METROPOLITAN EXPOSITION RECREATION COMMISSION

RESOLUTION NO. 15-07

For the purpose of selecting Northwest Control Company, Inc. for the Arlene Schnitzer Concert Hall – "HVAC Controls Upgrade" and authorizing the General Manager of Visitor Venues to execute a contract with Northwest Control Company.

WHEREAS, the Arlene Schnitzer Concert Hall (ASCH) HVAC controls system has reached the end of its useful life and requires replacement; and

WHEREAS, the ASCH has very limited control of the HVAC system in the facility; and

WHEREAS, Portland'5 staff have worked with the Energy Trust of Oregon (ETO) to receive an incentive from the ETO in an amount up to 20% of the total project cost; and

WHEREAS, Section 7(B) of the Metropolitan Exposition Recreation Commission's (MERC) Contracting and Purchasing Rules, requires competitive sealed bids under ORS Chapter 279C for public improvements such as this project; and

WHEREAS, MERC staff has evaluated the bids and Northwest Control Company, Inc. is the lowest responsive and responsible bidder with a bid amount of two hundred sixty-nine thousand, two hundred seventy & 00/100 dollars ($269,270.00)

BE IT THEREFORE RESOLVED as follows:

1. MERC selects Northwest Control Company, Inc. as the lowest responsive and responsible bidder in response to the Request for Bids for the Arlene Schnitzer Concert Hall – HVAC Controls Upgrade.

2. MERC approves the contract with Northwest Control Company, Inc. in the form substantially similar to the attached Exhibit A and authorizes the General Manager of Visitor Venues to execute the contract on behalf of the Commission.

Passed by the Commission on May, 6 2015.

Chair

FOR Secretary/Treasurer

Approved As to Form:
Alison R. Kean, Metro Attorney

By: _____
Nathan A. S. Sykes
Deputy Metro Attorney

MERC STAFF REPORT

Agenda Item/Issue: For the purpose of selecting Northwest Control Company, Inc. for the Arlene Schnitzer Concert Hall -"HVAC Controls Upgrade" and authorizing the General Manager of Visitor Venues to execute a contract with Northwest Control Company, Inc.

Resolution No: 15-07 **Presented by:** Josh Lipscomb

Date: May 6, 2015

Background and Analysis: The current building controls system is twenty five years old, support from the manufacturer is limited as their personnel are no longer trained on a system of our vintage, and we have experienced random systemic failures. This project is the 2nd phase of 3 to replace the HVAC controls at each of the Portland'5 facilities. The Antoinette Hatfield Hall was the first building and is almost complete, The Keller Auditorium will be last. This project is budgeted in Fiscal Year 2015-16. We propose to start six weeks early to accommodate the estimated project timeline within the availability of the building's scheduled events.

Building operations and engineering staff are dependent on buildings control systems to deliver appropriate airflow and insure the comfort of our clients and patrons. The risks associated with losing control of the building systems are very significant. If we are unable to insure the appropriate minimum airflow requirements in our public spaces, then we cannot open our doors to the public.

Building controls systems have improved drastically in twenty five years leading to far more effective decision making with significantly more information available to building operators. We have designed a system and written a specification for all three buildings that can be deployed as money becomes available to fund the projects, but allows for one consistent web-based interface for operators and maximum flexibility for service maintenance vendors.

We expect significant energy use improvements with extensive HVAC scheduling capabilities, labor savings through significantly improved analytics and mobile diagnosis for engineers, and improved patron/client satisfaction by programming the controls system to independently respond to differing conditions in the theater.

The scope of work for this project includes replacement of the original Siemens HVAC building controls system (pneumatic) with a direct digital control (DDC) system to control HVAC. MERC Staff prepared and issued Bid Documents and a Request for Bids in accordance with MERC's Purchasing Policies for the HVAC Controls Upgrade at the Arlene Schnitzer Concert Hall.

MERC contracting code requires competitive sealed bids under ORS Chapter 279C for public improvements such as this HVAC controls upgrade project. As such, MERC is required to accept the lowest responsive and responsible bid. Through the venues' commitment to contracting with firms owned by and employing individuals from diverse backgrounds, MERC staff included in the bid documents good faith program requirements for outreach to the State of Oregon Certified Minority-Owned, Women-Owned and Emerging Small Business (MWESB) community and the First Opportunity Target Area (FOTA) community.

The program establishes procedures to maximize utilization of MBEs, WBEs and ESBs for MERC projects. The following steps required to help MERC monitor the usage of these firms, were outlined in the RFB and were included in the evaluation of bids:

> "1. Identify areas in which Bidder intends to use sub-contractors.
> 2. Attend the Pre-Bid meeting if held. Meet any MBE/WBE/ESB firms at the Pre-Bid meeting.
> 3. Contact several (or all) certified MBE/WBE/ESB firms listed (with the State of Oregon) to perform the work needed.
> Metro Procurement Services can provide Bidder with a list of firms upon request

bidsandproposals@oregonmetro.gov.
4. Negotiate with interested, available and capable MBE/WBE/ESB firms who submit competitive bids.
5. Report to MERC all sub-contractors contacted. Please include their response and price quoted.
6. List all sub-contractors that Bidder intend to use on this project.

Please note a selected MBE/WBE/ESB firm must be used unless MERC authorizes a substitution after contract award.

The following MBE/WBE/ESB Program forms are to be completed and returned as part of your Bid submission. Contact Procurement services at bidsandproposals@oregonmetro.gov if additional information is required."
In addition to these requirements, the RFB was published in the online version of El Hispanic News and the Daily Journal of Commerce, as well as ORPIN.

On March 25, 2015, MERC staff conducted a site walk for potential bidders in which 3 mechanical contractors and 4 subcontractors attended: One subcontractor was ESBs, one was a MBE and WBE and none were from the FOTA. Two bids were received on April 8, 2015 and ranged from $269,270.00 to $298,180.00. The lowest responsive and responsible bidder was Northwest Control Company, Inc., in the amount of two hundred sixty-nine thousand, two hundred seventy and 00/100 dollars ($269,270.00). The lowest responsive and responsible bidder, Northwest Control Company, Inc. did include an ESB subcontractor, Jobe Technologies (pipe insulation) for this project. Of the (3) ESB low voltage subcontractors contacted by Northwest Control Company, Inc., only 1 responded and declined a bid but did discuss future opportunity.

FISCAL IMPACT: This project is budgeted in FY 2015-16 in the amount of $275,000.00. There is enough budget appropriation authority in the MERC Fund to approve the entire contract amount in FY 2014-15. . The $269,270.00 bid amount and other associated costs (i.e. permitting) is expected to exceed the budget amount. Portland'5 forecasts budget savings from its FY 2015 Capital Program which will be carried over to FY 2016 to fund an ample contingency for this project. Additionally, the project cost is expected to be offset by both the estimated energy and operational labor savings, and by a rebate from the Energy Trust of Oregon (ETO).

RECOMMENDATION: Staff recommends that the Metropolitan Exposition-Recreation Commission, by Resolution No. 15-07, approve the contract award and written contract (attached hereto) with Northwest Control Company, Inc., for the amount of two hundred sixty-nine thousand, two hundred seventy & 00/100 dollars ($269,270.00) for the HVAC Controls Upgrade at the Arlene Schnitzer Concert Hall.

Metro | Exposition Recreation Commission
600 NE Grand Ave., Portland, OR 97232-2736
503-797-1700

Construction Agreement

MERC CONTRACT NO. 305019

THIS CONSTRUCTION AGREEMENT is between Metropolitan Exposition Recreation Commission, an appointed commission of Metro, located at 600 N.E. Grand Avenue, Portland, OR 97232-2736, referred to herein as "MERC" or "Metro," and Northwest Control Company, Inc., referred to herein as "Contractor," located at 8750 SE McLoughlin Blvd, Portland, OR 97269.

THE PARTIES AGREE AS FOLLOWS:

ARTICLE I
SCOPE OF WORK AND CONTRACT TERMS

CONTRACTOR shall perform the work and/or deliver to MERC the goods described in the Scope of Work attached hereto and incorporated herein as Attachment A. All services and goods shall be of good quality and otherwise in accordance with the Scope of Work. CONTRACTOR shall perform the work and/or deliver to MERC the goods described in the Scope of Work strictly in accord with the terms of this Construction Agreement and the General Conditions attached hereto and incorporated herein as Attachment B.

ARTICLE II
TERM OF CONTRACT

The term of this Contract shall be for the period commencing May 13, 2015 through and including December 2, 2015 Substantial completion per Section 9.4 of the General Conditions is August 21, 2015.

ARTICLE III
CONTRACT SUM AND TERMS OF PAYMENT

MERC shall pay the CONTRACTOR for work performed and/or goods supplied as described in the Scope of Work, in the maximum amount of TWO HUNDRED SIXTY-NINE THOUSAND, TWO HUNDRED SEVENTY AND NO/100THS DOLLARS ($269,270.00) (the "Maximum Price"). MERC shall not be responsible for payment of any materials, expenses or costs other than those which are specifically included in the Scope of Work. The Maximum Price includes all fees, costs and expenses of whatever nature. Each of MERC's payments to Contractor shall equal the percentage of the work Contractor accomplished during the billing period. Contractor's billing invoices shall include the MERC contract number, Contractor name, remittance address, invoice date, invoice number, invoice amount, tax amount (if applicable), and an itemized statement of work performed and expenses incurred during the billing period, and will not be submitted more frequently than once a month.

Contractor's billing invoices shall be sent to metroaccountspayable@oregonmetro.gov. The MERC contract number shall be referenced in the email subject line. Contractor's billing invoices for services through June 30 shall be submitted to Metro by June 30. Payment shall be made by MERC on a Net 30 day basis upon approval of CONTRACTOR invoice.

ARTICLE IV
BONDS

In addition, for public works subject to ORS 279C.800 to 279C.870, CONTRACTOR and every subcontractor shall have a public works bond required by 2005 Oregon Laws Chapter 360 filed with the Construction Contractors Board before starting work on the project, unless exempt under Section 2 of 2005 Oregon Laws Chapter 360.

ARTICLE V
PUBLIC CONTRACTS

All applicable provisions of ORS chapters 187 and 279A, 279B, and 279C and all other terms and conditions necessary to be inserted into public contracts in the State of Oregon, are hereby incorporated as if such provision were a part of this Agreement. Specifically, it is a condition of this contract that CONTRACTOR and all employers working under this Agreement are subject employers that will comply with ORS 656.017 as required by 1989 Oregon Laws, Chapter 684.

Construction Agreement

MERC CONTRACT NO. 305019

For public work subject to ORS 279C.800 to 279C.870, the CONTRACTOR shall pay prevailing wages. If such public work is subject both to ORS 279C.800 to 279C.870 and to 40 U.S.C. 276a, the CONTRACTOR and every subcontractor on such public work shall pay at least the higher prevailing wage. The CONTRACTOR and each subcontractor shall pay workers not less than the specified minimum hourly rate of wage in accordance with Section 7 of 2005 Oregon Laws Chapter 360. MERC shall pay an administrative fee as provided in ORS 279C.825(1) to the Bureau of Labor and Industries pursuant to the administrative rules established by the Commissioner of Labor and Industries. CONTRACTORS must promptly pay, as due, all persons supplying to such contractor labor or material used in this contract. If the CONTRACTOR or first-tier subcontractor fails, neglects, or refuses to make payment to a person furnishing labor or materials in connection with the public contract for a public improvement within 30 days after receipt of payment from the public contracting agency or a contractor, the CONTRACTOR or first-tier subcontractor shall owe the person the amount due plus shall pay interest in accordance with ORS 279C.515. If the CONTRACTOR or first-tier subcontractor fails, neglects, or refuses to make payment, to a person furnishing labor or materials in connection with the public contract, the person may file a complaint with the Construction Contractors Board, unless payment is subject to a good faith dispute as defined in ORS 279C.580. CONTRACTOR must pay any and all contributions and amounts due to the Industrial Accident Fund from contractor or subcontractor and incurred in the performance of the contract. No liens or claims are permitted to be filed against MERC on account of any labor or material furnished. CONTRACTORS are required to pay the Department of Revenue all sums withheld from employees pursuant to ORS 316.167.

For public improvement work all CONTRACTORS must demonstrate that an employee drug-testing program is in place.

ARTICLE VI
COUNTERPARTS

This Contract may be executed in counterparts or multiples, any one of which will have the full force of an original.

ARTICLE VII
DELIVERY OF NOTICES

Any notice, request, demand, instruction, or any other communications to be given to any party hereunder shall be in writing, sent by registered or certified mail or fax as follows:

To Contractor: Randy Rollins
Northwest Control Company, Inc
PO Box 22919
Milwaukie, OR 97269
503-656-7609 fax

To Metro: Metro Procurement Services
600 NE Grand Ave
Portland, Oregon 97232
503-797-1791 fax

With Copy to: Randi Selleck
600 NE Grand Ave
Portland, OR 97232
503.-797-1795 fax

CONTRACTOR

By_____

Print Name_____

Date_____

METROPOLITAN EXPOSITION RECREATION COMMISSION

By_____

Print Name_____

Date_____

Construction Agreement

MERC CONTRACT NO. 305019

ATTACHMENT A TO CONSTRUCTION AGREEMENT – SCOPE OF WORK

1. Purpose and Goal of Work

MERC is contracting for upgrades to the HVAC Controls at the Portand'5 Centers for the Arts Arlene Schnitzer Concert Hall. The Arlene Schnitzer Concert Hall is located at 1037 SW Broadway, Portland, OR 97205.

2. Scope of Work

Description of Work

Work is to include all labor, materials, tools, equipment, and services necessary, for upgrades to the HVAC Controls at the Portand'5 Centers for the Arts Arlene Schnitzer Concert Hall. The scope of work is to be as detailed below and as per the contract attachments as referenced below.

Proposed work includes:

Contractor shall replace the existing digital control system in this facility. The existing system is a mix of digital, electric and pneumatic controls. All existing devices and parts not used (tubing, control valves, compressors, sensors, etc.) shall be removed. Contractor shall provide a complete control system for those HVAC as noted on the drawings. Contractor shall provide a completely open Niagara framework control system to operate these systems.

Control System Manufacturer is Honeywell Niagara AX WEBs, BACnet version.

Contractor is responsible for cleanliness of work areas and shall pick up and dispose of debris created during construction. Contractor is responsible for cover up and protection of existing equipment/building materials. Contractor is to maintain a worksite free of hazardous work conditions and construction debris. Contractor shall not interfere with scheduled events or prohibit any tenants or clients from accessing other spaces in the building. Loud noise can be an issue in the facility; therefore any work that may be louder than a hand drill or similar will need to be coordinated with Portland'5, so as to not disturb events/clients. Dust control is the responsibility of the Contractor. Although work is expected to be in areas without impact on events, work will need to be done around building schedule. Schedule will need to be coordinated with Portland'5 project manager. Contractor shall work with the Portland'5 provided schedule. This project may require Contractor to work "off hours" in order to complete the project in a timely manner as agreed upon with the Portland'5.

Material submittals are required before materials are ordered and must be approved by Portland'5 Project Manager and MFIA.

Deliverables/Outcomes

- Contractor is to provide one (1) set of Red Line drawings, and two (2) hard copies and one (1) electronic copy Operation and Maintenance manuals upon project completion.

- Contractor shall provide, or set per Portland'5 specification, a superuser account for all stations built and all internal credentials for full administration of system, including Platform Authentication Credential(s) for system hardware.

- **Work under this Contract shall commence on May 13, 2015 and "substantial completion" shall occur by August 21, 2015. Commissioning of the system shall begin on August 24, 2015 and shall be completed by October 2, 2015. If Contractor fails to achieve substantial completion by August 21, 2015 or fails to complete commissioning of the system by October 2, 2015, then MERC may assess liquidated damages equal to $500 per day for each day Contractor is late on delivery.**

The Scope of Work includes the Plan Set, Specifications, any Addenda attached hereto, and any Change Orders entered into in accord with the terms of the Contract.

ATTACHMENT C: Planset, Titled "Portland'5 Centers for the Arts – Arlene Schnitzer Concert Hall" and dated February 27, 2015;

MERC CONTRACT NO. 305019

ATTACHMENT D: Specifications, titled "Portland'5 Center for the Arts HVAC Control Upgrades", and dated March, 2015;

RFB Addendum 1 and any modifications of any of the foregoing in the form of Addenda or Change Orders entered into in accordance with the terms of the Contract. Where applicable, reference to this Contract herein shall be deemed to refer to all of the Contract Documents.

Contractor shall provide all labor, tools, equipment, machinery, supervision, transportation, permits, and every other item and service necessary to perform the Work described in the Contract Documents. Contractor shall fully comply with each and every term, condition and provision of the Contract Documents.

MERC CONTRACT NO. 305019

ATTACHMENT B - SECTION 007200
METRO GENERAL CONDITIONS

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MERC CONTRACT NO. 305019

METRO GENERAL CONDITIONS

ARTICLE 1
GENERAL PROVISIONS

1.1 Definitions. Unless otherwise defined or specified in the Contract Documents, the following terms shall have the meanings indicated:

1.1.1 Addendum: A document issued by Metro during the solicitation period clarifying, adding, deleting, or materially changing Metro's solicitation documents.

1.1.2 Alternate Bids: Portions of the Work for which a Bidder must submit a separate Bid amount. Alternate Bid items may or may not be awarded at Metro's discretion.

1.1.3 Architect: A person retained by Metro as its design professional for the Work and authorized to practice architecture in the State of Oregon. The term "Architect" refers to the Architect or the Architect's authorized representative.

1.1.4 "As-Builts" or Record Documents: Those drawings made, revised, or annotated by Contractor and approved by Metro during the performance of the Contract, fully illustrating how all elements of the Work were actually installed and completed.

1.1.5 Aspirational Target: Target of intended utilization of MBE, WBE, and ESB firms that a contractor has no contractual obligation to meet.

1.1.6 Authorized Representative: A person acting on behalf of another through expressly delegated authority as specified in these Contract Documents.

1.1.7 Bid. The written offer of a Bidder to perform the Work as defined in these Contract Documents submitted in compliance with Metro's Bid Documents and Public Contracting Rules.

1.1.8 Bidder: A person acting directly or through a duly and legally authorized representative who submits or intends to submit a Bid for the Work as described in these Contract Documents.

1.1.9 Bid Documents: Those documents upon which a Bidder bases its bid to Metro.

1.1.10 Business Day: Calendar day excluding Saturdays, Sundays, and legal holidays.

1.1.11 Bid Forms: Forms required by Metro to be submitted with a Bid.

1.1.12 City or County: The city or county in which the Work is located.

1.1.13 Change Order: A written document signed by Metro and Contractor stating their agreement upon all of the following:

1.1.13.1 The change in the Work;

1.1.13.2 The amount of any adjustment in the Contract Amount; and

1.1.13.3 The extent of any adjustment to the Contract Time.

1.1.14 Clarification: A written document consisting of supplementary details, instruction or information issued by Metro after the award of Contract that clarifies or supplements the Contract Documents and becomes a part of the Contract Documents. A Clarification may or may not affect the scope of Work.

1.1.15 Completion: See "Substantial Completion" and "Final Completion and Acceptance."

1.1.16 Construction Schedule or Schedule: The timeline described in Article 5.

1.1.17 Contract: The Contract Documents.

1.1.18 Contract Amount: The total amount shown in the Construction Agreement as modified by any Change Orders.

1.1.19 Contract Documents or Contract or Bidding Documents: All of the following documents: the Advertisement for Bids, the Invitation to Bid, the Instructions to Bidders, the Bid Forms, the Construction Agreement, the Performance Bond, the Labor and Materials Payment Bond, the General Conditions, the Supplementary Conditions, the Specifications, the drawings, the approved and updated Construction Schedule, and any modifications of any of the foregoing in the form of Addenda, Clarifications, Change Orders, or Force Account Work.

1.1.20 Contractor: The person having entered into this Contract with Metro and who is responsible for the complete performance of the Work contemplated by the Contract Documents and for the payment of all legal debts pertaining to the Work, including its officers, agents, employees, and representatives.

1.1.21 Contract Time: The amount of time stated in the Contract Documents for the performance of all or a specified portion of the Work, as modified by any Change Orders.

1.1.22 Critical Path Method or CPM: The critical path method of scheduling as understood and interpreted by standard industry practice.

