes are deeper than existing boxes being replaced (i.e. panelboard tubs), provide appropriate trim around box to provide for a neat and workmanlike appearance. Verify exact methods and materials with Architect.
- O. Where equipment is removed and/or replaced, patch and paint surface newly exposed to match surrounding surface finish. Verify exact methods and materials with Architect.

END OF SECTION

ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 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.

1.3 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.

1.4 SUBMITTAL AND RECORD DOCUMENTATION

- A. None required.

PART 2 - PRODUCTS

2.1 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.
- 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.

2.2 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

3.1 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.

3.2 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
Neutral - White
Ground - Green

251 to 600V btwn phases

Phase A - Brown
Phase B - Orange
Phase C - Yellow
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.

3.3 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.

3.4 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.

3.5 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

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 DESCRIPTION

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

1.2 SUBMITTAL AND RECORD DOCUMENTATION

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

PART 2 - PRODUCTS

2.1 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.

2.2 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 where boxes are not cast in place. Flush anchors or concrete inserts.
- D. Flush Ceiling Outlets: Steel City 6010 series or equal bar hangers.

2.3 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.

2.4 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.

2.5 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

3.1 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.

3.2 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.

3.3 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

1.1 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.

1.2 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.

1.3 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.

1.4 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 is not permitted.

1.5 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

2.1 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.

2.2 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.

2.3 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.

2.4 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.

2.5 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

3.1 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.

3.2 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

1.1 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.

1.2 SUBMITTAL AND RECORD DOCUMENTATION

- A. None required.

PART 2 - PRODUCTS

2.1 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

3.1 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

1.1 DESCRIPTION

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

1.2 COORDINATION

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

1.3 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.

1.4 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.

1.5 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

2.1 PANELBOARDS

- A. Panels shall be factory pre-assembled using tin-plated aluminum 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.

2.2 ACCEPTABLE MANUFACTURERS

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

PART 3 - EXECUTION

3.1 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

1.1 DESCRIPTION

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

1.2 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.

1.3 SUBMITTAL AND RECORD DOCUMENTATION

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

PART 2 - PRODUCTS

2.1 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. Switches connected to emergency circuits shall be red.
- 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. Receptacles connected to emergency circuits shall be red.
- 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. Plates on emergency receptacles and switches shall be red.
- 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.

- G. Tamper-resistant (child-proof) receptacles shall be a type which contains internal contacts which require the presence of both blades to energize the receptacle, and shall be UL 498 listed. Hubbell #HBLSG62H or equal.

2.2 ACCEPTABLE MANUFACTURERS

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

PART 3 - EXECUTION

3.1 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.
- F. In general, lighting switches shall be installed on latch side of doorway.

3.2 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.

3.3 LABELING

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

END OF SECTION

CIRCUIT PROTECTIVE DEVICES

PART 1 - GENERAL

1.1 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.

1.2 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

1.3 PRODUCT DELIVERY, STORAGE, AND HANDLING

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

1.4 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

2.1 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.
 5. Combination-type arc-fault circuit interrupter circuit breakers shall be UL 1699 listed.
- 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.

2.2 FUSES

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 i^2t 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 i^2t 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.

2.3 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

3.1 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.
- I. Circuit breakers shall be combination-type arc-fault circuit interrupter where serving dwelling unit areas as required by the NEC.

3.2 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

FENCES AND GATES

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide new fencing and gates at the chiller and generator pad as indicated on the Drawings and as specified herein.

1.2 REFERENCES

- A. ASTM International (ASTM):
 1. ASTM A53: Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 2. ASTM A121: Standard Specification for Metallic-Coated Carbon Steel Barbed Wire.
 3. ASTM A153: Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 4. ASTM A392: Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
 5. ASTM A653: Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 6. ASTM A764: Standard Specification for Metallic Coated Carbon Steel Wire, Coated at Size and Drawn to Size for Mechanical Springs.
 7. ASTM F567: Standard Practice for Installation of Chain-Link Fence.
 8. ASTM F626: Standard Specification for Fence Fittings.
 9. ASTM F1043: Standard Specification for Strength and Protective Coatings on Steel Industrial Fence Framework.
 10. ASTM A824: Standard Specification for Metallic-Coated Steel Marcellled Tension Wire for Use with Chain Link Fence.
 11. ASTM F900: Standard Specification for Industrial and Commercial Steel Swinging Gates.
- B. Federal Specifications: FS RR-F-191K/GEN: Fencing, Wire, and Post Metal (and Gates, Chain Link Fence Fabric).