1.1.23 Day: Calendar day including Saturdays, Sundays, and legal holidays.

1.1.24 Defective Work: Work that (a) is performed in an unsatisfactory, faulty, or deficient manner; (b) does not conform to the Contract Documents; (c) does not meet the requirements of any reference standard, test, or approval referred to or incorporated by the Contract Documents; or (d) has been damaged by anyone other than Metro prior to Acceptance of the Work, whether or not such Work is in Metro's possession or use.

1.1.25 Direct Costs: The costs of labor (including benefits), materials, and equipment incurred by the person performing the Work or part of the Work.

1.1.26 Drawings: The graphic and pictorial portions of the Contract Documents, wherever located and whenever issued, showing the design, location, and dimensions of the Work, generally including plans, elevations, sections, details, schedules, and diagrams.

1.1.27 Engineer: A person lawfully practicing engineering. The term “Engineer" refers to the Engineer or the Engineer's authorized representative.

1.1.28 Environmental Laws: Any applicable statute, law, ordinance, order, consent decree, judgment, permit, license, code provision, covenant deed, common law, treaty, convention, or other requirement pertaining to protection of the environment, health or safety, natural resources, conservation, wildlife, waste management, or disposal of hazardous substances or pollution, including but not limited to regulation of releases to air, land, water, and groundwater.

1.1.29 Equal, Approved, Approved Equal: The material or product to be supplied or installed is equal to or better than that specified in function, performance, reliability, quality, and general configuration and is approved by Architect or Engineer. Equality in reference to the Project design requirements shall be determined by Architect or Engineer prior to installation of any material or product in the Project. Where the term "or equal" is not used and a sole product is specified, the term "or equal" is implied.

1.1.30 Final Completion: Full performance of all of the Work and acceptance of the Project by Metro.

1.1.31 Final Payment: The balance of the Contract Amount to be paid to the Contractor upon Final Completion and Acceptance of the Work. “Final Payment” includes payment of any withheld Retainage less deductions permitted or required by the Contract.

1.1.32 Force Account Work: Work, ordered in writing by Metro, for which Contractor must report its actual costs in accordance with Section 8.4 of the General Conditions.

1.1.33 Force Majeur: An earthquake, flood, typhoon, cyclone, or other natural phenomenon of catastrophic proportions or intensity.

1.1.34 General Conditions: The Metro General Conditions of the Contract for Construction set forth in this document.

1.1.35 Hazardous Materials: Any substance defined or designated as being radioactive, infectious, hazardous, dangerous, or toxic by any federal, state, or local statute, regulation, or ordinance presently in effect or subsequently enacted. For purposes of Section 10.7, the term "introduce" means the physical placement or transportation of Hazardous Materials in or on the Project Site regardless of whether the Hazardous Material was specified, required, or otherwise addressed in the Contract Documents.

1.1.36 Landscape Architect: A person lawfully practicing landscape architecture. The term "Landscape Architect" refers to the Landscape Architect or the Landscape Architect's authorized representative.

1.1.37 LEED Certification: A Leadership in Energy and Design Certification issued by the United States Green Building Council (USGBS).

1.1.38 Lump Sum: A way of expressing the Contract Amount for the Work, or the price bid for a portion of the Work, stated as a single price for all labor, materials, supplies, incidental work, overhead, and profit.

1.1.39 Metro: A metropolitan service district organized under the laws of the State of Oregon and the Metro Charter.

1.1.40 Metro Chief Operating Officer or COO: The Chief Operating Officer of Metro.

1.1.41 Metro Council or Council: Metro’s elected governing body.

1.1.42 Minority Business Enterprise, Women Business Enterprise and Emerging Small Business ("MWESB"): A firm eligible to participate as a Minority Business Enterprise, Women Business Enterprise or Emerging Small Business (collectively referred to as "MWESB") because it meets the criteria as established by the Office of Minority Women and Emerging Small Business in the State of Oregon. A firm will no longer qualify as an MWESB on this Contract when it receives notification of decertification, denial of recertification, or notice of graduation by the certifying agency.

1.1.43 MWESB Program: Metro's program to provide maximum opportunities to Minority, Women-Owned and Emerging Small Business Enterprises in contracts, which is contained in Metro Code Section 2.04.100 to 2.04.190.

1.1.44 Notice to Proceed: The written notice given by Metro to the Contractor to proceed with all or part of the Work. The Notice to Proceed will also establish the date and time of a preconstruction conference.

1.1.45 Overhead: When applied to the cost of the Work, includes the following items, when reasonable and necessary for completion of the Work:

1.1.45.1 All on-site payroll costs, taxes, insurance, fringe benefits, and bonuses of same, for supervising, estimating, expediting, purchasing, drafting, and clerical/secretarial services where directly incurred in the performance of the Contract.

1.1.45.2 Small tools (less than $250 capital cost per item).

1.1.45.3 Contractor-owned equipment.

1.1.45.4 Equipment maintenance and repairs.

1.1.45.5 Temporary construction, utilities, and safety requirements.

1.1.45.6 Transportation of materials other than direct identifiable cost of specific deliveries, or as included in price of material.

1.1.45.7 Parking fees for workers (if applicable).

1.1.45.8 Permit fees paid by the Contractor pursuant to the Contract Documents.

1.1.45.9 Cost of reproduction.

1.1.45.10 Field office costs. Home or branch office overhead shall not be included, but shall be part of Contractor's profit and shall include but is not limited to the following:

1.1.45.10.1 Accounting functions of Contractor's home and branch office.

1.1.45.10.2 General expenses of Contractor's home and branch office.

1.1.45.10.3 Interest on capital.

1.1.45.10.4 Salaries of any home and branch office estimators and administration.

1.1.46 Owner: Metro.

1.1.47 Person: An individual, partnership, corporation, joint venture, limited liability corporation, joint stock company, or other legal entity.

1.1.48 Plans: Drawings.

1.1.49 Profit: That portion of Contractor's Bid price that is not Direct Costs or Overhead

1.1.50 Project: The Work described in the Contract Documents.

1.1.51 Project Manager: The Metro representative on the construction Site. The Project Manager will be an employee of Metro who will represent Metro to the extent of his authority as delegated by the Chief Operating Officer. For purposes of administering this Contract the term "Project Manager" will refer to the on-site Metro representative and to any duly appointed assistants who may be designated in writing. The Architect or Engineer will be called upon as required by and at the direction of Metro for technical assistance and for interpretation of the Contract Documents.

1.1.52 Proposal: The written offer of a Proposer to perform the Work as defined in these Contract Documents submitted in compliance with Metro's Request for Proposals and Public Contracting Rules.

1.1.53 Proposal Documents: Those documents upon which a Proposer responds to a Request for Proposals.

1.1.54 Proposer: A person who responds or intends to respond to a Request for Proposals issued by Metro.

1.1.55 Provide: To furnish and install complete and in place and ready for operation and use.

1.1.56 Punch List: The list prepared by the Architect or Engineer and/or Project Manager at the time of Substantial Completion that reflects Contractor's incomplete, nonconforming Work. Punch List items must be completed to the satisfaction of the Architect or Engineer and Metro in order for the Project to reach Final Completion and Acceptance.

1.1.57 Reference Specifications: Bulletins, standards, rules, methods of analysis or testing, codes, and Specifications of other agencies, engineering societies, or industrial associations referred to in the Contract Documents that when included in the Contract Documents establish the basis by which specific portions of the Work are to be performed. All such references specified refer to the latest edition thereof, including any Amendments in effect and published at the time of advertising for Bids or of issuing the permit for the Project.

1.1.58 Release: When used in regard to environmental laws or regulations, "release" as defined in Oregon or federal law.

1.1.59 Request for Bid (RFB): A solicitation to perform Work where a Contract is awarded based on price.

1.1.60 Request for Information (RFI): A written request made by Contractor for additional information to clarify an ambiguity in the Contact Documents.

1.1.61 Request for Proposals ("RFP"): A solicitation to perform Work issued where a Contract is awarded based on factors other than or in addition to price.

1.1.62 Retainage or Retention: The difference between the amount earned by Contractor on the Contract and the amount paid on the Contract by Metro.

1.1.63 Schedule of Values: The detailed breakdown of a lump-sum contract amount as required in Section 9.2.

1.1.64 Separate Contract: A contract between Metro and a party other than Contractor for the construction or furnishing of a portion of the Project.

1.1.65 Shown, As Shown: Work shown on the drawings that is a part of the Contract Documents.

1.1.66 Site: The real property upon which the Project is located.

1.1.67 Solicitation Documents: An RFB.

1.1.68 Special Inspector: A representative of Metro, Architect, Engineer or Geotechnical Engineer with specialized knowledge applicable to the installation of certain elements of the Work.

1.1.69 Specifications: That portion of the Contract Documents consisting of the written requirements for materials, equipment, construction systems, standards, and workmanship for the Work, and performance of related services, including any Reference Specifications.

1.1.70 Subcontractor: A person that has a contract with Contractor to perform a portion of the Work at the Site.

1.1.71 Submittals: Includes shop drawings, samples, manufacturer's brochures, pamphlets, catalog cuts, color charts, or other descriptive data, clearly defining the article, material, equipment, or device proposed by Contractor for use in the Work. "Shop drawings" are the drawings and diagrams showing details of fabrication and erection that Contractor is required to submit to the Architect or Engineer.

1.1.72 Substantial Completion: The stage in the progress of the Work, as determined by Metro, when the Work or designated portion thereof is sufficiently complete in accordance with the Contract Documents so that Metro can lawfully occupy or use the Work for its intended use.

1.1.73 Supplier: An individual, partnership, corporation or joint venture entering into an agreement with Metro or Contractor for furnishing a portion of the Work that requires no labor at the Site, other than common carriers.

1.1.74 Unit Price: The dollar amount to complete a particular portion of the Contract Work, as defined in the Bid and Supplementary Conditions, and includes all costs, including but not limited to equipment, labor, materials, incidentals, Overhead, and Profit for the portion of Work described.

1.1.75 Unusually Persistent Severe Weather: Exists in any period when daily rainfall exceeds 0.50 inch during a month when the monthly average rainfall exceeds the normal monthly average by over twenty-five percent (25%), or when average daytime temperatures at the Project are less than 32 degrees F and are accompanied by accumulations of ice or snow, continuing for a day or more in excess of the annual average number of consecutive days severe weather conditions persist for the part of the Metro region where the Project is located (“Annual Average”). The Annual Average shall be calculated for this purpose based on ten-year averages reported in the Local Climatological Data for Portland Oregon, available at the Portland Weather Service Office. Contractor shall incorporate said Annual Average number of consecutive days severe weather conditions exist into the Project schedule at Project inception.

1.1.76 Work: Unless the context requires otherwise, the construction and services required by the Contract Documents, whether completed or partially completed, and includes all other labor, materials, equipment, and services provided or to be provided by Contractor to fulfill Contractor's obligations. The Work may constitute all or a portion of the Project as the context requires.

1.2 Interpretation and Use of Contract Documents.

1.2.1 Intent and Effect of the Contract. The Contract Documents form the Contract for construction and represent an integrated agreement between the Parties. The Contract supersedes all prior negotiations, representations, or agreements between the Parties, either written or oral. The Contract Documents are complementary, and what is required by one shall be as binding as if required by all. The intent of the Contract Documents is to include all items necessary for the proper execution and completion of the Work. Unless otherwise stated in the Contract Documents, words describing materials or Work that have a well-known technical or trade meaning shall be construed in accordance with such meanings.

1.2.2 Modification of Contract Documents. The Contract Documents may only be modified by written Amendment or Change Order signed by both Parties.

1.2.3 Divisions and Headings. Titles and headings are for the convenience of organizing the Contract Documents and shall not control or limit the Contractor's obligations under the Contract.

1.2.4 Mandatory Nature of Specifications and Drawings. Mention in the Specifications or indication on the drawings of articles, materials, operations, sequence, or methods requires Contractor to furnish and install (i.e., provide) each article mentioned or indicated, of the quality or according to qualifications noted, to perform each operation called for, in the sequence called for, and to provide therefore all necessary labor, equipment, and incidentals. The determination of the type of operations and methods to be utilized in the performance of the Work shall be the responsibility of Contractor unless the Contract Documents prescribe a specific type of operation, sequence, or method, in which case Contractor shall comply with the prescribed operation, sequence, or method. Sentences in the imperative tense or command format in these Contract Documents shall be deemed to be directed to Contractor and to require Contractor to perform the services and/or provide the materials described.

1.2.5 Precedence of Contract Documents. All determination of the precedence of, or resolution of discrepancies in, the Contract Documents shall be made by Metro, but in general, precedence will be in accordance with the following list with the highest precedence item at the top:

1.2.5.1 Executed Construction Agreement.

1.2.5.2 Supplementary Conditions.

1.2.5.3 General Conditions, Advertisement for Bids, Instructions to Bidders, Invitation to Bid, Bid Forms, Performance Bond, and Labor and Materials Payment Bond.

1.2.5.4 Specifications.

1.2.5.5 Drawings.

1.2.5.6 Contractor's Proposal. Within each of the above documents, detailed information takes precedence over general information and words take precedence over numbers unless obviously incorrect.

Amendments, Addenda, Clarifications, and all Change Orders to the Contract Documents take the same order of precedence as the specific sections that they are amending.

1.2.6 Meaning of Miscellaneous Phrases. Unless the context requires otherwise, phrases in the Contract Documents shall be interpreted as follows:

1.2.6.1 Wherever the words "as directed," "as instructed," "as required," "as permitted," or words of like effect are used, it shall be understood that the direction, requirement, or permission of Metro is intended.

1.2.6.2 The words "sufficient," "necessary," "proper," and the like shall mean sufficient, necessary, or proper in the judgment of Metro.

1.2.6.3 The words "approved," "acceptable," "satisfactory," or words of like import, shall mean approved by, or acceptable to, or satisfactory to Metro.

1.2.7 Discrepancies, Errors and Omissions. The intent of the Contract Documents is to require Contractor to perform and provide every detail and item necessary for completion of the Project. The Contract Documents are not complete in every detail, however, and Contractor shall comply with their intent and meaning, taken as a whole, and shall not avail itself of any manifest errors or omissions to the detriment of the Work. Should any error, omission, discrepancy, or ambiguity appear in the Contract Documents, instructions, or Work done by others, Contractor shall immediately upon discovery submit a Request for Information to Metro pursuant to Section 3.3. If Contractor proceeds with any such Work without receiving a response to the Request for Information, Contractor shall be responsible for all resulting damage and defects, and shall perform any Work necessary to comply with the Request for Information at no cost to Metro. Any Work or material not indicated in the Contract Documents that is manifestly necessary for full and faithful performance of the Work in accordance with the intent of the Contract Documents shall be indicated by Contractor on the shop drawings and provided by Contractor to the same extent as if both indicated and specified. Any Work indicated on the drawings but not specified, or vice versa, shall be furnished in the manner specified above as though fully set forth in both. Work not particularly detailed, marked, or specified shall be the same as similar parts that are detailed, marked, or specified. In case of discrepancy or ambiguity in quantity or quality, the greater quantity or better quality as determined by Metro shall be provided at no extra cost to Metro.

1.2.8 Standards that Apply Where Detailed Specifications Are Not Furnished. Wherever in these Contract Documents or in any directions given by Metro pursuant to or supplementing these Contract Documents, it is provided that Contractor shall furnish materials or manufactured articles or shall do work for which no detailed Specifications are set forth, the materials or manufactured articles shall conform to the usual standards for first-class materials or articles of the kind required, with due consideration of the use to which they are to be put. Work for which no detailed drawings or Specifications are set forth herein shall conform to the usual standards for first-class work of

the kind required. Dimensions not expressly provided in the Contract Documents are to be computed, rather than determined by scale or rule.

1.3 Supply of Contract Documents. Metro shall supply Contractor, without charge, a maximum of ten (10) sets of Contract Documents. Contractor shall contact Metro for additional sets of documents for which Contractor shall be charged the cost of printing.

1.4 Use of Contract Documents. The Contract Documents were prepared for use in the construction of this Project only. No part of the Contract Documents shall be used for any other construction or for any other purpose except with the written consent of Metro. Any unauthorized use of the Contract Documents is at the sole responsibility of the user and such unauthorized use shall be deemed an activity in the performance of the Contract for purposes of Contractor's duty to indemnify under Article 11.

1.5 Copyright. All submittals, record documents, and any other products or documents produced by Contractor pursuant to this Contract are the property of Metro and it is agreed by the Parties hereto that such documents are works made for hire. Contractor does hereby convey, transfer, and grant to Metro all rights of reproduction and the copyright to all such documents.

1.6 Contractor's Status as Independent Contractor. It is understood and agreed that the relationship of Contractor to Owner shall be that of an independent contractor under ORS 670.600. The Contractor further agrees that Contractor, its officers, agents, and employees, any Subcontractor or Supplier of Contractor of any tier, or its officers, agents, or employees, are not officers, employees, or agents of Metro under the Oregon Tort Claims Act (ORS 30.260 through 30.300). Contractor and its officers, agents, employees, and its Subcontractors and Suppliers of any tier and their officers, agents, and employees will make no claim whatsoever against Metro for indemnification pursuant to ORS 30.260 to 30.300. Contractor agrees to hold Metro harmless and indemnify Metro from any such claims.

1.7 No Third-Party Beneficiary to the Contract. The Parties agree that the execution of the Contract is not intended to, nor does it, create any third-party beneficiary rights in any person.

1.8 Severability Clause. Should any provision of this Contract at any time be in conflict with any law, regulation, or ruling, or be legally unenforceable for any reason, then such provision shall continue in effect only to the extent that it remains valid. In the event that any provision of this Contract shall become legally unenforceable, in whole or in part, the remaining provisions of this Contract shall nevertheless remain in full force and effect.

1.9 Notice or Service. Any written notice required or allowed under the Contract shall be deemed to have been communicated to the other Party and service thereof shall be deemed to have been made if such notice is delivered in person to the individual, a member of the partnership or joint venture, or an officer of the corporation for whom it was intended, or if delivered at or sent by regular, registered, or certified mail to the last business address of the relevant person or Party known to the person or Party giving the notice, or to Contractor's Site office if the notice is directed to Contractor. Notice may be delivered by e-mail as long as a hard copy is mailed the same day to the relevant person by the methods noted above. The date or time of service for purposes of all notices required or allowed under the Contract shall be the date and/or time upon which the relevant document was mailed or delivered as above described. The address given in the Bid or Proposal by the Contractor is hereby designated as the legal business address of Contractor, but such address may be changed at any time by ten (10) days' prior notice in writing, delivered to Metro.

ARTICLE 2
CONTRACTOR

2.1 Responsibilities of the Contractor.

2.1.1 The Contractor will perform the Work as required by the Contract Documents, including but not limited to providing all labor, materials, equipment, tools, machines, and incidental work necessary for its performance. The Contractor will supervise and direct the Work using the Contractor's best skill and attention. Contractor is solely responsible for and will have control of all of the means and methods of construction. Contractor shall be responsible to Metro for the acts and omissions of the Contractor's employees, Subcontractors, and their agents and employees, and other persons or entities performing portions of the Work for or on behalf of the Contractor or any of its Subcontractors. Contractor shall perform or cause to be performed all labor, services, and Work of whatever nature and shall provide or cause to be provided all materials, equipment, tools, and other facilities of whatever nature necessary to complete the Work and shall otherwise cause the Work to be completed in accordance with the Contract Documents.

2.1.2 Until the Work is completed and accepted by Metro, the Contractor is responsible for any damage it causes to either permanent or temporary work, utilities, materials, plants, and equipment, all of which must be repaired to the satisfaction of the Project Manager at the Contractor's expense. Damage caused by vandals must be covered by the Contractor's insurance. Damage to any portion of the Work that has been completed and accepted by Metro and that is open for public use is not the responsibility of the Contractor if caused by third persons, such as vandals.

2.1.3 It shall be the duty of Contractor to comply with all procedures established and/or implemented by Metro. In the event any such procedures are at variance with other provisions of these Documents, such procedures shall prevail.

2.2 Documents.

2.2.1 The Contractor will maintain at the Site for Metro one record As-Built copy of the drawings, plans, Specifications, Addenda, Change Orders, and other modifications, in good order and marked currently to record changes and selections made during construction, as well as one record copy of shop drawings that have been reviewed and are being used. These as-built documents shall incorporate all changes and substitutions to the Work, including without limitation changes or substitutions arising from Change Orders, construction change directives, and details clarified by requests for information, supplemental instructions, or approved shop drawings. The Contractor's as-built documentation shall be available to the Architect or Engineer and Metro during the course of the Project.

2.2.2 The Contractor shall maintain all approved permit drawings in a manner that will make them accessible at the Project Site to governmental inspectors and other authorized agencies. All approved drawings shall be wrapped, marked, and delivered to Metro within 60 days of Substantial Completion.

2.2.3 The Contractor must continuously maintain at the Project Site all material safety data sheets, safety records, daily logs, and other Contract documentation necessary to immediately ascertain the safety of the Work and to establish compliance with life safety policies, hazardous materials requirements, and the Contract Documents.

2.2.4 The Contractor, with its Subcontractors, will prepare draft record Contract Documents showing all as-built conditions as required under this Section 2.2 and submit them to Metro for review. Based on Metro's review and comments, if any, and pursuant to Metro's close-out policies and procedures, Contractor will prepare and deliver to Metro within 60 days of Substantial Completion, final, accurate, and complete record Contract Documents, including without limitation record drawings and Specifications showing the exact "as-built" conditions of the Work.

2.3 Contractor's Authorized Representative. Prior to commencing any Work under this Contract, the Contractor shall appoint in writing an authorized representative or representatives. Such appointment shall include the name and title of each representative along with the extent to which each representative is authorized to represent, bind, and act for Contractor. The description of extent of representation shall include but not be limited to the maximum dollar value of Change Orders that the individual may authorize, whether the individual may respond to RFPs and for what maximum dollar amount, and whether the individual may submit a claim pursuant to Section 3.4.

2.4 On-Site Representation Required. Contractor shall at all times be represented at the Site by one or more of such authorized representatives who, cumulatively, shall have complete authority to represent, bind, and act for Contractor in all matters pertaining to or related to this Contract. In the event that Metro deems it reasonably necessary to take immediate actions at the Site pertaining or relating to this Contract and Contractor has failed to comply with this Section and is consequently not fully represented at the Site at such time, then Contractor shall be deemed to acquiesce in all actions so taken by Metro.

2.5 Contractor's Office at the Site. Prior to commencement of Work at the Site, Contractor shall establish a field office at the Site acceptable to the Project Manager. This office shall be located in a job trailer or temporary building. This office shall be the headquarters of Contractor's representatives authorized to receive notices, instructions, drawings, or other communications from the Project Manager on behalf of Metro or the Architect or Engineer, and to act on Change Orders or other actions. Such notices, instructions, drawings, or other communications given to such a representative or delivered to Contractor's Site office in his/her absence shall be deemed to have been given to Contractor.

2.6 Use of the Site by Contractor. Contractor shall have complete and exclusive use of the premises for execution of the Work within the boundaries shown on the drawings. The Contractor’s use of the premises is limited only by Metro’s right to perform Work or to retain other contractors on portions of the Project. All construction activities, storage, staging, and Work shall be confined to the limits of Work, as per the drawings. Under no circumstances shall portions of the Site beyond the limits of Work be disturbed. The Contractor shall appropriately fence and maintain barriers to confine limits of Work to those areas indicated on the drawings. All driveways and entrances to the Site shall remain clear and available to Metro and emergency vehicles at all

times. The Contractor shall not use these areas for parking or storage of materials. The Contractor shall schedule delivery of materials to minimize space and time requirements for storage of materials and equipment on Site. The Contractor shall keep roadway pavement clean, free of mud, rocks, debris associated with materials, and vehicles. The Contractor shall coordinate use of the premises under the direction of the Architect or Engineer and Owner. The Contractor shall assume all responsibility for the protection and safe keeping of the Site, structures, and products stored on the Site included in this Contract. At no cost to Metro, the Contractor shall move any stored products that interfere with operations of Metro or construction activities. The Contractor shall obtain and pay for the use of additional storage or Work areas needed for operations.

2.7 Review of Project Conditions. Prior to execution of the Contract, the Contractor will evaluate the conditions and limitations under which the Work is to be performed, including without limitation (i) the geographical and topographical location, condition, layout, and nature of the Project Site and surrounding areas; (ii) generally prevailing climatic conditions; (iii) anticipated labor supply and costs; (iv) availability and cost of materials, tools, and equipment; (vi) ease or difficulty of access to the Project Site by vehicles, equipment and workers; and (v) other similar issues. The Contractor shall be solely responsible for providing a safe place for the performance of the Work. Metro will not be required to make any adjustment to the Contract Time or the Contract Price in connection with any failure by the Contractor to have complied with the requirements of this Section.

2.8 Construction Staking. Contractor shall provide all necessary construction staking as to lines and grades shown on the drawings. Contractor shall protect and preserve all control points in their original position or be responsible for providing new control points established from Architect's original control points.

2.9 Construction Staging Area. Coordinate use of the Site with Owner prior to utilization of the area. Providing Site security, barriers, and other temporary protection is the responsibility of the Contractor. Limit all construction activities within the Work limits shown on the drawings. All areas disturbed in any way or during construction and not covered by roads, parking, or structures shall be rehabilitated to their pre-construction condition.

2.10 Key Personnel. Contractor shall submit, in writing, to Metro a list of the names, addresses, and telephone numbers of its key personnel who are to be contacted in case of emergencies on the job during non-working hours, including Saturdays, Sundays, and holidays, and all other key personnel as may be required.

2.11 Contractor's Employees and Subcontractors.

2.11.1 Contractor shall enforce strict discipline and good order among the Contractor's employees and other persons carrying out the Work. Contractor shall not permit employment of unfit persons or persons not properly skilled in tasks assigned to them. It is the Contractor's responsibility to hire all personnel for the proper and diligent performance of the Work, and the Contractor shall maintain labor peace for the duration of the Project. In the event of a labor dispute, the Contractor shall not be entitled to any increase in the Contract Sum.

2.11.2 Metro may notify the Contractor that it needs to exclude or remove from the Project Site any or all employees, agents, suppliers, or representatives of the Contractor or its Subcontractors who threaten the safety of others or who are disruptive to the Project or Metro's operations. The Contractor will supply replacement personnel promptly after receiving notice of exclusion or removal. Nothing in this Section requires the Contractor to take any particular employment or contract action with regard to an employee or Subcontractor.

2.11.3 Contractor shall give Metro, at its request at any time, full and correct information as to the number of workers employed in connection with each subdivision of the Work, the classification and rate of pay of each worker, the cost to Contractor of each class of materials, tools, and appliances used by it in the Work, and the amount of each class of materials used in each subdivision of the Work.

2.12 Contractor to Supply Sufficient Material and Workers. Contractor shall at all times keep on the premises sufficient material and employ sufficient supervision and workers to prosecute the Work at the rate necessary to substantially complete the Work within the time specified in the Contract and in accordance with the Construction Schedule. Contractor shall coordinate the Work of its Subcontractors so that information required by one will be provided by others involved in time for incorporation in the Work in proper sequence and without delay of any materials, devices, or provisions for future Work.

2.13 Construction Plant, Equipment, and Methods.

2.13.1 The construction plant and equipment provided by Contractor, and Contractor's methods and organization for handling the Work, shall be such as will secure a good quality of Work and rate of progress that will ensure the completion of the Work within the time specified, in accordance with the Construction Schedule, and without violating city, local, state, or federal environmental regulations during construction.

2.13.2 Contractor shall give Metro full information in advance as to Contractor's plans for carrying on any part of the Work. If at any time before the commencement or during the progress of the Work, any part of

Contractor's plant or equipment, or any of Contractor's methods of executing the Work, appear to Metro to be inadequate to ensure the required quality, environmental protection, or rate of progress of the Work, Metro may order Contractor to increase or improve its facilities or methods, and Contractor shall promptly comply with such orders. Neither compliance with such orders nor failure of Metro to issue such orders shall relieve Contractor from the obligation or liability to secure the quality of Work and the rate of progress required by the Contract. Contractor shall be responsible for overload of any part or parts of structures beyond their safe calculated carrying capacities and for release of pollutants into surrounding waters resulting from Contractor's activities on the Site.

2.13.3 Contractor shall provide temporary utilities pursuant to the Specifications and shall be responsible for the safety and adequacy of its plant, equipment, and methods.

2.14 Permits.

2.14.1 The Contractor, without additional expense to Metro, is responsible for obtaining and paying for any necessary fees, licenses, and Permits and for complying with any federal, state, and municipal laws, codes, and regulations applicable to the performance of the Work, unless expressly provided otherwise in other portions of the Contract Documents. Notwithstanding this Section, Metro will submit Contract Documents to the City of Portland and pay all plan check fees and building permit fees.

2.14.2 The Contractor understands that preliminary approval of Metro's plans and Specifications by regulatory agencies does not prohibit such agencies from requesting changes in order that the Work complies with the provisions of applicable codes, laws, and regulations. The Contractor agrees that a reasonable number of changes directed by regulatory inspectors is inherent in the nature of construction work and that its Bid includes the costs of making them. The Contractor will bear the expense of complying with the requirements of regulatory inspectors for a reasonable number of changes even if such requirements require different or additional Work than that originally contemplated by the Contract Documents.

2.15 Contractor's Temporary Structures. Contractor shall obtain all necessary permits for and shall erect and maintain at its own expense, and remove upon completion of the Work or as ordered by Metro, temporary structures, sheds, barriers, walks, hoisting equipment, scaffolds, etc., as are necessary for the Work pursuant to these Contract Documents. Contractor's temporary structures, equipment, stored materials, stored equipment, etc., shall be located so as not to interfere with the prosecution of the Work. If not so located, they shall be moved by Contractor, as directed by Metro, at no cost to Metro. Contractor's temporary structures, equipment, or materials that obstruct progress of any portion of the Work shall be removed or relocated by Contractor at Contractor's expense.

2.16 Compliance with Product Manufacturer's Recommendations. Unless otherwise directed by the Architect or Engineer, the Contractor shall perform all Work in accordance with the product manufacturer's recommendations, Specifications, or directions for best results. No predatory step or installation procedure may be omitted unless specifically authorized by the Contract Documents or at the direction of the Architect or Engineer. Conflicts among manufacturer's directions or the Contract Documents shall be resolved by the Architect or Engineer.

2.17 Accounting Records.

2.17.1 The Contractor and Subcontractors shall maintain all fiscal records relating to this Contract in accordance with generally accepted accounting principles. In addition, Consultant and sub-consultants shall maintain any other records necessary to clearly document:

2.17.1.1 The performance of the Contractor, including but not limited to Contractor compliance with Contract plans and Specifications, compliance with fair contracting and employment programs, compliance with Oregon law on the payment of wages and accelerated payment provisions, and compliance with any and all requirements imposed on Contractor or Subcontractor under the terms of the Contract or subcontract;

2.17.1.2 Any claims arising from or relating to the performance of Contractor or Subcontractor under this Contract;

2.17.1.3 Any cost and pricing data relating to the Contract; and

2.17.1.4 Payments made to all suppliers and sub-consultants.

2.17.1.5 The records described in this Section 2.17.1 are the Contract Records.

2.17.2 The Contractor and Subcontractors shall maintain the Contract Records for the longer period of (a) six years from the date of final completion of the Contract to which the Contract Records relate or (b) until the conclusion of any audit, controversy, or litigation arising out of or related to the Contract.

2.17.3 The Contractor and Subcontractors shall make Contract Records available to Metro and its authorized representatives, including but not limited to the staff of any Metro department and the staff of Metro's

Auditor, within the boundaries of the Metro region, at reasonable times and places regardless of whether litigation has been filed on any claims. If the Contract Records are not made available within the boundaries of Metro, the Contractor or Subcontractor agrees to bear all of the costs for Metro employees, and any necessary consultants hired by Metro, including but not limited to the costs of travel, per diem sums, salary, and any other expenses that Metro incurs in sending its employees or consultants to examine, audit, inspect, and copy those records. If Contractor elects to have such Contract Records outside these boundaries, the costs paid by Contractor to Metro for inspection, auditing, examining, and copying those records shall not be recoverable costs in any legal proceeding.

2.17.4 The Contractor and Subcontractors authorize and permit Metro and its authorized representatives, including but not limited to the staff of any Metro department and the staff of Metro Auditor, to inspect, examine, copy, and audit the books and records of Contractor or Subcontractor relating to this Contract, including tax returns, financial statements, other financial documents, and any documents that may be placed in escrow according to any Contract requirements. Metro shall keep any such documents confidential to the extent permitted by Oregon law.

2.17.5 The Contractor and Subcontractors agree to disclose the Contract Records requested by Metro and agree to the admission of such records as evidence in any proceeding between Metro and Contractor and Subcontractors, including but not limited to a court proceeding, arbitration, mediation, or other alternative dispute resolution process.

2.17.6 The Contractor and Subcontractors agree that in the event such Contract Records or any audit disclose that Metro is owed any sum of money or establish that any portion of any claim made against Metro is not warranted, Contractor and Subcontractors shall pay all costs incurred by Metro in conducting the audit and inspection. Such costs may be withheld from any sum that is due or that becomes due from Metro.

2.17.7 Failure of the Contractor or Subcontractors to keep or disclose Contract Records as required by this Contract or any solicitation document may result in debarment as a bidder or proposer for future Metro contracts as provided in ORS 279B.130 and Metro Code Section 2.04.070(c), or may result in a finding that the Contractor or Subcontractor is not a responsible bidder or proposer as provided in ORS 279B.110 and Metro Code Section 2.04.052.

ARTICLE 3
ADMINISTRATION OF THE CONTRACT

3.1 Authority and Relationships of Metro and Architect or Engineer. Except as specifically provided in this Section, no individual other than the Metro Chief Operating Officer or the Project Manager, duly appointed as set forth below, shall have any authority to make representations, statements, or decisions of whatever nature binding Metro or Architect or Engineer regarding any aspect of this Contract. Except as specifically provided in this Article, Contractor shall have no right to, and shall not rely on, any such representation, statement, or decision. Any reference to action by Metro in this Contract requires the written approval of the Metro Chief Operating Officer or the Project Manager designated in writing by the Metro Chief Operating Officer as having authority to act for Metro, but only to the extent that such authority is expressly delegated in writing.

3.2 Authority of Metro. The Work must be performed to the complete satisfaction of the Project Manager.

3.2.1 The decision of the Project Manager will be final, binding, and conclusive on the Contractor on all questions that arise regarding the quantity of materials and Work, the quality of materials and Work, the acceptability of materials furnished and Work performed, the acceptable rate of progress of the Work, the interpretation of the plans and Specifications, the measurement of all quantities, the acceptable fulfillment of the Contract on the part of the Contractor, and payments under the Contract.

3.2.2 Work will not be considered completed until it has passed final inspection by the Project Manager and is accepted by Metro. The authority of the Project Manager is such that the Contractor must at all times carry out and fulfill the instructions and directions of the Project Manager insofar as they concern the Work to be done under the Contract.

3.2.3 If the Contractor fails to comply with any reasonable order made under the provisions of this Section, the Project Manager may cause unacceptable Work to be remedied or removed and replaced, and unauthorized Work to be removed, and to deduct the costs thereof from any money due or to become due to the Contractor.

3.2.4 The Project Manager has the authority to suspend Work for cause as set forth in Section 3.5.

3.2.5 Metro may call for meetings of Contractor, Contractor's Subcontractors, and Suppliers as Metro deems necessary for the proper supervision and inspection of the Work. Such meetings shall be held at the Site on regular working days during regular working hours, unless otherwise directed by Metro. Attendance shall be mandatory for all Parties notified to attend.

3.2.6 Nothing in this Section or elsewhere in the Contract is to be construed as requiring the Project Manager to direct or advise the Contractor on the method or manner of performing any Work under the Contract. No approval or advice as to the method or manner of performing or producing any materials to be furnished constitutes a representation or warranty by Metro that the result of such method or manner will conform to the Contract, relieve the Contractor of any of the risks or obligations under the Contract, or create any liability to Metro because of such approval or advice.

3.2.7 An Architect, Engineer, designer, or other person hired by Metro under a separate contract is not the Project Manager, unless the Contract Documents expressly state otherwise. The Contractor will be notified in writing if the Project Manager is to be changed.

3.2.8 Contractor has no right to and shall not rely on representations of whatever nature made by any individual, whether or not employed by or purporting to represent Metro, unless such individual has been specifically and expressly delegated authority to make such representations pursuant to these Contract Documents. Likewise, Contractor has no right to and shall not rely on any representations of authorized changes in the Contract of whatever size or nature unless such change is in writing and signed by Metro.

3.2.9 Nothing contained in this Section shall obligate Metro or Architect or Engineer to supervise Contractor's Work under this Contract, and Contractor shall remain fully responsible for the complete and proper supervision of all of the Work.

3.3 Request for Information. If the Contractor believes that the Work to be done or any of the matters relative to the Contract Documents are not sufficiently detailed or explained in the Contract Documents, or if the Contractor has any questions as to the meaning or intent of the Contract Documents, Contractor shall immediately submit to Architect or Engineer and Metro a written Request for Information ("RFI") that shall fully describe the information sought.

3.3.1 The RFI shall be directed to the Project Manager and Architect or Engineer. Subcontractors shall direct correspondence through the Contractor to the Project Manager and Architect or Engineer. At a minimum the RFI shall contain: (1) project title, (2) identify the nature and location of each clarification/verification, (3) date, (4) response by and RFI number, (5) subject, (6) initiator of the question, (7) indication of the costs, (8) Contract drawings reference, (9) Contract Specification section, and (10) descriptive text and space for a reply. Each RFI shall be numbered sequentially beginning with #001, and a separate RFI shall be submitted for each item. Verbal discussions/clarifications for minor items can be addressed with the Architect or Engineer by phone and the Contractor shall follow up with a confirming RFI.

3.3.2 It is Contractor's responsibility to request information under this Section in sufficient time for review by the Architect or Engineer and Metro so that the orderly progress and prosecution of the Work is not delayed.

3.3.3 The Architect or Engineer, in consultation with Metro, shall interpret the meaning and intent of the Contract Documents and shall issue, within five (5 working days of receiving an RFI from Contractor, a written Clarification describing such meaning and intent. Additionally, the Architect or Engineer, after consulting with Metro, may at any time issue a written RFI as deemed necessary to carry out the Work included in the Contract Documents. Notwithstanding any dispute or disagreement that Contractor may have concerning any such RFI, Contractor shall perform the Work as prescribed and in accordance with all such RFI.

3.3.4 If notified by Metro or the Architect or Engineer that an RFI is forthcoming, any related Work done before the receipt of the RFI shall be coordinated with Metro so as to minimize the effect of the RFI on Work in progress. Any related Work not coordinated with Metro or the Architect or Engineer done before receipt of the RFI shall be at Contractor's risk and at no cost to Metro if that Work does not conform to the Clarification.

3.3.5 If Contractor proceeds with Work that is not sufficiently detailed or explained in the Contract Documents without requesting and obtaining an RFI pursuant to this Section, Contractor shall do so at its own risk and shall, at no cost to Metro, perform any additional Work that may be required by Metro to bring the Work into conformance with the intent of the Contract Documents.

3.4 Contractor's Claims.

3.4.1 Generally. No claim by Contractor shall be considered or allowed under this Contract except as specifically provided and prescribed under this Section. Failure to make a claim as specifically prescribed by this Section or failure to perform disputed Work, if any, as directed by Metro shall bar Contractor from any recovery or extension of time resulting from the facts surrounding the claim. Contractor's full and complete compliance with this

Section shall be a condition precedent to any right of Contractor to further prosecute any claim against Metro arising out of or related to Work described in the Contract Documents. Every decision and action of Metro shall be considered final unless Contractor makes a claim concerning such decision or action pursuant to this Section.

3.4.2 Types of Claims. Contractor claims are limited to the following:

3.4.2.1 Claims based on Excusable Delays as described in Section 3.4.3.

3.4.2.2 Claims based on differing Site conditions as described in Section 3.4.4;

3.4.2.3 Claims based on Clarifications or Change Orders issued by Metro or any other decision, action, or failure to act by Metro as described in Section 3.4.5.