1.3 QUALITY ASSURANCE

- A. Like items of materials provided hereunder shall be the end products of one manufacturer in order to achieve standardization for appearance, maintenance, and replacement.
- B. Provide complete, including all erection accessories, fittings and fastenings.
- C. Conform to applicable standards and specifications of the Chain Link Fence Manufacturers Institute.
- D. All dimensions and gages of material are subject to accepted steel producing industry tolerance standards.
- E. Qualification of Installer: Installer shall be experienced in fence installations and shall examine conditions under which fence and gates are to be installed. Installer to be approved by manufacturer.

1.4 SUBMITTALS

- A. Shop Drawings: Submit shop drawings, including fence layout, dimensions, details illustrating fence height, sizes of posts, rails, braces, gates, footings and accessories.
- B. Product Data: Submit product data illustrating materials to be used.
- C. Submit written certification that materials provided are of sufficient gage and strength and of appropriate quality for anticipated usage and the local climatic conditions.

FENCES AND GATES

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver material in undamaged condition in manufacturer's original packaging with all tags and labels intact and legible. Handle and store material in such manner as to avoid damage.
- B. Carefully store materials off the ground to provide proper protection against oxidation caused by ground moisture.

1.6 WARRANTY

- A. Provide manufacturer's written warranty guaranteeing against material defects and breakage for a minimum period of 1 year.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Materials shall be new and products of recognized, reputable manufacturers. Used, rerolled, or regalvanized materials are not acceptable.
- B. Steel pipe and other framework shall be hot-dip galvanized in accordance with ASTM A53 or per ASTM A653, Coating Designation G235. All accessories shall be hot-dip galvanized in accordance with ASTM A153.
- C. All galvanized surfaces damaged by field welding shall be field repaired in accordance with the manufacturer's recommendations.

2.2 FRAMEWORK

- A. General: FS RR-F-191K/GEN, Fencing, Wire, and Post Metal (and Gates, Chain Link Fence Fabric). Steel pipe, Grade A, heavy wall, round, shall be produced to conform to ASTM A53 standard weight (Schedule 40), except the hydrostatic testing requirement is waived. The product of the yield strength and the section modulus shall not be less than that of pipe conforming to ASTM A53. Standard post lengths for setting on or in concrete shall be as required for conditions shown.
- B. Overall Height of Fence: 6'-0".
- C. Posts and rail 4" and under will meet ASTM F 1043 Group 1-C.
- D. Posts 6 5/8" and 8 5/8" OD will meet ASTM F 1043 Group 1-A.
- E. Line Posts: 2-3/8" minimum outside diameter (O.D.) Schedule 40 galvanized steel pipe weighing 3.65 lb/ft.
- F. Terminal Posts (End, Corner, Angle, and Pull Posts) and Personnel Gate Posts: 2.875" minimum O.D. Schedule 40 galvanized steel pipe weighing 5.79 lb/ft.
- G. Post Footings: Fences 6' and under will have:
 - 1. 36" x 10" Terminal/Gate post footings.
 - 2. 24" x 8" Line post footings.
- H. Top Rail: 1.660" O.D. Schedule 40 galvanized steel pipe weighing 2.27 lb/ft.
- I. Gates: Gates will comply with ASTM F 1043 Group 1-C, ASTM F 900, and will have commercial grade hardware.

FENCES AND GATES

- J. Gate Frames:
1. Posts and Rails: Round:
 - a. Fence Height: 6 feet.
 2. Duty Rating: Heavy.
 3. Tube or Pipe Diameter and Thickness: According to ASTM F 761.
 - a. Brace Rail: 1.66".
 - b. Pedestrian Gate Frame: 2.0".
 - c. Line Post: 2.375".
 - d. End and Corner post: 2.875".
 4. Gates: Comply with ASTM F654 and the following:
 - a. Type II, double swing steel frame tubing.
 - b. Fabric Height: 2 inches.
 - c. Leaf Width: as indicated.
 5. Hardware: Latches permitting operation from both sides of gate, hinges, center stops. Fabricate latches with integral eye openings for padlocking; padlock accessible from both sides of gate.
 6. Metallic-Coated Steel: Posts, rails, and frames protected with an external coating of not less than 0.6 oz. of zinc/sq. ft., a chromate conversion coating, and a clear, verifiable polymer film; with an internal protective coating of not less than 0.6 oz. of zinc/sq. ft. or 81 percent, not less than 0.3-mil- thick, zinc pigmented coating.
- K. Swinging Gate: Hot dipped galvanized carbon steel pipe, 1.625" O.D., 2.27 pounds per lineal foot, minimum.