3.4.3 Claims For Excusable Delays.

3.4.3.1 Definition of Excusable Delay. A Delay is "Excusable" if such act, event, or condition has a materially adverse effect on the ability of Contractor to perform its obligations under this Contract as scheduled, and/or materially increases the cost to Contractor to perform such obligations as scheduled and if such act, event, or condition and its effect:

3.4.3.1.1 Are beyond the reasonable control of Contractor (or any third party for whom Contractor is directly responsible); and

3.4.3.1.2 Do not arise out of (a) strikes, labor disputes, or other labor difficulties involving Contractor or its Subcontractors or Suppliers or entities providing transportation to Contractor or its Subcontractors or Suppliers; (b) labor shortages; or (c) changing economic conditions; and

3.4.3.1.3 Could not have been reasonably anticipated by Contractor.

3.4.3.2 Types of Excusable Delay Claims. Excusable Delays are either Compensable or Non-compensable. Claims for Non-compensable Excusable Delays are limited to claims for extension of Contract Time. Contractor may claim both an increase in the Contract Amount and an extension of the Contract Time for Compensable Excusable Delays.

3.4.3.3 Non-Compensable Excusable Delay Claims. Delays resulting from the following acts, events, and conditions are Non-Compensable Excusable Delays:

3.4.3.3.1 An act of force majeur.

3.4.3.3.2 Unusually Persistent Severe Weather. No claim for extension of the Contract Time will be considered for Unusually Persistent Severe Weather unless Contractor submits documentation within 72 hours of the occurrence of the Unusually Persistent Severe Weather satisfactory to Metro establishing that the weather at the Project Site satisfied the definition of Unusually Persistent Severe Weather and that the delay could not have been avoided by either rescheduling the Work or implementing reasonable measures to protect against the weather so that the Work could proceed.

3.4.3.3.3 Acts of a public enemy, war (whether or not declared), or governmental intervention resulting therefrom, blockage, embargo, insurrection, riot, or civil disturbance.

3.4.3.3.4 The failure to issue or renew, or the suspension, termination, interruption, or denial of, any permit, license, consent, authorization, or approval essential to the Work, if such act or event is not the result of the willful or negligent action or inaction of Contractor or of any third party for whom Contractor is directly responsible, and if Contractor is taking, has taken, or will cause to be taken, all reasonable actions in good faith to contest such action (it being understood that the contesting in good faith of any such action shall not constitute or be construed as a willful or negligent act of Contractor).

3.4.3.3.5 The failure of any appropriate federal, state, municipal, county, or other public agency or authority or private utility having operational jurisdiction over the Work or Site to provide and maintain utilities, services, water and sewer lines, and power transmission lines to the Site, that are required for and essential to the Work.

3.4.3.3.6 Epidemics or quarantines.

3.4.3.3.7 Material, equipment, or fuel shortages or freight embargoes.

3.4.3.3.8 Priorities or privileges established for the manufacture, assembly, or allotment of material by order, decree, or otherwise of the U. S. or by any department, bureau, commission, committee, agent, or administrator of any legally constituted public authority.

3.4.3.4 Compensable Excusable Delay Claims. Delays resulting from the following acts, events, and conditions are Compensable Excusable Delays:

3.4.3.4.1 Changes in the Work ordered by Metro if they require additional time to complete the Work and adversely impact the Critical Path.

3.4.3.4.2 The prevention by Metro of Contractor from commencing or prosecuting the Work.

3.4.3.4.3 Failure by the Architect or Engineer to respond to a Request for Information within five (5) working days of submittal by the Contractor.

3.4.3.5 Inexcusable Delays. Delays resulting from the following acts, events, and conditions shall not result in Excusable Delays:

3.4.3.5.1 Any delay that could have been avoided by the exercise of care, prudence, foresight, and diligence on the part of Contractor.

3.4.3.5.2 Any delay in the prosecution of parts of the Work that may in itself be unavoidable but that does not necessarily prevent or delay the prosecution of other parts of the Work nor the Substantial Completion of the Work of this Contract within the time specified.

3.4.3.5.3 Any reasonable delay resulting from the time required by Metro for review of submittals or shop drawings submitted by Contractor and for the making of surveys, measurements, and inspections.

3.4.3.5.4 Any delay arising from an interruption in the prosecution of the Work on account of the reasonable interference from Other Metro Contractors that does not necessarily prevent the Substantial Completion of the Work of this Contract within the time specified.

3.4.3.5.5 Any delay resulting in any manner from labor disputes, strikes, or difficulties or any delay resulting in any manner from any labor-related event, act, or condition whether or not Contractor has any control over such event, act, or condition.

3.4.3.5.6 Any delays in delivery of equipment or material purchased by Contractor or its Subcontractors or Suppliers (including Metro-selected equipment. Contractor shall be fully responsible for the timely ordering, scheduling, expediting, delivery, and installation of all equipment and materials.

3.4.3.6 Excusable Delay Claims Procedure.

3.4.3.6.1 Contractor shall, within forty-eight (48) hours of the start of the occurrence or Contractor's first knowledge of the occurrence that is the basis of the claim for Excusable Delay, whichever is earlier, notify Metro in writing of such delay. The written notice by Contractor shall indicate the cause of the delay and shall estimate the possible time extension requested. Within ten (10) days after the cause of the delay has been remedied, Contractor shall give written notice to the Project Manager of any actual time extension and, if the Excusable Delay is a Compensable Excusable Delay, any increase in the Contract Amount requested as a result of the aforementioned occurrence in accordance with this Contract. If Contractor believes that a single circumstance or set of facts gives rise to both a claim for an extension to the Contract Time and an increase in the Contract Amount, Contractor must state both such allegations in one written claim or waive the unstated allegation.

3.4.3.6.2 Submission of timely written notice as specified above shall be mandatory and failure to comply shall be a conclusive waiver to any claim for Excusable Delay by Contractor. Oral notice or statement will not be sufficient.

3.4.3.6.3 Within twenty-one (21) days after Contractor submits to the Project Manager such a written notice for an extension of Contract Time and/or increase in the Contract Amount, the Project Manager will issue the decision on each request. If Contractor is dissatisfied with such decision, Contractor may preserve its claim as provided and prescribed by Section 3.4.6.

3.4.4 Claims for Differing Site Conditions-- Contractor shall promptly, and before the conditions are disturbed, give written notice to the Project Manager of (i) subsurface or latent physical conditions at the Site that differ materially from those indicated in this Contract, or (ii) physical conditions at the Site that were unknown and not reasonably discoverable by means of the Review of Project Conditions required by Section 2.7, are of an unusual nature that differ materially from those ordinarily encountered and generally recognized as inherent in Work of the character provided for in the Contract. The Project Manager shall investigate the Site conditions promptly after receiving the notice. If the conditions do materially so differ as to cause an increase or decrease in Contractor's cost of, or the time required for, performing any part of the Work under this Contract, whether or not changed as a result of the conditions, an equitable adjustment shall be made and a Change Order issued. If Contractor is dissatisfied with the decision of the Project Manager under this Section, Contractor may preserve its claim as provided and prescribed by Section 3.4.6.

3.4.5 Other Contractor Claims-- Contractor claims based on Clarifications or Change Orders issued by Metro or any other decision, action, or failure to act by Metro shall be made according to this Section.

3.4.5.1 Contractor shall, within forty-eight (48) hours following discovery of the facts that give rise to its claim, notify the Project Manager in writing of its intent to make the claim. Within ten (10) days following discovery of the facts that give rise to its claim and prior to commencing the Work or conforming to the Clarification on

which the claim is based, if any, Contractor shall submit its formal written claim to the Project Manager. Contractor's formal claim shall include a description of:

3.4.5.1.1 The factual occurrences upon which Contractor bases the claim including the decision, action, or failure to act by Metro or its authorized representatives that allegedly give rise to the claim;

3.4.5.1.2 How Metro's decision, action, or failure to act has affected Contractor's performance or otherwise affected Contractor;

3.4.5.1.3 Whether the claim is for an extension in the Contract Time or increase in the Contract Amount, or both, and the specific extension or increase requested;

3.4.5.1.4 The provisions of the Contract upon which the claim is based.

3.4.5.2 Submission of written notice of intent to make a formal claim as specified above shall be mandatory and failure to comply shall be a conclusive waiver to any claim by Contractor. Oral notice or statement will not be sufficient nor will notice or statement after commencing the Work in question.

3.4.5.3 After the written notification is submitted by Contractor (if the claim is not resolved or withdrawn in writing) and only upon written direction by the Project Manager, Contractor shall proceed without delay to perform the Work pursuant to the direction of the Project Manager. While the Work on an unresolved claim is being performed, Contractor shall keep track of costs and maintain records in the manner set forth in the section on Force Account Work, at no cost to Metro. Such notice by Contractor and the fact that Contractor is keeping track of costs and maintaining records shall not in any way be construed as proving the validity of the claim nor the costs thereof.

3.4.5.4 Provided the claim or claims have been submitted in accordance with the requirements of this Section, the Project Manager will consider and investigate the claim or claims of Contractor. Within twenty-one (21) days of receipt of the above-described written notification of claim, the Project Manager will advise Contractor of the Project Manager's decision to accept or reject the claim or claims, in full or in part. If Contractor is dissatisfied with the decision of the Project Manager under this Section, Contractor may preserve its claim as provided and prescribed by Section 3.4.6.

3.4.6 Preservation of Claims -- Within thirty (30) days after a rejection of a claim, in whole or in part, by Metro under Sections 3.4.3, 3.4.4 or 3.4.5, Contractor may preserve its claim by submitting a fully documented claim package to the Metro Procurement Officer. That package shall include substantiating documentation with an itemized breakdown of Contractor and Contractor's Subcontractors' costs on a daily basis that shall include but not be limited to labor, material, equipment, supplies, services, Overhead, and Profit. All documentation that Contractor believes is relevant to the claim shall be provided in the claim package, including without limitation payroll records, purchase orders, quotations, invoices, estimates, correspondence, profit and loss statements, daily logs, ledgers, and journals. Failure to submit the claim package in full compliance with this requirement and/or maintain cost records as herein required will constitute a waiver of the claim. If Contractor elects to pursue any claims by filing a lawsuit against Metro, it must commence such lawsuit within six (6) months after the date of Substantial Completion. Failure to commence a lawsuit within this time limitation shall constitute a waiver of all such claims by Contractor.

3.5 Metro's Right to Stop, Perform, or Delete Work.

3.5.1 If the Contractor fails to correct Work not in conformance with the Contract or fails to carry out Work in accordance with the Contract, Metro may issue a written order to the Contractor to stop all or part of the Work until the deficiency set forth in the order has been corrected. Metro has no duty to exercise this right for the benefit of anyone other than Metro.

3.5.2 If the Contractor refuses or fails to comply with the Contract, Metro may correct any deficiency or defect or perform Work that the Contractor has failed to perform, or take other appropriate action, without prejudice to any other remedy Metro may have under the Contract. Before taking that action, Metro will provide the Contractor and its sureties with seven days' written notice of its intentions, unless an emergency or dangerous condition exists, in which case the action may be taken without notice. If Metro performs part of the Contractor's Work, corrects deficiencies, or is required to take action as a result of an emergency or dangerous condition, Metro will deduct the cost of that action from any payment then or thereafter due the Contractor. If the cost of Metro's action exceeds any sums held by Metro and otherwise payable to the Contractor, the Contractor agrees to reimburse Metro for any excess costs.

3.5.3 Metro has the right to delete Work from this Contract, and the Parties agree that such action does not constitute a breach of contract. Therefore, Metro may delete Work from the Contract and perform it with its own forces or have such Work performed by another Contractor. If Work is deleted from the Contract, the cost of performing such Work will be deducted from the Contract Amount to be paid to the Contractor. Any objection to the change in Contract Amount must be processed as a claim as required by Section 3.4.5.

3.5.4 Metro's rights as stated in this Section 3.5 are in addition to and do not limit Metro's other rights or remedies.

3.6 Metro's Right to Adjust Payments.

3.6.1 Adjusted Payments for Delay. Time is of the essence in this Contract. Metro and Contractor understand and agree that Metro will be damaged if Contractor fails to substantially complete the Work within the Contract Time, and that Metro will be vulnerable to further damages if Metro is obligated to continue paying Contractor for Work performed after the Contract Time has expired. It is therefore agreed that upon the expiration of the Contract Time, Metro may adjust its payments to Contractor by any combination of the following: (1) making no further payments to Contractor until the Work is substantially complete; (2) paying the Subcontractor costs incurred by Contractor without any overhead, profit, or fee of any kind going to Contractor; and/or (3) collection of liquidated damages as designated in the Contract. Permitting Contractor to continue and finish the Work or any part thereof after the Contract Time has expired shall not waive any of Metro's rights under this Section or the balance of the Contract Documents.

3.6.2 Adjusted Payments Not a Bar to Metro's Right to Other Damages. Payment of adjusted payments shall not release Contractor from obligations in respect to the complete performance of the Work, nor shall the payment of such adjusted payments constitute a waiver of Metro's right to collect any additional adjusted payments that it may sustain by failure of Contractor to fully perform the Work, it being the intent of the Parties that the aforesaid adjusted payments be full and complete payment only for failure of Contractor to complete the Work on time. Metro expressly reserves the right to make claims for any and all other damages that Metro may incur due to Contractor's failure to perform in strict accordance with this Contract.

3.7 Mediation. Both Parties shall endeavor to negotiate resolutions to all disputes arising out of this Contract. Any controversy or claim arising out of or relating to this Contract that remains unresolved after such negotiations shall be submitted to mediation prior to the commencement of litigation.

3.7.1 The mediator shall be an individual mutually acceptable to both Parties. Should the Parties disagree on the selection of a mediator, the Parties shall look to the local circuit court or the Oregon Dispute Resolution Commission. Each Party shall pay its own costs for the time and effort involved in mediation. The cost of the mediator shall be split equally between the two Parties.

3.7.2 Both Parties agree to exercise their best effort in good faith to resolve all disputes in mediation. Participation in mediation is a mandatory requirement on both Metro and Contractor. The schedule and time allowed for mediation shall be mutually acceptable. The mediation process is nonbinding.

3.7.3 Contractor agrees to consolidation of any mediation between Metro and Contractor with any other mediation involving, arising from, or relating to this Contract.

3.8 Litigation. All disputes not resolved by mediation shall be decided exclusively by a court of competent jurisdiction in Multnomah County under the laws of the state of Oregon.

3.9 Work to Continue Notwithstanding Dispute. In no event shall submission of a dispute arising out of this Contract by either Party relieve Contractor of its obligation to fully perform the requirements of the Contract as directed by Metro pending resolution of the dispute pursuant to the procedures set forth in this Article. In the event Contractor, in Metro's opinion, fails to fully perform the requirements of the Contract pending resolution of a dispute, Metro shall be entitled to exercise its rights to impose adjusted payments pursuant to Section 3.6, and/or terminate the Contract pursuant to Article 15 of these General Conditions.

ARTICLE 4
SUBCONTRACTING AND ASSIGNMENT OF THE CONTRACT

4.1 Subcontracting. Contractor shall arrange and delegate its Work in conformance with trade practices and union regulations, if applicable, but shall remain responsible to Metro for performance of all Work required or implied by the Contract Documents. Contractor shall also be responsible for coordinating the efforts of its Subcontractors and Suppliers.

4.2 Objection to Subcontractors or Suppliers. Metro reserves the right to make reasonable objection to any of Contractor's Subcontractors or Suppliers if Metro discovers any data or information at any time during the performance of the Contract that gives Metro a basis for such reasonable objection. Metro will notify Contractor in writing if Metro has any reasonable objection to any of Contractor's Subcontractors or Suppliers. Contractor shall not subcontract with any Subcontractor or Supplier to which Metro has made a reasonable objection. In the event of Metro's reasonable objection to any Subcontractor or Supplier, Contractor shall propose another entity to which Metro has no reasonable objection.

4.3 Substitution, Change, or Addition of Subcontractors or Suppliers. At any time that Contractor intends to substitute, change, or add a Subcontractor or Supplier during the performance of the Contract, Contractor shall give Metro prior written notice of such intention. Contractor shall not substitute, change, or add any such Subcontractor or Supplier if Metro gives Contractor reasonable objection in writing within ten (10) days after Metro receives such notice.

4.4 Removal of Subcontractors at Request of Metro. When any Subcontractor fails to prosecute a portion of the Work in a satisfactory manner, Metro may so notify Contractor. If the Subcontractor fails to cure the unsatisfactory Work promptly, Contractor shall remove such Subcontractor immediately upon written request of Metro and Contractor shall request approval from Metro of a new Subcontractor to perform this section of the Work at no increase in the Contract Amount, and with no change in the Contract Time.

4.5 Metro Not Obligated to Detect Unsatisfactory Work. Nothing contained in this Contract shall obligate Metro or place on Metro an affirmative duty to detect or discover unsatisfactory Work or materials of Contractor's Subcontractors or Suppliers. Failure of Metro to detect or discover such unsatisfactory Work or materials shall not relieve Contractor of any of its obligations under this Contract.

4.6 No Contractual Relationships Between Metro and Contractor's Subcontractors and Suppliers. Nothing contained in this Contract is intended nor shall be construed to create any contractual or third party beneficiary relationship between Metro and any of Contractor's Subcontractors, Suppliers, or agents, save and except in relation to the Labor and Materials Payment Bond.

4.7 Contractor's Agreements with Subcontractors.

4.7.1 Contractor shall provide in all subcontract and supply agreements that the Subcontractor or Supplier will be bound by the terms and conditions of this Contract to the extent that they relate to the Subcontractor's or Supplier's Work. Contractor shall require each Subcontractor to enter into similar agreements with sub-tier Subcontractors and Suppliers. Contractor shall make available to each proposed Subcontractor and Supplier, prior to the execution of the subcontract or supply agreement, copies of the Contract Documents that apply to the Work and materials to be provided by the Subcontractor or Supplier. Subcontractors and Suppliers shall similarly make copies of applicable portions of such documents available to their respective proposed sub-tier Subcontractors and Suppliers.

4.7.2 All Subcontractor and Supplier agreements shall also provide that they are assignable to Metro at Metro's option, in the event that Metro terminates the Contract. Contractor will provide to Metro a copy of all subcontracts and supply contracts for permanent materials.

4.7.3 The Contractor will provide Metro with copies of all of its subcontracts, purchase orders, and supply agreements relating to the Work upon Metro’s request within three (3) business days of the request.

4.8 Assignment. Contractor shall constantly give its personal attention to the faithful prosecution of the Work. Contractor shall keep the Work under its personal control and shall not assign any or all of Contractor's rights, by power of attorney or otherwise, nor delegate any of its duties except with the prior written approval of the Metro Council.

ARTICLE 5
TIME OF COMPLETION AND SCHEDULE FOR THE WORK

5.1 Prosecution of Work Generally. Contractor shall commence the Work within five (5) days after issuance of written Notice to Proceed from Metro and will diligently prosecute the Work to its Final Completion and Acceptance. The start of Work shall include attendance at preconstruction conferences, preparation and submittal of shop drawings, equipment lists, Schedule of Values, CPM construction schedules, requests for substitutions, and other similar activities, as described by these Contract Documents.

5.2 Time of Completion.

5.2.1 Contractor shall bring the Work to Substantial Completion within the Contract Time as set forth in the Construction Agreement.

5.2.2 The time limits stated in these Contract Documents are of the essence of this Contract. By executing the Construction Agreement, Contractor confirms that the Contract Time is a reasonable period for performing all of the Work.

5.2.3 Failure of Contractor to substantially complete the Work within the Contract Time and according to the provisions of these Contract Documents shall subject Contractor to liquidated damages pursuant to the applicable sections of these Contract Documents.

5.3 Extensions of Time. Extensions of the Contract Time shall be made pursuant to the procedure and according to the provisions and requirements contained in Articles 3 and 8 of these Contract Documents.

5.4 Project Scheduling. Contractor shall submit to Metro a detailed Construction Schedule for completion of the Work pursuant the Specifications following the Critical Path method. The Construction Schedule shall, when approved and as updated and approved by Metro, become a part of the Contract Documents.

5.5 Use of Completed Parts of the Work Before Acceptance.

5.5.1 Metro may decide to use part of the Work that has been completed before completion of all the Work required by the Contract. If that occurs, Metro will notify the Contractor in writing of its intention.

5.5.2 When use of part of the Work by Metro begins, the Contractor is:

5.5.2.1 Relieved of the duty of maintaining and protecting that portion of the Work, provided that it has been completed in accordance with the Contract.

5.5.2.2 Relieved of responsibility for injury or damage to the portion of Work used by Metro from use by public traffic or from the action of the elements of nature or from any other cause, except injury or damage resulting from the Contractor's own operations or from its negligence.

5.5.2.3 Relieved of the responsibility of cleaning up that portion of the Work before final acceptance, unless the Contractor's own operations require such cleanup.

5.5.3 Use by Metro of a part of the Work as described in this Section does not constitute final acceptance of the Work as a whole or in any part.

ARTICLE 6
COORDINATION WITH OTHER METRO CONTRACTORS

6.1 Other Metro Contractors Generally. Metro reserves the right to award other contracts in connection with the Work. Contractor shall allow such Other Metro Contractors reasonable opportunity for storage of their materials and execution of their Work, shall ensure that the execution of Contractor's Work properly connects and coordinates with Work of all Other Metro Contractors, and shall cooperate with Other Metro Contractors to facilitate the Work in such a manner as Metro may direct. Connection between the Work of the Contractor and Other Metro Contractors will be the responsibility of the Party that is last in time to construct, unless otherwise directed in the Contract Documents.

6.2 Duty to Inspect Other Metro Contractors' Work. Where Contractor's Work is associated with that of Other Metro Contractors, or is to interface in any way with such Other Metro Contractors' Work, Contractor shall examine, inspect, and measure the adjacent or in-place Work of such Other Metro Contractors. If Contractor determines that any defect or condition of such adjacent or in-place Work will impede or increase the cost of Contractor's performance or otherwise prevent the proper execution of Contractor's Work, Contractor shall immediately, and before performing any Work affected by the Other Metro Contractors' work, submit an RFI to Metro pursuant to Section 3.3. If Contractor proceeds without examining or inspecting the Work and submitting a Request for Information, Contractor shall be held to have accepted the Other Metro Contractors' Work or material and the existing conditions, shall be responsible for any defects in Contractor's Work resulting therefrom, and shall not be relieved of any obligation or any warranty under this Contract because of any such condition or imperfection. This provision shall be included in any and all of Contractor's subcontracts for Work to be performed.

6.3 Latent Defects in Other Contractor's Work. Section 6.2 does not apply to latent defects. Contractor shall report latent defects in any Other Metro Contractors' Work at any time such defects become known or Contractor should have known, and Metro shall promptly thereafter take such steps as may be appropriate. If Contractor in the exercise of reasonable care should have known of such defects but did not report them, such defects shall not be considered latent.

6.4 Duty to Maintain Schedule. It shall be the responsibility of Contractor to maintain its schedule so as not to delay the progress of the Project or the Work of Other Metro Contractors. Contractor is required to cooperate in every way possible with Other Metro Contractors. Except as otherwise specifically provided in this Contract, no additional compensation will be paid for such cooperation. If Contractor delays the progress of the Project or the progress of Other Metro Contractors, it shall be the responsibility of Contractor to take all of the steps necessary to bring the affected Work into compliance with any affected schedules and to indemnify Metro from all liability for such delays pursuant to Article 11. Metro shall be under no duty to monitor or detect any delays of Contractor or any Other Metro Contractor on the Project or any lack of coordination on the Project. Consequently, the failure of Metro to so monitor or detect shall not be construed as relieving Contractor of its duties to fully perform all of its obligations under the Contract.

6.5 Failure to Maintain Schedule.

6.5.1 If, in the opinion of Metro, Contractor falls behind the Construction Schedule or delays the progress of Other Metro Contractors and is not entitled to an extension of time pursuant to the Contract Documents, Contractor shall perform all steps that are necessary, in the opinion of Metro, to bring Contractor's Work into compliance with the Construction Schedule or to remedy any delay to the progress of Other Metro Contractors. Contractor shall submit operation plans to Metro that shall fully demonstrate the manner of intended compliance with this Section. The steps referred to above shall include but not be limited to:

6.5.1.1 Increased manpower in such quantities and crafts as will substantially eliminate the backlog of Work.

6.5.1.2 Increase, when permitted, the number of working hours per shift, shifts per working day, working days per week, or the amount of equipment or any combination of the foregoing, sufficient to eliminate the backlog of Work.

6.5.1.3 Reschedule activities to achieve maximum practical concurrence of accomplishment of activities.

6.5.1.4 Expedite delivery of materials and equipment, such as use of airfreight.

6.5.2 If Metro directs Contractor to take measures described in this Section, or if Contractor takes such measures without direction from Metro, Contractor shall bear all costs of complying. Metro shall, however, reimburse Contractor for reasonable costs of complying if such directive to accelerate from Metro was issued to overcome delay caused by the acts or omissions of Metro or persons acting for Metro, provided Contractor has complied with all applicable provisions of Articles 3 and 8 of these General Conditions.

6.5.3 Failure to maintain the construction schedule or to take action to regain the schedule or to furnish a schedule as outlined in the Specifications may result in withholding all or part of the monthly progress payments.

6.6 Failure to Coordinate Work. If Contractor fails to coordinate its Work with the Work of Other Metro Contractors as directed by Metro, Metro may, upon written notice to Contractor:

6.6.1 Withhold any payment otherwise due hereunder until Contractor complies with Metro's directions.

6.6.2 Direct others to perform portions of the affected Work and charge the cost of such Work against the Contract Amount or deduct the cost from sums held in Retainage.

6.6.3 Terminate any or all portions of the Work for Contractor's failure to perform in accordance with the Contract.

6.7 Other Metro Contractors' Failure to Coordinate. If Contractor determines that any Other Metro Contractor on this Project is failing to coordinate its Work with the Work of Contractor, Contractor shall notify Metro immediately and before performing any affected Work.

6.8 Conflicts Among Contractors. Any difference or conflict that may arise between Contractor and Other Metro Contractors in regard to their Work shall be adjusted as determined by Metro. If directed by Metro, Contractor shall suspend any part of the Work specified or shall carry on the same in such a manner as may be prescribed by Metro when such suspension or prosecution is necessary to facilitate the Work of Other Metro Contractors.

6.9 Coordination Drawings. Contractor shall prepare coordination drawings as determined necessary by Metro to satisfactorily coordinate and interface its Work with the Work of all Other Metro Contractors, thereby avoiding conflicts that may arise.

6.10 Furnished by Owner, Installed by Contractor ("FOIC") Items.

6.10.1 Owner Responsibilities for FOIC Items. Owner-furnished products/items are indicated on the drawings as FOIC items. Owner's responsibilities include: (1)arrangement for and delivery of necessary shop drawings, product data, and samples to the contractor; (2) arrangement of and payment for Product delivery to the Site; (3) delivery of Suppliers' bill of materials to Contractor; (4) inspection of deliveries jointly with the Contractor and recording shortages of and damaged or defective items; (5) submission of claims for transportation damage; (6) arrangement for replacement of damaged, defective, or missing items; and (7) arrangement for manufacturers' warranties, bonds, service, and inspections as required. Owner is responsible for scheduling all FOIC items in accordance with Contractor's Construction Schedule.

6.10.2 Contractor Responsibilities for FOIC Items. The following outlines the responsibilities of the Contractor for FOIC items: (1) designating a delivery date for each item in the Construction Schedule; (2) reviewing shop drawings, product data, and samples; (3) immediately notifying the Project Manager of any discrepancies or problems anticipated in the use of the product; (4) reviewing and unloading products at the Site; (5) promptly inspecting products jointly with Owner and recording shortages and damaged or defective items; (6) handling products at the Site,

including uncrating and storage; (7) protecting products from exposure to elements and damage; (8) assembling, installing, connecting, adjusting, and finishing product as stipulated in the Specifications; and (9) repairing or replacing items damaged by Contractor.

6.11 Conferences. At any time during the progress of the Work, Metro shall have authority to require Contractor to attend any conference of any or all of the Contractors engaged in the Project or related projects.

6.11.1 Project Meetings. The Contractor will schedule and chair meetings and conferences at the Project Site unless otherwise indicated. Contractor will inform participants and other individuals whose presence is required of the date and time of each meeting. The Contractor shall prepare an agenda, distribute to all attendees, and prepare minutes that reflect significant discussions and agreements achieved. Meeting minutes shall be distributed to everyone concerned, including Metro, within three (3) days of the meeting.

6.11.2 Pre-construction Conference. The Contractor will schedule a pre-construction conference prior to start of construction. The meeting will be scheduled at a time convenient to Metro and Architect or Engineer, but no later than five (5) days after execution of the Contract. The conference will be held at the Project Site or another convenient location. The purpose of the meeting is to review responsibilities and personnel assignments. Attendees will include authorized representatives of Metro, Architect or Engineer and its consultants, Contractor and its superintendent, major subcontractors and suppliers, and other concerned parties. All participants shall be familiar with the Project and be authorized to conclude matters relating to the Work. The agenda shall include tentative construction schedule, phasing, critical Work sequencing and long-lead items, designation of key personnel and their duties, procedures for processing field decisions and Change Orders, procedures for RFIs, procedures for testing and inspecting, procedures for processing applications for payment, distribution of Contract Documents, submittal procedures, preparation of record documents, use of premises, Work restrictions, Owner's occupancy requirements, responsibilities for temporary facilities and Site protection, construction waste management and recycling, parking availability, office, Work, and storage areas, equipment deliveries and priorities, first aid, security, progress cleaning, and working hours.

6.11.3 Pre-installation Conferences – Contractor will conduct a pre-installation conference at the Project Site before each construction activity that requires coordination with other construction and includes installation of FOIC items. Contractor is responsible for conducting these meetings, which shall occur on the same date as progress meetings, if possible. Attendees shall include the installers and representatives of manufacturers and fabricators involved in or affected by the installation and its coordination with other materials or installations. Agenda items will include Contract Documents, options, related RFIs, related Change Orders, purchases, deliveries, submittals, review of mock-ups, possible conflicts, compatibility problems, time schedules, weather limitations, manufacturers' written recommendations, warranty requirements, compatibility of materials, acceptability of materials, temporary facilities and controls, space and access limitations, regulations of authorities having jurisdiction, testing and inspecting, installation procedures, coordination with other Work, required performance results, protection of adjacent Work, and protection of the Site and its elements. The Architect or Engineer shall record significant conference discussions, agreements, and disagreements, including corrective action measures and action.

ARTICLE 7
CONTROL AND QUALITY OF WORK AND MATERIAL

7.1 Quality Control.

7.1.1 Generally. Contractor has the primary responsibility for quality control. Contractor will provide continuous superintendence and inspection to insure that the Work is completed in accordance with the plans and Specifications. During the performance of the Work, Metro, the Architect or Engineer, Special Inspectors, and any representatives of federal, state, and local agencies having jurisdiction over the Work may enter the Project Site, the shops where any part of the Work is being prepared, or the factories or sites where any materials for use in the Work are being or will be manufactured or derived. Contractor shall provide proper and safe facilities for such inspections, and shall make arrangements with manufacturers or other suppliers to facilitate inspection of their processes and products to such extent as Metro's interest may require. No claims for extension of the Contract Time or increase in the Contract Amount shall be allowed for any access allowed to Metro under this Section.

7.1.2 Quality Control Plan. Contractor shall prepare and submit a Quality Control Plan to the Project Manager within thirty (30) days following the Notice to Proceed. The Plan will describe the Contractor's procedures for implementing the Quality Control Plan. The Plan shall include without limitation the Quality Control organization, inspection procedures, tests anticipated, materials control, contingency plans related to fire protection and remediation of contaminated releases or other environmental improvement, and reports. Metro reserves the right to accept, reject,

or modify the Quality Control Plan. Contractor will submit an interim Quality Control Plan prior to the start of Work to cover the first thirty (30) days of construction.

7.1.3 Quality Control Manager. Prior to initiation of construction, Contractor shall designate in writing a Quality Control Manager who shall be responsible for coordinating Contractor's Quality Control Program. The individual so designated shall be the interface with the Project Manager on matters relating to submittals, inspection, scheduling, unacceptable Work product, and corrective actions. Metro reserves the right to accept or reject the Quality Control Manager designated by Contractor.

7.2 Inspection. Contractor has the primary responsibility for providing inspection and testing, except as otherwise set forth in the Specifications. Metro and its agents will also inspect at their discretion or as outlined in the Specifications.

7.2.1 Generally. At all times during construction of the Work, Contractor shall permit Metro, the Architect or Engineer, and Special Inspectors, or any representatives of federal, state, and local agencies having jurisdiction over the Work, to visit and monitor the progress of the Work for conformance of the Work with the Contract Documents.

7.2.2 Special Inspections.

7.2.2.1 At all times during construction of the Work, Contractor shall permit Metro, the Architect or Engineer, and Special Inspectors, or any representatives of federal, state, and local agencies having jurisdiction over the Work, to visit and inspect the Work, the materials and the manufacture and preparation of such materials, and subject the Work and materials to inspection and testing to determine if the Work conforms to the requirements of the Contract Documents. Contractor shall maintain proper facilities and safe access for all such inspections.

7.2.2.2 The Contractor is responsible for scheduling and coordination of special inspections. Contractor shall be diligent in scheduling special inspections and make every effort to combine special inspections to avoid unnecessary budget impacts.

7.2.2.3 The Contract Documents or regulatory agencies may require that portions of the Work be observed, reviewed, tested, or inspected before they are obscured or covered. Similarly, upon request, the Project Manager is entitled to observe portions of the Work before they are covered or obscured. Contractor shall be solely responsible for notifying Project Manager at least two (2) working days prior to performing such Work so that necessary arrangements for inspection and testing can be made. If the Contractor covers or obscures a portion of the Work that is required or requested to be observed, it will uncover the Work for observation and bear any cost associated with that activity without a change in Contract Time.

7.2.2.4 The Project Manager may request to see a portion of the Work that has been covered regardless of the requirements of the Contract Documents, regulatory agencies, or a prior request. Thereafter the Contractor must comply with Metro's request. If, on inspection by the Project Manager, the portion of the Work that is uncovered is found to be in accordance with the Contract Documents, Metro will bear all costs associated with that activity and provide additional Contract Time if that activity would cause the Contractor to incur liquidated damages. But if, upon inspection by the Project Manager, the portion of the Work that is uncovered is found not to be in accordance with the Contract Documents, the Contractor will correct the Work and bear any cost associated with that activity without a change in Contract Time. Metro retains the right at any time during construction, or at any time during production, fabrication, or preparation of the Work, to test samples to determine whether they meet the requirements of the Contract Documents. Metro may test any sample, regardless of prior certification, and regardless of whether any prior certification was required. Metro may either conduct the test with its own forces or hire other persons to perform this Work.

7.2.2.5 Metro retains the right at any time during construction, or at any time during production, fabrication, or preparation of the Work, to test samples to determine whether they meet the requirements of the Contract Documents. Metro may test any sample, regardless of prior certification, and regardless of whether any prior certification was required. Metro may either conduct the test with its own forces or hire other persons to perform this Work.

7.2.2.6 If a sample is to be tested prior to its incorporation into the Work, the Contractor may not incorporate the material, product, part, or equipment into the Work until testing is completed and Metro gives permission for its use.

7.2.2.7 Metro will bear the costs of testing unless the tests show that the material, product, part, or equipment failed the test and did not conform to the requirements of the Contract, in which case the Contractor will bear the costs of testing.

7.2.2.8 If the sample was previously incorporated into the Work and testing shows that the sample does not meet the requirements of the Contract Documents, the Contractor will pay for the test and for replacing and repairing any equipment, materials, products, or portion of the Work in order to meet the requirements of the Contract Documents.

7.2.3 Notice to Metro for Certain Work Days. Whenever Contractor intends to perform Work on Saturday, Sunday, or any legal holiday, it shall give written notice to Metro of such intention at least two (2) working days prior to performing such Work, or such other period as may be specified by Metro, so that Metro may make the necessary arrangement for testing and inspection.

7.2.4 Correction of Defective Work Before Acceptance. Any defective Work or Work that otherwise fails to conform to the Contract Documents that is discovered before Final Completion and Acceptance of the Work, shall be corrected immediately by Contractor, and any unsatisfactory materials shall be rejected and replaced with satisfactory materials, notwithstanding that they may have been overlooked by the authorized inspector. The inspection of the Work by Metro, the Architect or Engineer, or any other agency shall not relieve Contractor of any of its obligations to perform fully all of the terms and provisions of the Contract Documents.

7.2.5 Acceptance Not Implied by Failure to Object. Failure or neglect on the part of Metro or any of its authorized representatives to condemn or reject defective, improper, or inferior Work or materials shall not be construed to imply a final acceptance of such Work or materials and shall not be construed as relieving Contractor of its duties to perform fully all requirements of the Contract Documents.

7.2.6 Replacement and correction of defective Work before the Work is completed and accepted is not limited by any warranty period otherwise established by the Contract.

7.3 Unsatisfactory Materials and Workmanship.

7.3.1 Generally. Material, Work, or workmanship that, in the opinion of the Project Manager, does not conform to the Contract Documents, or is not equal to the samples submitted to and approved by the Project Manager, or is in any way unsatisfactory or unsuited to the purpose for which it is intended, will be rejected. Contractor shall bear the cost of correcting or removing, as deemed necessary by Metro, all non-conforming materials, defective Work, or unsatisfactory workmanship. Contractor shall make a close inspection of all materials as delivered, and shall promptly replace all defective materials with conforming materials without waiting for their rejection by Metro.

7.3.2 Removal of Rejected or Non-Conforming Work or Material. All rejected material or Work, and all defective or non-conforming Work or material, shall be removed from the Site without delay. If Contractor fails to do so within forty-eight (48) hours after having been so directed by Metro, the rejected material may be removed by Metro and the cost of removal charged against Contractor and deducted from Retainage held by Metro or offset against payments due Contractor, at Metro's option. If in the judgment of Metro it is undesirable or impracticable to replace any defective or non-conforming Work or materials, the compensation to be paid to Contractor shall be reduced by Change Order or Force Account, as applicable, by such amount as, in the judgment of Metro, shall be equitable.

7.4 General Warranty of Contractor. Contractor warrants to Metro that materials and equipment provided 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 and contaminants not inherent in the quality required or permitted, and that the Work will conform with the requirements of the Contract Documents. Work not conforming to these requirements, including substitutions not properly approved and authorized, may be considered defective. Contractor's warranty excludes remedy for damage or defect caused by abuse, modifications not executed by Contractor, improper or insufficient maintenance, improper operation, or normal wear and tear under normal usage. If required by Metro, Contractor shall furnish satisfactory evidence as to the kind and quality of materials and equipment. The warranty made by Contractor under this Section shall be in addition to any other specific warranties and certifications required elsewhere in these Contract Documents.

7.5 Third-Party Warranties.

7.5.1 The Contractor shall obtain from Subcontractors, manufacturers, and suppliers guarantees and warranties according to the Contract Documents with the optimum terms and longest periods reasonably obtainable. The documentation must also include all maintenance and operational documentation required to sustain said warranties.

7.5.2 All guarantees or warranties of materials furnished to the Contractor or Subcontractor by any manufacturer or supplier shall be deemed to run for the benefit of the Owner.

7.5.3 As a condition of Substantial Completion of the Project by the Owner, the Contractor shall deliver to the Owner three (3) bound volumes of all guarantees and warranties on material furnished by all manufacturers and suppliers to the Contractor and all its Subcontractors, with duly executed instruments properly assigning the guarantees and warranties to the Owner. The guarantees and warranties in each bound volume shall be

grouped together by trade and properly indexed. The Contractor shall assign to the Owner, and shall deliver to the Owner, all manufacturers' warranties not later than the date of Substantial Completion.

7.6 Subcontractor Warranties. The Contractor shall and does hereby assign to the Owner the benefits of all warranties and guarantees of all Subcontractors, but such assignment shall not relieve the Contractor of its warranty obligations to the Owner under these General Conditions and other Contract Documents.

7.7 Correction of Work by Contractor.

7.7.1 Any portion of the Work that does not conform to the requirements of the Contract is unacceptable or defective and must be removed and corrected by the Contractor, even if it is contended that Project Manager or other assigned personnel knew or should have known of the existence of the unacceptable Work. This obligation includes defective Work discovered during construction and within one (1) year after the date of Substantial Completion.