2.3 CHAIN LINK FABRIC

- A. Chain-link fabric to be galvanized before weave and meet ASTM A392 Class 1 (1.2 oz.) as manufactured by Pacific Fence & Wire Company or approved equal.
- B. Fence fabric will have a knuckle/knuckle selvage. The wire will have a minimum 9-gauge finish.
- C. The standard diamond size will be 2".
- D. Fabric ends shall occur only at terminal, corner, or pull posts.
 1. Attach fabric to terminal, corner, or pull posts with tension bars and tension bar clips with maximum 12" on center.
 2. Fasten fabric to line posts, top, brace, and bottom rails with tension wire with maximum 15" on center.

2.4 TIES OR CLIPS

- A. Of adequate strength, provided in sufficient number for attaching fabric to all line posts at intervals not exceeding 15" and not exceeding 24" when attaching fabric to top rail.

2.5 TENSION WIRE

- A. Galvanized tension wire will have a 7-gauge finish and meet ASTM A 824 Type II and will be Marcellled.
- B. Galvanized hog rings will be 9-gauge Class III and be spaced at 24" on center minimum.

2.6 FITTINGS

- A. Fittings shall be pressed steel of good commercial quality in conformance with ASTM F626. Steel fittings shall be galvanized with 1.8-ounce zinc per square foot of surface per ASTM A153.

FENCES AND GATES

- B. Standard Fence Fittings will meet ASTM F626 (Domestic).
- C. Heavy Brace and Tension Bands 1/8" x 1" are required.
- D. Fence ties are to be 11-gauge steel with frequency outlined in ASTM standard.

2.7 SWINGING GATE HARDWARE

- A. Provide hinge mechanisms to carry weight of gates and to operate smoothly.
 - 1. The hinges shall be designed to permit the gate to swing a full 180 degrees.
- B. Provide mounting surfaces and/or boxes as required for hardware mounting.
- C. Commercial grade fork latches are to be installed on gates and must be able to accommodate District padlocks.
 - 1. The gate latch shall be capable of retaining the gate in a closed position.
- D. Double Gate Latch: The gate latch shall be a drop rod or plunger bar arranged to engage the gate stop. Center drop rod or plunger bar shall not be used in areas with gravel when fence is located in landscaped area.
- E. Keepers shall be provided for each gate over 5' so that they do not swing unintentionally.

2.8 DECORATIVE SLATTING

- A. Fabricated from a combination of quality virgin and certified post consumer and post industrial polyethylenes, color pigments, and UV stabilizers. Thickness of slats to be 0.200" ±0.030" in "Black" color. Width of slats to be as required for the chain link mesh fabric. Provide with the manufacturer's top clip or bottom retainer for permanently locking the slats in place. Provide with the manufacturer's standard 15-year warranty.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Posts shall be set in concrete with fence post extending through bottom of concrete
- B. Top rails shall be installed through line post caps and spliced with 6" sleeves. Bottom rail or tension wire shall be installed uniformly 1" above finish grade.
- C. Fabric shall be installed taut, on outside of posts and rails, uniformly 1" above ground level.
- D. Install rigid, plumb, true, in alignment and in strict accordance with the manufacturer's written instructions and recommendations. Comply with applicable requirements of ASTM F567.
- E. Set posts plumb, 1/4" in 10 feet vertical tolerance. Set posts not less than 2'-6" deep in 12" diameter footings extending to bottom of posts and to 3" below finished grade.
- F. Equip each terminal, pull and gate post with brace rails and adjustable 3/8" diameter tension rods. Space rail couplings at 21'-0" centers maximum.
- G. Furnish continuous 7-gage coil spring tension wire at top of chain link fabric.
- H. Gate frames are to be plumb and level to allow gates to swing smoothly.
- I. Peen all bolts after nuts are tightened to prevent removal.

FENCES AND GATES

- J. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on exterior side of fence, and anchor to framework so that fabric remains in tension after pulling force is released. Make the attachments of the chain link to the posts with tension bars and bands. Tie wires for fabric shall be 9-gage and shall be given a minimum of two full wraps around the fabric at each connection. Space ties 24" on center maximum.
- K. Gate Installation:
 - 1. Swinging Gate: Install per the manufacturer's recommendations.
- L. Set fence and gate posts in concrete footings sized per fence manufacturer's recommendations.
- M. Adjust all moving parts to operate correctly at final acceptance and as required during warranty period.
- N. Decorative Slat Installation:
 - 1. Install at locations indicated on Drawings.
 - 2. Install slats vertically into the mesh and permanently retained into position with the manufacturer's securement system.

END OF SECTION