7.7.1.1 All portions of the Work that do not conform to the requirements of the Contract Documents must be corrected within a reasonable time at the Contractor's sole expense and without an extension of Contract Time.

7.7.1.2 Metro may replace or correct Work within a reasonable time if the Contractor fails to do so and may charge the Contractor with all reasonable costs incurred while performing that Work, as well as the costs of storing any salvageable materials or equipment. If that occurs, Metro is also entitled to deduct such costs from any sums otherwise due the Contractor.

7.7.1.2.1 If salvageable materials, equipment, or both are stored, Metro will notify the Contractor of the storage and give the Contractor ten days to remove the materials. If the Contractor fails to remove them by the end of that time, Metro may sell them in any commercially reasonable manner, whether privately or publicly.

7.7.1.2.2 If sale is made, Metro will keep all proceeds to the extent that the proceeds do not exceed the costs incurred in correcting and replacing the Work and in storing the materials and equipment. The Contractor will pay Metro any difference in costs that may remain after the sale. If the proceeds exceed Metro's cost, however, it will forward those sums to the Contractor.

7.7.2 In the case of equipment manufactured by others and supplied and/or installed by Contractor, the one (1)-year period shall commence upon the date of first beneficial operation of such equipment by Metro. In the case of Work that is corrected or replaced by Contractor, the one (1)-year period shall commence again on the date of acceptance by Metro of such corrected or replaced Work. Testing shall not be construed to mean acceptance.

7.7.3 If Metro does not require correction or replacement of defective Work or Work failing to conform to the Contract Documents, Contractor, if required by Metro, shall repay to Metro such portion of the Contract Amount as is equitable under the circumstances, as determined by Metro.

7.7.4 Contractor's responsibilities under this Section shall not extend to correction or replacement of defects that are attributable to mistreatment by Metro or to normal wear and tear.

7.8 Warranty and Correction Agreements by Subcontractors.

7.8.1 Generally. In addition to any requirements for written warranties required by the Specifications, Contractor shall require all of its Subcontractors and Suppliers of any tier to make the same warranty to Metro as Contractor makes under Section 7.4. Contractor shall also require all of its Subcontractors and Suppliers of any tier to agree to correct or replace defective Work or Work not conforming to the Contract Documents, and to take full responsibility for defective materials in the same manner as Contractor agrees to correct or replace such Work under Section 7.5.

7.8.2 Form of Submissions. Contractor shall require all of its Subcontractors and Suppliers of any tier to sign documents evidencing the promises made pursuant to Section 7.8.1 above and shall submit such documents to Metro with its request for Final Payment. Such documents shall be signed by both Contractor and the applicable Subcontractor or Supplier and shall be in the form attached as Exhibit 1 to these General Conditions.

7.9 Remedies Not Exclusive. The remedies provided for in this Article shall not be exclusive, but are in addition to all other remedies of Metro with respect to latent defects, frauds, or failure to perform all Work as required by the Contract Documents.

7.10 Proof of Compliance with Contract Provisions. For Metro to determine whether Contractor has complied or is complying with the requirements of the Contract that are not readily enforceable by inspection and test of the Work, Contractor shall, upon request, promptly submit to Metro such properly authenticated documents as may be necessary to demonstrate compliance with the Contract or other satisfactory proof of its compliance with such requirements.

7.11 Patents, Copyrights, Trademarks. All fees or costs of claims for any patented invention, article, or arrangement or any copyrights or trademarks that may be used upon or in any manner connected with the performance of the Work or any part thereof, shall be included in the Bid or Proposal for doing the Work. Contractor shall save, keep, hold harmless, and fully indemnify Metro and Architect or Engineer from all damages, claims for damage, lawsuits, costs, expenses, or liabilities of whatever nature in law or equity, including attorney fees and court costs, that may at any time arise or be set up for any infringement of the patent rights, copyrights, or trademarks of any person or persons in consequence of the use by Metro of articles to be supplied under the Contract and of which Contractor is not the patentee or assignee or has not the lawful right to sell the same. This is in addition to all other hold-harmless and indemnification clauses in these Contract Documents.

7.12 Anti-Trust Claims.

7.12.1 By entering into this Contract, Contractor, for consideration paid to Contractor under the Contract, does irrevocably assign to Metro any claim for relief or cause of action that Contractor now has or that may accrue to Contractor in the future, including at Metro's option, the right to control any such litigation on such claim for relief or cause of action, by reason of any violation of 15 USC Section 1-15, ORS 646.725, or ORS 646.730 in connection with any goods or services that are used, in whole or in part, for the purpose of carrying out Contractor's obligations under this Contract.

7.12.2 Contractor shall require all Subcontractors and Suppliers to irrevocably assign to Metro, as a third-Party beneficiary, any right, title, or interest that has accrued or may accrue to the Subcontractors or Suppliers by reason of any violation of 15 USC Section 1-15, ORS 646.725, or ORS 646.730, including, at Metro's option, the rights to control any litigation arising hereunder, in connection with any goods or services provided to the Subcontractors or Suppliers by any person, in whole or in part, for the purpose of carrying out the Subcontractors' or Suppliers' obligations as agreed to by Contractor in pursuance of the completion of the Contract. Contractor shall require all Subcontractors and Suppliers to Execute the Assignment of Antitrust Claims attached as Exhibit 2 to these General Conditions as part of Contractor's subcontract with Subcontractor or Supplier.

7.12.3 In connection with Contractor's, Subcontractors' or Suppliers' assignment, it is an express obligation of Contractor, Subcontractor, or Supplier that it will take no action that will in any way diminish the value of the rights conveyed or assigned hereunder to Metro. It is an express obligation of Contractor, Subcontractor, or Supplier to advise the Office of Metro Attorney:

7.12.3.1 In advance, of its intention to commence any action on its own behalf regarding such claims for relief or causes of action;

7.12.3.2 Immediately, upon becoming aware of the fact that an action has been commenced on its own behalf by some other person or persons, of the impendency of such action; and

7.12.3.3 The date on which it notified the obligor(s) of any such claims for relief or causes of action of the fact of its assignment to Metro.

7.12.4 In the event that any payment under any such claim is made to Contractor, Subcontractor, or Supplier, it shall promptly pay over to Metro its proportionate share thereof, if any, assigned to Metro under this Section 7.12.

ARTICLE 8
CHANGES IN THE WORK

8.1 Change Orders Generally.

8.1.1 Metro and the Contractor mutually agree that changes in plans, quantities, or details of the Work are inherent in the nature of construction and may be necessary or desirable. Therefore, without impairing the Contract, Metro reserves the right to require changes determined necessary or desirable to complete the proposed construction within the general scope of the Work provided for in the Contract or to order extra Work if that is required. Performance of changed or extra Work will not invalidate the Contract or release the Contractor's surety from its obligations. Changes to the Contract Amount, if any, as a result of the performance of changed or extra Work must be made pursuant to this Article 8.

8.1.2 The only authorized method for increasing or changing the amount of compensation, increasing the amount of Contract Time, or changing the scope of Work to be performed is through the execution of a written Change Order.

8.1.3 Change Orders must be executed in advance when any changed or extra Work for which additional compensation is due will be performed, unless the Work is Force Account Work.

8.1.4 Metro may, at its discretion, also require the signature of Contractor's surety on the Change Order. Prior to the approval of such Change Order, the Architect or Engineer shall have approved any design modifications entailed thereby.

8.1.5 Agreement on any Change Order shall constitute a final settlement of all matters relating to the changes in the Work that are the subject of the Change Order, including without limitation all direct and indirect costs associated with such change, and any and all adjustments to the Contract Sum or Contract Time.

8.2 Procedure for Determining Impact of Change Orders on Contract Amount.

8.2.1 Price before Proceeding. If Metro intends to order changes in the Work, it may request a proposal by Contractor for the proposed added or deleted Work before directing Contractor to commence Work. Within fourteen (14) days after issuance of such request by Metro, Contractor shall furnish three (3) copies of a complete breakdown of costs of both credits and additions directly attributable to the change in the Work proposed, itemizing materials, labor, taxes, effect on Contract Time, if any, and Overhead and Profit on a form approved by Metro and in accordance with the limitations described in the following Section. Subcontract Work shall be so indicated and written proposals from Subcontractors or Suppliers shall be included with similar breakdowns provided. Following submission of its cost breakdown, Contractor shall meet with Metro to discuss all aspects of scope, costs, scheduling, and construction methods.

8.2.2 Proceed While Pricing. If Metro finds it necessary to make changes in the Work in an expeditious manner, it may direct Contractor to proceed with the change while preparing a proposal for the added or deleted Work. In such an instance, Metro may assign an estimated value to the change that Contractor shall not exceed without further authorization by Metro. Within fourteen (14) days after issuance of such by Metro, Contractor shall furnish three (3) copies of a complete breakdown of costs of both credits and additions directly attributable to the change in the Work proposed, itemizing materials, labor, taxes, effect on Contract Time, if any, and Overhead and Profit on a form approved by Metro and in accordance with the limitations described in the following Section. Subcontract Work shall be so included with similar breakdowns provided. Following submission of its cost breakdown, Contractor shall meet with Metro to discuss all aspects of scope, costs, scheduling, and construction methods.

8.2.3 Unit Prices. If the proposed additional or deleted Work is the subject of Unit Prices stated in the Contract Documents or subsequently agreed upon, such Unit Prices shall be binding upon Contractor in calculating the increase or decrease in the Contract Amount attributable to the proposed additional or deleted Work.

8.3 Limitations when Change Orders Impact Contract Amount. The following limitations shall apply in the calculation of the costs of changes in the Work:

8.3.1 Overhead and Profit.

8.3.1.1 Contractor will be permitted a reasonable allowance for Profit and Overhead on its increased Direct Cost resulting from any changes in the Work ordered by Metro. Likewise, Profit and Overhead will be deducted for any portion of the Work that is deleted. In the case of a change involving both credits and extras, Overhead and Profit shall be applied to the net extra after subtraction of credits.

8.3.1.2 Overhead and Profit for the entity performing the Work with its own crews shall not exceed ten percent (10%) of the Direct Cost of the changed Work.

8.3.1.3 Overhead and Profit for Contractor or Subcontractor who has had the Work performed by a lower tier Subcontractor shall not exceed five percent (5%) of the Direct Cost of the changed Work.

8.3.1.4 If the Work is performed by a second-tier Subcontractor, the total Overhead and Profit for all tiers shall in no event exceed twenty percent (20%) of the Direct Cost of the changed Work. Distribution of this Overhead and Profit among the tiers is the responsibility of Contractor.

8.3.2 Taxes and Insurance. Federal, state, regional, county, and local taxes, including but not limited to income taxes, excise taxes, sales and use taxes, and payroll taxes and insurance shall be shown separately, will be allowed on extras, and shall be credited on credits. No Overhead and Profit will be allowed on taxes and insurance.

8.3.3 Bond Premiums. The actual rate of bond premium as paid on the additional Direct Cost plus the cost of taxes defined in 8.3.2 will be allowed. No Overhead and Profit will be allowed on such premiums.

8.3.4 Equipment Costs. The allowance for equipment costs (both rental and Contractor-owned equipment) shall be limited to those rates in the Rental Rate Bluebook published by Dataquest Incorporated, 1290 Ridder Park Drive, San Jose, California 95131-2398, (800) 227-8444.

8.4 Force Account Work.

8.4.1 If Contractor does not respond to Metro's Request for Proposal with a cost breakdown within the fourteen (14)-day period as required above, or if Metro determines that Contractor's breakdown of costs is unreasonable in consideration of the Work proposed to be added or deleted, or if Metro determines that the proposed

Work must be commenced promptly to avoid delay to the Project, Metro may issue an order for Force Account Work and Contractor shall promptly perform or delete the Work described in such order. Change, if any, in the Contract Amount due to such Force Account Work shall be the sum total of the following items:

8.4.1.1 Actual labor cost, including premium on worker's compensation insurance and charge for social security taxes, and other taxes pertaining to labor.

8.4.1.2 The proportionate cost of premiums of public liability property damage and other insurance applicable to the extra Work involved and required by these Contract Documents.

8.4.1.3 Actual cost of material, including applicable taxes pertaining to materials.

8.4.1.4 Actual cost of plant and equipment rental, at rates to be agreed upon in writing before the Work is begun or at rates per Section 8.3.4 above. No charge for the cost of repairs to plant or equipment will be allowed. Equipment items having a capital cost of under $250.00 are considered small tools and classified as Overhead.

8.4.1.5 Overhead and Profit as provided and limited in Section 8.3.

8.4.1.6 The proportionate actual costs of premiums for bonds required by these Contract Documents.

8.4.2 Whenever any Force Account Work is in progress, each working day Contractor shall furnish to Metro a detailed written report signed by Contractor and Project Manager of the amount and cost of all of the items listed in (1) through (6) above, and no claim for compensation for such extra Work will be allowed unless such report shall have been made. Metro reserves the right to provide such materials as it may deem expedient, and no compensation, overhead, or profit will be allowed to Contractor for such materials.

8.5 Contractor Proposals for Changes in Work.

8.5.1 Generally. At any time during the performance of the Work, Contractor may propose to Metro changes in Work that Contractor believes will result in higher quality Work, improve safety, shorten the Contract Time, decrease the Contract Amount, or otherwise result in better or more efficient Work.

8.5.2 Purpose. Metro encourages Contractor to submit Value Engineering Change Proposals ("VECPs") in order to avail Metro of potential cost savings that may result. Contractor and Metro will share any savings, computed in accordance with this Section 8.5. Contractor is encouraged to submit VECPs whenever it identifies an area that can be improved, using the format described herein.

8.5.3 Application. This clause applies to a Contractor-developed and documented VECP that: (1) requires a change to this Contract to implement the VECP, and (2) reduces the Contract Price without impairing essential functions or characteristics of the Work, provided it is not based solely on a change in specified quantities.

8.5.4 Documentation. At a minimum, the following information shall be submitted by Contractor with each VECP: (1) description of the existing requirements of the Contract Documents that are involved in the proposed change; (2) description of the proposed change; (3) discussion of differences between existing requirements and the proposed change, together with advantages and disadvantages of each changed item; (4) itemization of the requirements that must be changed if the VECP is accepted (e.g., drawing numbers and Specifications); (5) justification for changes in function or characteristics of each such affected item and effect of the change on the performance of the end item; (6) effect of proposed change on life-cycle costs, including operation and maintenance, replacement costs, and life expectancy; (7) date or time by which a Change Order adopting the VECP must be issued in order to obtain the maximum cost reduction, noting any effect on Contract Time or delivery schedule; and (8) cost estimate for existing Contract requirements correlated to its lump sum breakdown and proposed changed requirements. Costs of development and implementation by Contractor shall be identified. Estimated Metro costs (e.g., cost of testing and redesign) shall also be identified.

8.5.5 Submission. Proposals will be processed expeditiously; however, Metro will not be liable for any delay in acting upon any proposal submitted pursuant to this clause. Contractor shall have the right to withdraw, in whole or in part, any VECP at any time prior to acceptance by Metro.

8.5.6 Acceptance. Metro may accept, in whole or in part, by Change Order, any VECP submitted pursuant to this clause. Until a Change Order is issued, Contractor shall remain obligated to perform in accordance with this Contract. The decision as to acceptance or rejection of any VECP will be at the sole discretion of Metro and will be final and not subject to review by mediation or otherwise.

8.5.7 Sharing. If a VECP submitted by Contractor pursuant to this clause is accepted, Contractor shall proceed with the change and the Contract Price will be adjusted in accordance with the following provisions:

8.5.7.1 Definitions:

8.5.7.1.1 Estimated Gross Savings to Contractor ("GS"): The difference between cost of performing the Work according to the existing requirement and the cost if performed according to the proposed change. In each instance, Contractor's profit shall not be considered part of the cost.

8.5.7.1.2 Contractor Costs ("CC"): Reasonable costs incurred by Contractor in preparing the VECP and making the change such as cancellation or restocking charges where required.

8.5.7.1.3 Estimated Net Savings to Contractor ("NS"): GS less CC.

8.5.7.1.4 Metro's Costs ("OC"): Reasonable costs incurred by Metro for evaluating and implementing the VECP, such as testing and redesign, where required.

8.5.7.2 Calculations:

8.5.7.2.1 The Contract Price shall be reduced by an amount equal to 70 percent of NS plus 50 percent of OC.

8.5.7.2.2 Contractor's profit will not be reduced by application of the VECP.

8.5.8 Subcontracts. Contractor shall include appropriate value engineering incentive provisions in all subcontracts of $25,000 or greater. Contractor may include such provisions in any agreement. Subcontracts shall contain a provision that any benefits accruing to Contractor as a result of an accepted VECP initiated by a Subcontractor shall be shared by Contractor and Subcontractor. To compute any adjustment in the Contract Price under Section 8.5.7.2 above, Contractor's costs of preparation and charge for a VECP shall include any preparation and change costs. Examples are cancellation or restocking charges, when required.

8.6 Impact of Authorized Changes in the Contract. Changes in the Work made pursuant to this Article and extensions of the Contract Time allowed by Metro due to such changes shall not in any way release any warranty or promises given by Contractor pursuant to the provisions of the Contract Documents, nor shall such changes in the Work relieve or release the sureties of bonds executed pursuant to said provisions. The sureties, in executing such bonds, shall be deemed to have expressly agreed to any such change in the Work and to any extension of Contract Time made by reason thereof.

ARTICLE 9
PAYMENTS AND COMPLETION

9.1 Scope of Payment. Payment to Contractor of the Contract Amount for performing all Work required under the Contract, as adjusted for any Change Orders approved as hereinbefore specified, shall be full compensation for furnishing all labor, materials, equipment, and tools necessary to the Work, and for performing and completing, in accordance with these Contract Documents, all Work required under the Contract, and for all expenses incurred by Contractor for any purpose in connection with the performance and completion of said Work. Whenever it is specified in the Contract that Contractor is to do Work or provide materials of any class for which no price is fixed in the Contract, Contractor will do such Work or provide such materials without extra charge or allowance or direct payment of any sort, and that the cost of doing such Work or providing such materials is included in its Bid or Proposal.

9.2 Schedule of Values.

9.2.1 Generally. Within fifteen (15) days after the Notice to Proceed, Contractor shall submit a detailed breakdown costs itemized per Construction Specification Institute division format. The format and detail of the breakdown shall be as directed by Metro. This breakdown shall be referred to as the Schedule of Values.

9.2.2 Review of Schedule of Values. Metro will review the Schedule of Values to ascertain that the dollar amounts of the Schedule of Values are in fact fair cost allocations for the Work item listed. Upon concurrence by Metro, a formal approval of this Schedule of Values will be issued. Metro shall be the sole judge of fair cost allocations. Contractor's monthly progress payment requests shall reflect the cost figures included in the approved Schedule of Values and shall be based on completed Work items or percentages of Work items completed prior to the end of the payment period as more fully described below.

9.3 Progress Payment Procedure.

9.3.1 Generally. Subject to the approval of Metro, disbursements shall be made by Metro of progress payments upon written request of Contractor and pursuant to the Contract Documents as specified in Section 9.3.2.

9.3.2 Before the end of each calendar month, Contractor shall file with the Project Manager in duplicate on a form approved by Metro, a proposed payment estimate for the period commencing on the 26th day of the previous month through midnight on the 25th day of the calendar month in question. Metro and the Architect or

Engineer shall review Contractor's estimate and shall determine the value of Contractor's Work based on the Schedule of Values and incorporated labor and materials for the payment period. Contractor shall not be paid for any Work that is, in Metro's opinion, defective or improper, or for Work needed to correct Contractor's defective or improper Work. Contractor shall be paid 95 percent (95%) of the determined value of Work accomplished, less any offset or withholding of sums by Metro allowed under the Contract Documents, within thirty (30) days after receipt by Metro of Contractor's payment estimate. Metro will routinely withhold five percent (5%) as Retainage. No inaccuracy or error in any monthly progress payment estimates shall operate to release Contractor or its surety from damages arising from such Work or from the enforcement of each and every provision of the Contract Documents, and Metro shall have the right subsequently to correct any error made in any estimate for progress payments.

9.3.3 Retainage.

9.3.3.1 Metro will withhold Retainage from each payment at a rate of five percent (5%) in accordance with ORS 279C.570.

9.3.3.2 All funds retained by Metro under this Section shall be retained in a fund by Metro and paid in accordance with ORS 279C.550 to 279C.580.

9.3.3.3 Contractor may elect to deposit bonds or securities of the type described below with Metro or in any bank or trust company to be held in lieu of the cash Retainage described above and for the benefit of Metro. In such event, Metro shall reduce the Retainage in an amount equal to the value of the bonds and securities and shall pay the amount of the reduction to Contractor in accordance with ORS.279C.570. Interest on such bonds or securities shall accrue to Contractor. Bonds and securities deposited or acquired as described above shall be of a character approved by the Metro Director of Finance & Regulatory Services including but not limited to:

9.3.3.3.1 Bills, certificates, notes, or bonds of the United States.

9.3.3.3.2 Other obligations of the United States or its agencies.

9.3.3.3.3 Obligations of any corporation wholly owned by the federal government.

9.3.3.3.4 Indebtedness of the Federal National Mortgage Association.

9.3.3.4 Contractor may elect to require Metro to deposit the accumulated Retainage in an interest bearing account in a bank, savings bank, trust company, or savings association for the benefit of Metro. Interest on such an account shall accrue to Contractor.

9.3.3.5 If Metro incurs additional costs as a result of Contractor's exercise of any of the above-described options, Metro may recover such costs from Contractor by reduction of the Final Payment. Metro shall inform Contractor of all such accrued costs.

9.3.4 Payment for Material Stored Off Site. Payment for material stored off of the Site will not be allowed unless the payment for such material benefits Metro in terms of lead time, scarcity, schedule, etc. Metro has sole discretion as to what materials will be paid for in advance of delivery to or installation on Site. Proof of off-site material purchases (invoice or checks and photo documentation) and appropriate insurance coverage will be required for payment. Title to all equipment and materials shall pass to Metro upon payment therefore or incorporation into the Work, whichever shall first occur, and Contractor shall prepare and execute all documents necessary to effect and perfect such transfer of title. Contractor must provide to Metro written consent from Contractor's surety approving the advanced payment for materials stored off-site. The maximum prepayment allowed by Metro shall be 75 percent of the actual fair market value of the item being considered. Metro shall be the sole judge of fair market value. Contractor shall protect stored materials from damage, and damaged or otherwise unacceptable materials, even though paid for, shall not be incorporated into the Work.

9.3.5 Other Conditions Precedent to Payment.

9.3.5.1 It is a condition precedent to Contractor's rights to any payments under the Contract that all bills for labor and materials, including labor and materials supplied by or to Contractor, shall have been paid in full and, if requested by Metro, Contractor shall submit receipted invoices and/or lien waivers, as evidence of payment in full of all such accounts. As a further condition precedent to Contractor's right to any payments under this Contract, Contractor shall submit a claims release before any payment in the form set forth in Exhibit 3 to these General Conditions, and a final claims release stating Contractor has been paid in full prior to the Final Payment in the form set forth in Exhibit 4 to these General Conditions.

9.3.5.2 Payments to Contractor shall be conditioned upon Contractor complying with all provisions of this Contract regarding scheduling and progress reports submissions and upon Contractor furnishing all other information and data necessary to ascertain actual progress. Metro's determination that Contractor has failed or refused to furnish the required information, data, schedules, or other reports shall constitute a basis for withholding all

payments until the required information, data, revised schedules, and diagrams, if necessary, and other reports are furnished.

9.3.6 Payment Does Not Imply Acceptance of Work. The granting of any progress payment, or the receipt thereof by Contractor, shall not constitute acceptance of the Work or any portion thereof, and shall in no way lessen the liability of Contractor to replace unsatisfactory Work or material, though the unsatisfactory character of such Work or material may or may not have been apparent or detected at the time such payment was made.

9.3.7 Offset of Sums Due Metro from Contractor. In addition to any retention rights allowed Metro under this Contract, it is mutually understood and agreed that Metro may, upon prior written notice to Contractor, offset from any payment otherwise due Contractor as much as may be necessary to protect and compensate Metro from any costs or expenses it may incur due to any breach of the Contract by Contractor, including applicable liquidated damages. Any sums so offset shall become the property of Metro.

9.4 Substantial Completion.

9.4.1 Metro is also entitled to occupy or use all or a portion of the Work on Substantial Completion. Occupancy or use on Substantial Completion does not constitute Metro's acceptance of the Work not complying with the requirements of the Contract Documents, nor does it waive rights Metro has to completion of the Contract in accordance with the requirements of the Contract Documents.

9.4.1.1 When Contractor considers the Work to be substantially complete, Contractor shall submit to Metro a written notice that the Work is substantially complete

9.4.2 Within a reasonable time after receipt of such notice, Metro and Architect or Engineer will review the Work, including a physical inspection, to determine the status of completion. Should the Architect or Engineer and Metro determine that the Work is not substantially complete:

9.4.2.1 The Project Manager will promptly notify Contractor in writing, giving the reasons therefore.

9.4.2.2 The Contractor shall remedy the deficiencies in the Work, and thereafter send a second written notice of Substantial Completion to Metro.

9.4.3 The above-described procedure shall be followed until the Work is, in the opinion of Metro and Architect or Engineer, substantially complete. At that point:

9.4.3.1 Metro or the Architect will prepare a Certificate of Substantial Completion on AIA Document G704, accompanied by the approved Punch List of items to be completed or corrected as verified and amended by the Architect or Engineer.

9.4.3.2 Metro shall submit the Certificate of Substantial Completion to Contractor for signature.

9.4.4 Punch List. When the Work is substantially complete, the Contractor shall prepare a Punch List of items to be completed or corrected for review and approval by Metro and the Architect or Engineer. Metro or the Architect shall be responsible for preparing the final Punch List. The Contractor remains responsible to complete the Work in accordance with the Contract Documents regardless of whether an item is omitted from the Punch List.

9.4.4.1 The Contractor is required to proceed promptly to complete the items on the Punch List and any other items that may be discovered to be incomplete or incorrect regardless of whether they are on the Punch List or not. If the Contractor fails to complete the Punch List within 30 days or such other time as Project Manager may allow, Metro may terminate any further services of the Contractor under the Contract and complete the Punch List items remaining to be completed or corrected with Metro's own forces or by hiring another Contractor to perform the Punch List Work. Costs of performing the Punch List Work by Metro will be deducted from any payments otherwise due the Contractor.

9.4.4.2 The Contractor will notify Metro when the Punch List Work is complete, and Final Payment will then be made in accordance with. After receipt of that Notice, Metro will inspect the Work to determine whether the Punch List is complete as provided in Section 9.5 of these General Conditions.

9.4.4.3 If the Work is not complete despite the Contractor's notice that the Punch List items are complete, and Metro has hired an Architect or Engineer to assist it on the Project, the Contractor will pay costs for the Architect's or Engineer's services if more than two inspections of the Work are required because the Punch List remains incomplete.

9.4.4.4 On Substantial Completion, Metro will be responsible for utilities, insurance, security, maintenance, and damage to Work caused by Metro's agents and employees unless otherwise provided in the Certificate of Substantial Completion. The Contractor remains responsible for damage to Work caused by its Subcontractors, agents, and employees during the performance of Punch List Work.

9.5 Final Completion and Acceptance.

9.5.1 When Contractor considers the Work to be finally complete, Contractor shall submit written certification to Metro that:

9.5.1.1 Contract Documents have been reviewed.

9.5.1.2 Work has been inspected for compliance with Contract Documents.

9.5.1.3 Work has been completed in accordance with Contract Documents to include submission of record documents.

9.5.1.4 Equipment systems have been tested in the presence of Metro and are operational.

9.5.1.5 Work is ready for final inspection.

9.5.2 Architect or Engineer and Metro will promptly review the Work and include a physical inspection to verify the status of completion and shall inform Metro of the conclusions. Metro shall, within fifteen (15) days after receipt of Contractor's certification, either accept the Work or notify Contractor of the Work yet to be performed on the Contract as outlined below.

9.5.3 Should the Architect or Engineer and Metro consider that the Work is incomplete or defective:

9.5.3.1 Project Manager or the Architect or Engineer will promptly notify Contractor in writing, listing the incomplete or defective Work.

9.5.3.2 Contractor shall take immediate steps to remedy the stated deficiencies, and send a second written certification to Metro that the Work is complete. Metro will then advise the Architect or Engineer.

9.5.3.3 Architect or Engineer and Metro will review and re-inspect the Work.

9.5.4 The procedure set forth in Section 9.5.3 shall be followed until the Work is, in the opinion of Metro and Architect or Engineer, finally complete. Contractor shall immediately thereafter prepare and submit Closeout Submittals as described below.

9.6 Closeout Submittals. Contractor shall submit the following items, as applicable, with its request for Final Payment:

9.6.1 Evidence of Compliance with Requirements of Governing Authorities.

9.6.2 Project record documents in accordance with the Specifications.

9.6.3 Operation and maintenance data in accordance with the Specifications.

9.6.4 Warranties in accordance with requirements of various Specification sections and these General Conditions.

9.6.5 Extra stock and maintenance materials. Contractor shall submit receipts, signed by Metro, for the various specific items.

9.6.6 Evidence of payment and release of claims in accordance with the following section.

9.6.7 Consent of surety to Final Payment.

9.6.8 Certificates of insurance for products and completed operations in accordance with Article 12 of these General Conditions.

9.6.9 If Contractor is a non-resident bidder or proposer, complete documentation of Contractor's compliance with ORS 279A.120.

9.7 Releases. Contractor and each assignee under any assignment in effect at the time of Final Payment shall execute and deliver, at the time of application for Final Payment, as a condition precedent to Final Payment, discharging and releasing Metro and the Architect or Engineer of and from all liabilities, obligations, and claims arising under this Contract. The Final Release shall be in the form attached as Exhibit 4 to these General Conditions. In addition to the above-described release, Contractor shall:

9.7.1 Submit to Metro an affidavit certifying that Contractor has paid all federal, state and local taxes including excise, use, sales, and employee withholding taxes.

9.7.2 Deliver to Metro written releases of all rights to file claims against Metro or to file claims on any bonds in connection with the Contract, signed by each Subcontractor and Supplier who performed labor or furnished materials in connection with the Work. The release shall be in the form attached as Exhibit 5 to these General Conditions.

9.7.3 Deliver to Metro Contractor's written undertaking, with sureties acceptable to Metro:

9.7.3.1 To promptly pay and obtain a release of claims on any bonds that may in the future affect the premises; and

9.7.3.2 To defend, indemnify, and save Metro harmless from any liability or expense because of any claim on any bond or any other claim related to the Contract or the Work.

9.8 Final Payment. Upon application of Contractor and Contractor's completion of and compliance with all of the provisions of the above Sections and settlement of all claims arising from the Contract, including claims that

Metro may have against Contractor, Metro shall pay Contractor the balance of the Contract Amount subject to the availability of monies and less any previous payments, offsets, and withholdings allowed Metro under this Contract, and Retainage that has been returned to Contractor. Acceptance of Final Payment by Contractor shall constitute a waiver of all claims of whatever nature that Contractor may have or allege to have against Metro arising out of or related to Work described in the Contract Documents.

9.9 No Waiver of Rights. Neither the final review by Metro, nor any order or certificate for the payment of money, nor any payment for, nor acceptance of the whole or any part of the Work by Metro, nor any extension of time, nor any position taken by Metro shall operate as a waiver of any provision of this Contract or of any power herein reserved by Metro or any right to damage herein provided, nor shall any waiver of any breach of this Contract be held to be a waiver of any other or subsequent breach. All of Metro's remedies provided in this Contract shall be taken and construed as cumulative; that is, in addition to each and every other remedy herein provided; and Metro shall have any and all equitable and legal remedies that it would in any case have.

ARTICLE 10
SAFETY, USE OF SITE, AND PROTECTION OF THE WORK

10.1 Laws and Regulations.

10.1.1 The Contractor must comply with all federal, state, and municipal laws in regard to all matters concerning this Contract. This includes but is not limited to compliance with the ADA. The Contractor must also comply with the orders, rulings, decrees, and decisions of any administrative or judicial officials that in any manner whatsoever affect the Project, the Work, the safety of persons around the Work Site, or the manner in which the Work is performed.

10.1.2 If the Contractor observes that any portion of the Work is to be performed in a way that violates any law, code, or regulation, it must immediately notify Metro in writing.

10.1.3 Contractor will divert a minimum of 85% of all construction and demolition waste to recycling and reuse markets, and, if the Work is performed in the City of Portland, comply with City of Portland Code 17.102.270 and related administrative rules.

10.2 Safety Requirements.

10.2.1 Safety Generally.

10.2.1.1 Contractor shall be solely and completely responsible for the safety of the Work and the Site, including but not limited to the safety of all persons and property involved in the Work at the Site at any time until Final Completion and Acceptance of the Work.

10.2.1.2 All Work shall be performed in full accordance with all applicable safety codes, laws, ordinances, and requirements including but not limited to the Safety and Health Regulations for Construction promulgated by the Secretary of Labor under Section 107 of the Contract Work Hours and Safety Standards Act as set forth in Title 29 of the Code of Federal Regulations, federal and state OSHA, Metro's insurance standards, and all other applicable safety codes. Where any of these are in conflict, the more stringent requirement shall be followed. Contractor's failure to thoroughly familiarize itself with the aforementioned safety provisions shall not relieve it from any requirements in the Contract Documents to comply with such safety provisions or from any penalties for failure to so comply.

10.2.1.3 Contractor shall inspect the Work and the Site daily and immediately correct any unsafe conditions. All job personnel shall be knowledgeable of and comply with the above safety requirements.

10.2.1.4 Contractor shall take all precautions to prevent the possibility of fire resulting from Contract operations. Contractor shall provide properly maintained emergency fire extinguishing equipment of a readily available type and quantity as necessary to meet potential fire hazards.

10.2.1.5 In an emergency affecting safety of persons or property, the Contractor shall act to prevent the threatened damage, injury, or loss and immediately notify Metro.

10.2.2 Health and Safety Program. Contractor shall develop, publish, and implement the overall Health and Safety Program for the Project. This Program shall conform to all applicable codes. Contractor shall submit the written Health and Safety Program to Metro for review and comment within fourteen (14) days after the receipt of the written Notice To Proceed. The Program, as approved by Metro, shall subsequently be distributed to and implemented by Contractor's personnel, as well as its Subcontractors and Suppliers. Contractor shall fully implement and comply with the approved Safety Program.

10.2.3 Health and Safety Officer. Prior to initiation of construction, Contractor shall designate in writing a Site Health and Safety Officer who shall be responsible for coordinating Contractor's Health and Safety Program. The individual so designated shall be the interface with the Project Manager on matters relating to safety

and Contractor's compliance with the approved Safety Program. Metro reserves the right to accept or reject the Health and Safety Officer designated by Contractor.

10.3 First Aid.

10.3.1 Contractor shall maintain on the Site during Work operations, a member of its work force who is qualified in administering first aid to its personnel and shall have available in its job office the first aid equipment as required to meet all applicable safety codes. The names and credentials of qualified personnel will be submitted to the Project Manager.

10.3.2 Contractor shall require or provide adequate clothing and protective gear for all personnel working on the job Site. This includes but is not limited to hard hats, substantial boots or shoes, shirts with sleeves at all times, eye and ear protection, gloves, face masks, welding hoods, and safety belts as required for the type of Work being done.

10.4 Use of Site.

10.4.1 The Contractor shall confine operations at the Site to areas permitted by applicable laws, statutes, ordinances, codes, rules and regulations, and lawful orders of public authorities and the Contract Documents, and shall not unreasonably encumber the Site with materials or equipment.

10.4.2 Prior to commencement of the Work, the Contractor shall review the Project Site with Metro in detail and identify the area of the Work, staging areas, connections or interfaces with existing structures and operations, and restrictions on the Project Site area. The Contractor will ensure that all forces on the Project Site are instructed about the acceptable working and staging areas and restrictions on use of the Site. The Contractor, with advance consent of Metro, will erect such barriers, signage, and devices as are necessary to restrict access to the Project Site to approved personnel and to prevent unauthorized access by construction personnel to non-Work areas.

10.4.3 The Contractor and its Subcontractors shall receive prior approval from Metro before delivering or storing any materials or tools on Metro's premises. Upon approval, materials and tools will be stored so that they do not hamper the operation of equipment or persons and do not present a fire or safety hazard.

10.4.4 Contractor and its Subcontractors shall not erect on the Project Site any signage intended to advertise or promote their business without the prior written consent of Metro.

10.4.5 If the Contractor removes Metro's property, fixtures, materials, or other equipment to perform the Work, the Contractor shall be responsible for the safekeeping of all such property, fixtures, materials, or other equipment including without limitation assuring that such items are not lost, damaged, or destroyed, and are upon Metro's directive are either returned to their original location, reinstalled, replaced, or repaired as necessary.

10.4.6 When all or a portion of the Work is suspended for any reason, the Contractor shall securely fasten down all coverings and protect the Work, as necessary, from damage by any cause

10.4.7 At completion of the Work, the Contractor shall remove waste materials, rubbish, the Contractor's tools, construction equipment, machinery, and surplus material from and about the Project, and shall return any damage or altered portion of Metro's property to at least its pre-construction condition.

10.5 Protection of Work, Persons, and Property Against Damage.

10.5.1 Contractor shall protect the Work from damage due to construction operations; the action of the elements, including erosion due to normal and extraordinary weather conditions; the carelessness of other contractors; vandalism; or any other cause whatever until Final Completion and acceptance of the Work.

10.5.2 The Contractor will keep the Project Site safe in compliance with applicable law. Safety includes but is not limited to: (1) providing approved types of secured and adequate barricades or fences that are easily visible from a reasonable distance around open excavations; (2) closing up or covering with steel plates all open excavations at the end of each Working Day in all street areas and in all other areas when it is reasonably required for public safety; (3) marking all open Work and obstructions by lights at night; (4) installing and maintaining all necessary signs, lights, flares, barricades, railings, runways, stairs, bridges, and facilities; (5) observing any and all safety instructions received from Project Manager; and (6) following all laws and regulations concerning worker and public safety. If the law requires greater safety obligations than those imposed by Metro, the Contractor must comply with the law.

10.5.3 The Contractor will protect, and take every reasonable precaution to avoid damage to, all public and private property that might be damaged by its operations.

10.5.4 If public or private property, or both, is damaged by the Contractor's operations, the Contractor must either repair the damage or have the damage repaired by others at its own expense, without additional

compensation from Metro. The repair must bring the damaged property back to the same condition it was in before the damage occurred. If repair and restoration is not feasible, the Contractor will pay Metro for the full cost of the damage. If the damage has been caused to property of Metro, Metro has the right to determine whether or not the property will be repaired and restored by the Contractor. If Metro elects to have the property repaired with its own forces or by another entity, the Contractor will pay Metro all costs associated with that repair and restoration.

10.5.5 The Contractor must give reasonable Notice to Metro and occupants of property adjacent to the Work to permit them to remove vehicles, trailers, and other possessions, as well as salvage or relocate plants, trees, fences, sprinkler systems, or other improvements in the Easement or Right-of-Way that are designated for removal or that might be destroyed or damaged by the Contractor's operations.

10.5.6 All federal, state, and local safety and environmental protection laws, rules, and orders, including fire codes, applicable to the Work to be done under the Contract, shall be obeyed, complied with, and enforced by Contractor.

10.5.7 Contractor shall provide and maintain such guards, fences, barriers, signs, regulatory and warning lights, and other traffic control and safety devices adjacent to and on the Site as may be necessary to prevent accidents to the public and damage to property. Contractor shall also provide, place, and maintain such lights as may be necessary for illuminating the said signs, guards, fences, barriers, and other traffic and safety control devices.

10.5.8 Upon Final Completion and Acceptance of the Work, Contractor shall remove all temporary signs, lights, barriers, etc., from the Site.

10.5.9 The Contractor must protect worksites and storage and disposal areas from washouts and erosion, and take all necessary precaution to control or abate dust, nuisances, and air pollution arising from the performance of Work by taking necessary actions to prevent this. Such actions include but are not limited to cleaning up, sweeping, sprinkling, covering, enclosing, or sheltering Work areas and stockpiled materials, and removing promptly from paved areas earth or other materials that may become airborne or that may be washed into waterways or drainage systems.

10.6 Utilities.

10.6.1 The Contractor is responsible for locating light and power poles, underground electrical, underground communication, sewer, gas, and water piping, gas/water "shut off" boxes and covers, and all other utility lines. The Contractor will follow rules adopted by the Oregon Utility Notification Center. Those rules are set forth in the Oregon Administrative Rules. Copies of these rules may be obtained by contacting the Center. If the Contractor has questions about the rules, it is to contact the Center. The Parties agree that any Project plans or permits issued by Metro are deemed to have this language incorporated by reference.

10.6.2 The Contractor will give Notice to Metro of any intended excavation it may have at least 48 hours in advance of the proposed excavation. If the intended excavation or other work would cause any interruption in utility service, the Contractor will give notice to Metro at least five (5) days in advance. The specific schedule for all interruptions in utility services must be coordinated with the Project Manager.

10.6.3 The Contractor will maintain any markings showing the presence of underground facilities. If the Contractor does not maintain such markings, and Metro is required to reestablish them, the Contractor will pay Metro any and all costs associated with that activity.

10.6.4 The Contractor will exercise special care in executing subsurface work in proximity of known subsurface utilities, improvements, and easements. The Contractor will arrange for and pay the cost of disconnecting, removing, relocating, capping, replacing, or abandoning all public and private utilities impeding construction operations, all in accordance with servicing utilities' regulations and governing codes. The Contractor will cap abandoned utilities. The Contractor will provide maintenance of all on-site active above-grade and below-grade services. Any utilities damaged by Contractor shall be repaired immediately to Owner's satisfaction.

10.7 Hazardous Substances Encountered During Construction and Other Environmental Laws.

10.7.1 With respect to Hazardous Materials to be used during the course of the Work, the Contractor will implement and enforce a program to inventory and properly store and secure all Hazardous Materials that may be used or may be present on the Project Site, maintain available for inspection at the Project Site all material safety data sheets, and comply with all regulations required by law for the storage, use, and disposal of Hazardous Materials. The program must provide for notification of all personnel of potential chemical hazards. Review of these hazards must be included in the Contractor's safety training program. The Contractor will submit to Metro a list of all Hazardous Materials to be brought by the Contractor or its Subcontractors onto Metro's property, including the purpose for their use on the Project.

10.7.2 In the event of a release or discovery of a preexisting release of Hazardous Materials, or if it is foreseeable that injury or death to persons may occur because of any material or substance (including without

limitation Hazardous Materials) encountered on the Project Site, the Contractor must **immediately** (1) stop the Work or the portion of the Work affected, (2) notify Metro and the Architect or Engineer orally and in writing, and (3) protect against exposure of persons to the Hazardous Materials. The Contractor is to provide all written warnings, notices, reports, or postings required at law or by contract for the existence, use, release, or discovery of Hazardous Materials.

10.7.3 With respect to any Hazardous Materials or other material or substance reported to Metro under Section 10.7.2 above that were not introduced to the Project Site by the Contractor or its Subcontractors of any tier, Metro will obtain the services of a qualified environmental consultant to verify the presence or absence of the material or substance reported by the Contractor and, if the material or substance is found to be present, to verify that it is rendered harmless. Unless otherwise required by the Contract Documents, Metro will furnish in writing to the Contractor the names and qualifications of persons or entities that are to perform tests verifying the presence or absence of such material or substance, or that are to perform the task of removal or safe containment of such material or substance. The Contractor will promptly reply to Metro in writing, stating whether or not either has reasonable objection to the persons or entities proposed by Metro. If the Contractor has an objection to a person or entity proposed by Metro, Metro will propose another to which the Contractor has no reasonable objection. When the material or substance has been rendered harmless, Work in the affected area is to resume upon written agreement of Metro and the Contractor. By Change Order, the Contract Time may, subject to agreement by Metro and the Contractor, be extended appropriately and the Contract Amount will be increased in the amount of the Contractor's reasonable additional costs of shutdown, delay, and start-up, which adjustments are to be accomplished as provided in Article 8.

10.7.4 With respect to any Hazardous Materials or other material or substance reported to Metro under section 10.7.2 above that was introduced to the Project Site by the Contractor or its Subcontractors of any tier, the Contractor will be responsible to carry out the duties of (1) proposing to Metro and the Architect or Engineer a qualified environmental consultant, (2) obtaining and paying for the services of the environmental consultant, and (3) verifying that the material is rendered harmless, as otherwise set forth in Section 10.7.3 above. The Contractor will not be entitled to an increase in the Contract Amount as stated in the last sentence of Section 10.7.3 if the Contractor or its Subcontractors of any tier are responsible for the condition requiring the testing of the material and the stoppage of the Work. Remediation Work must be conducted by properly qualified contractors approved in advance by Metro. Generally, Metro may at its option contract directly with environmental consultants and remediation contractors, regardless of whether the Work will be performed at the Contractor's expense.

10.7.5 To the fullest extent permitted by law, Metro will indemnify the Contractor, Subcontractors, Architect or Engineer, and their consultants and agents, and employees of any of them and hold them harmless from and against claims, damages, losses, and expenses, including without limitation attorney fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance was not introduced to the Project Site by the Contractor or its Subcontractors of any tier, presents the risk of bodily injury or death, and has not been rendered harmless. No indemnification provided by Metro under this Section will be required to indemnify the Contractor, Subcontractors, or their employees or agents to the extent of liability for death or bodily injury to persons or damage to property caused in whole or in part by the Contractor's own negligence, but will require indemnity to the extent of the fault of Metro or its agents or representatives.

10.7.6 To the fullest extent permitted by law, the Contractor will indemnify Metro, the Project Manager, and employees of any of them and hold them harmless from and against claims, damages, losses, and expenses, including without limitation attorney fees, arising out of or resulting from performance of the Work in the affected area if in fact the material or substance was introduced to the Project Site by the Contractor or its Subcontractors of any tier, presents the risk of bodily injury or death, and has not been rendered harmless. No indemnification provided by the Contractor under this Section will be required to indemnify Metro or its agents or representatives to the extent of liability for death or bodily injury to persons or damage to property caused in whole or in part by Metro's own negligence, but will require indemnity to the extent of the fault of the Contractor or its agents or representatives.

10.8 Additional Requirements for Work at Metro Project Sites. The Contractor will comply with the following requirements in addition to the requirements set forth in this Article 10.

10.8.1 Safety and Health Precautions.

10.8.1.1 Contractor shall take all precautions to prevent the possibility of fire resulting from construction operations. Contractor will provide emergency fire extinguishing equipment of adequate type and quantity, readily available, and properly maintained. Contractor shall provide a fire watch and screening whenever welding is in progress in areas accessible or visible to Metro staff or the general public.

10.8.1.2 All contracted employees are expected to follow established safety procedures in the General Contractor's Safety Plan and report any safety violation or unsafe work practice to a lead worker or project manager. Violation of any safety procedure is a serious offense due to the severe consequences that may result and must be reported immediately. It is most important to report safety violations and unsafe work practices to individuals who can take immediate action to resolve the problem.

10.8.1.3 Vests and hardhats (as well as other personal protection attire as required by the General Contractor) are required to be worn at construction worksites. Contractors shall wear such vests at all times on the Project Site.

10.8.1.4 Any physical, mental, or emotional condition that may affect a Contractor or Subcontractor employee's ability to work safely, make sound judgments, or compromise their ability to react quickly in the event of an emergency, must be reported to their lead or project manager prior to the start of their shift.

10.8.1.5 For safety reasons, IPods, MP3 players, and other sound devices requiring earphones are prohibited during working hours.

10.8.1.6 The Contractor will provide warning signs, flagger(s), and other safety and health precautions that may become necessary or required for protection of Work or for protection of the public, Owner's personnel, and construction personnel, including Owner's and Architect's or Engineer's Representatives engaged on the Project. State of Oregon Workmen's Compensation Board Safety Codes for Construction Work and Federal Safety Codes, form a part of these Specifications.

10.8.2 Access to Metro Project Site. Contractor and Subcontractors will comply with the following requirements:

10.8.2.1 Locations for access to the Project Site by Contractor and Subcontractors shall be approved by the Project Manager.

10.8.2.2 The Contractor's representatives must always be on the premises when Subcontractors are working. Identification will be issued and worn for General Contractor's representatives.

10.8.2.3 The Contractor will keep a log of all Subcontractors that are working on-site each day. Subcontractors must always sign in with the Contractor and wear identification issued by the Contractor.

10.8.2.4 Construction on the Project Site is limited to 7 am to 5 pm, Monday through Friday, unless Work at other times is approved in advance by the Project Manager.

10.8.2.5 When Contractor needs access throughout the day to an area that is normally secured and inaccessible to visitors, the Project Manager will provide "contractor locks" and keys, and Contractor must keep said areas secure.

10.8.2.6 Contractor will ensure that all of its and Subcontractors' officers, employees, and agents are aware of and comply with the access requirements in this Section 10.8.2.

10.8.3 Site Protection/Safety.

10.8.3.1 The Project Site may be in operation and open to the public during construction of the Work. Construction Work in and around Owner's buildings occupied by Metro personnel or frequented by the public shall be conducted in such a manner as to permit such operation without jeopardy and with the absolute minimum of inconvenience to occupants and the public.

10.8.3.2 Metro may restrict hours of work to accommodate Metro activities or special events.

10.8.3.3 Construction Work that requires coordination with Metro staff activities will be planned in advance with the Project Manager. A meeting will be held with Metro staff to identify a plan for the activity.

10.8.3.4 The Contractor will take every precaution to minimize noise, spreading of dust and debris, causing undue vibrations or impacts, and other nuisances. The Contractor shall do no structural or other damage to any in-place improvements.

10.8.3.5 Metro-owned tools, vehicles, and other equipment may not be used at any time.

10.8.3.5.1 Tree/Vegetation Protection. The Contractor shall comply with the local government regulations applicable to the Project, and shall consult with the Project Manager prior to doing work that could impact the health of a tree or vegetation not scheduled for removal by contract documents.

10.8.4 Personnel and Subcontractors.

10.8.4.1 Smoking is prohibited in all areas of the Project Site except in designated smoking areas. Contractor and Project Manager to determine a designated smoking area.

10.8.5 Prejudicial remarks, actions, slurs, and jokes in the workplace that are offensive to people relative to their race, color, religion, national origin, sex, age, marital status, veteran status, disability, or sexual orientation are strictly prohibited. Sexual harassment is strictly prohibited. Contractors are expected to use a

reasonable person's standard of good judgment in their working relationships. No person shall be subjected to deliberate or repeated unsolicited verbal comments, gestures, or physical contact of a sexual nature, or that which is offensive, hostile, or intimidating.

10.8.6 Restrictions:

10.8.6.1 Contractors are not allowed to bring the following items onto the Project Site:

10.8.6.1.1 Weapons

10.8.6.1.2 Alcohol, narcotics

10.8.6.1.3 Skates/Skateboards/Rollerblades/Wheelies

10.8.6.1.4 Bicycles (if a Contractor employee is commuting to the Project Site via bicycle, arrangements can be made for appropriate parking and use).

10.8.6.1.5 Pets

10.8.7 Prohibited Conduct:

10.8.7.1 The following conduct is strictly prohibited and will result in the immediate ejection of the offending Contractor employee or Subcontractor from Project Site premises:

10.8.7.1.1 Possessing, using, transferring, offering, or being under the influence of any intoxicants or narcotics during working hours.

10.8.7.1.2 Willful deceit, gross negligence, or theft, including of personal or public property.

10.8.7.1.3 Neglect of duty, violation of Metro ordinances, regulations, and directives.

10.8.7.1.4 Willful or repeated negligent violation of established safety policies and procedures.

10.8.7.1.5 Possessing a firearm, illegal weapons, fireworks, or explosive device on Metro property

10.8.7.1.6 Harassment, discourteous treatment of any kind, or discrimination to staff, volunteers, or members of the public. Obscenities, profanity, yelling, shouting, abusive, or maligning tone of voice and/or language is considered discourteous and is prohibited.

10.8.7.1.7 Misuse of Metro property.

ARTICLE 11
INDEMNIFICATION

11.1 Indemnification.

11.1.1 Contractor shall assume all responsibility for the Work and shall bear all losses and damages directly or indirectly resulting to Contractor, Metro, Architect, Engineer, their officers, agents, and employees, or to others on account of the character or performance of the Work or accidents.

11.1.2 Contractor shall defend, indemnify, and hold harmless Metro, its officers, agents, and employees from all claims, liability, loss, damage, consequential or otherwise, and injury of every kind, nature, and description, directly or indirectly resulting from activities in the performance of the Contract, the ownership, maintenance, or use of motor vehicles in connection therewith, or the acts, omissions, operations, or conduct of Contractor or any Subcontractor or Supplier under the Contract in any way arising out of the Contract, irrespective of whether fault is the basis of the liability or claim.

11.1.3 Any specific duty or liability imposed or assumed by Contractor, as may be otherwise set forth in the Contract Documents, shall not be construed as a limitation or restriction of the general liability or duty imposed upon Contractor by this Section.

11.1.4 Such liabilities and losses from which Contractor shall indemnify and hold harmless the above-described indemnities shall include but not be limited to:

11.1.4.1 Special activities by Metro to verify and/or expedite delivery of materials and those losses incurred by Metro as a result of any delays to Other Metro Contractors resulting from acts of Contractor or its failure to act.

11.1.4.2 Acceleration payments to Other Metro Contractors on the Project or related projects resulting from Contractor falling behind the Construction Schedule for causes not entitling it to an extension of Contract Time under any provisions of the Contract Documents that cause other Metro Contractors to fall behind the Construction Schedule so that they must then accelerate the performance of the Work, as directed by Metro, in order to maintain progress.

11.1.4.3 Violations of the ordinances or regulations of Metro, any federal, state, county, or city laws or order of any properly constituted authority in any manner affecting this Contract, in addition to any laws or regulations that might affect this Contract.

11.1.5 Any and all suits, actions, damages, or claims of every name and description to which the above-indemnified may be subjected or put by reason of injury to persons or property arising out of, in connection with, or incident to the execution of the Work, or resulting from acts or omissions on the part of Contractor, its Subcontractors, officers, employees, or agents, and all attorney fees and court costs incident thereto.

11.1.6 No indemnification provided by the Contractor under this Article 11 or insurance provided under Article 12 will be required to indemnify Metro or its employees or agents to the extent of liability for death or bodily injury to persons or damage to property caused in whole or in part by their own negligence, but will require indemnity to the extent of the fault of the Contractor or those entities or persons for whom the Contractor is responsible.

ARTICLE 12
INSURANCE

12.1 General Insurance Requirement. The Contractor will purchase from and maintain in a company or companies lawfully authorized to do business in the State of Oregon such insurance as will protect the Contractor from claims set forth below that may arise out of or result from the Contractor's operations and completed operations under the Contract and for which the Contractor may be legally liable, whether such operations be by the Contractor or by a Subcontractor, or by anyone directly or indirectly employed by any of them, or by anyone for whose acts any of them may be liable:

12.1.1 Claims under workers' compensation, disability benefit, and other similar employee benefit acts that are applicable to the Work to be performed;

12.1.2 Claims for damages because of bodily injury, occupational sickness or disease, or death of the Contractor's employees;

12.1.3 Claims for damages because of bodily injury, sickness or disease, or death of any person other than the Contractor's employees;

12.1.4 Claims for damages insured by usual personal injury liability coverage and commercial general liability coverage (or its equivalent as approved in advance by the Owner);

12.1.5 Claims for damages, other than to the Work itself, because of injury to or destruction of tangible property, including loss of use resulting therefrom;

12.1.6 Claims for damages because of bodily injury, death of a person, or property damage arising out of ownership, maintenance, or use of a motor vehicle;

12.1.7 Claims for bodily injury or property damage arising out of completed operations;

12.1.8 Claims involving contractual liability insurance applicable to the Contractor's obligations under Article 12 of the General Conditions;

12.1.9 Claims for third-party injury and property damage (including without limitation clean-up costs) as a result of pollution conditions arising from the Contractor's operations or completed operations; and

12.1.10 Claims involving the Contractor's professional liability, solely to the extent that the Contractor accepts design or design/build responsibilities under the Contract.

12.2 Required Coverage. Without waiver of any other requirement of the Contract Documents, the Contractor will provide, pay for, and maintain in full force and effect at all times during the performance of the Work until final acceptance of the Work or for such further duration as required, the following policies of insurance issued by a responsible carrier. All of the Contractor's insurance carriers will be rated A VII or better by A.M. Best's rating service, unless otherwise approved by the Owner.

12.2.1 Workers' Compensation: Workers' compensation coverage sufficient to meet statutory liability limits.

12.2.2 Employer's Liability: The Contractor will purchase and maintain employer's liability insurance in addition to its workers' compensation coverage with at least the minimum limits in Section I.C below.

12.2.3 Commercial General Liability: The Contractor will purchase and maintain commercial general liability ("CGL") insurance on an occurrence basis, written on ISO Form CG 0001 (12/04 or later) or an equivalent form approved in advance by the Owner. CGL coverage will include all major coverage categories including bodily injury, property damage, and products/completed operations coverage maintained for at least six years following final payment. The CGL insurance will also include the following: (a) separation of insured; (b) incidental medical malpractice; and (c) per-project aggregate for premises operations.

12.2.4 Professional Liability/Errors and Omissions: To the extent that the Contractor accepts design or design/build responsibilities, the Contractor will purchase and maintain professional liability/errors and omissions insurance and cause those Subcontractors providing design services do so.

12.2.5 Automobile Liability: The Contractor will purchase and maintain automobile liability insurance with coverage for owned, hired, and non-owned vehicles on ISO form CA 00 01 or an equivalent form approved in advance by the Owner. The automobile liability insurance will include pollution liability coverage resulting from vehicle overturn and collision.

12.2.6 Pollution Liability: The Contractor will purchase a contractors' pollution liability policy. Coverage will include third-party claims for bodily injury, property damage, and environmental damage resulting from pollution conditions caused during the performance of covered operations for both on-site and migrating from the job site. Such coverage will include pollution conditions arising from covered operations including work performed by its Subcontractors and third-party claims against the Contractor alleging improper supervision of its Subcontractors.

12.2.7 Commercial Umbrella/Excess Coverage: The Contractor will purchase or maintain a commercial umbrella or excess liability policy to meet the minimum limits as described below in Section I.C. Commercial umbrella/excess liability coverage will include: (a) "Pay on behalf of" wording; (b) concurrency of effective dates with primary coverage; (c) punitive damages coverage (where not prohibited by law); (d) application of aggregate (where applicable) in primary coverage; (e) "care, custody, and control" coverage that follows the form for primary coverage; and (f) drop-down feature. Excess/umbrella coverage will be scheduled to the CGL, employer's liability, and automobile liability policies.

12.3 Limits. The insurance required by this Article 12 will be written for at least the limits of liability specified in this Section or required by law, whichever is greatest.

12.3.1	Workers' Compensation	Statutory Limits
12.3.2	Employer's Liability	
12.3.2.1	Each Accident	$1,000,000
12.3.2.2	Each Bodily Injury/Disease	$1,000,000
12.3.2.3	Aggregate Bodily Injury/Disease	$1,000,000
12.3.3	Commercial General Liability	
12.3.3.1	Each Occurrence	$2,000,000
12.3.3.2	General Aggregate	$2,000,000
12.3.3.3	Product/Completed Operations	$2,000,000
12.3.3.4	Personal & Advertising Injury	$2,000,000
12.3.3.5	Fire Damage Limit	$2,000,000
12.3.3.6	Medical Expense Limit	$2,000,000
12.3.4	Automobile Liability	
12.3.4.1	Combined Single Limit	$2,000,000
12.3.5	Pollution Liability	
12.3.5.1	Single Limit	$2,000,000
12.3.5.2	Aggregate	$2,000,000
12.3.6	Commercial Umbrella/Excess Coverage	
12.3.6.1	Each Occurrence	***Alternates: Min. $2,000,000/$5,000,000/$10,000,000***

12.4 Additional Insureds. The Contractor's third-party liability insurance policies will include the Owner and its officers, employees, agents, volunteers, partners, successors, and assigns as additional insureds. The policy endorsement must extend premise operations and products/completed operations to the additional insureds. The additional insured endorsement for the CGL insurance must be written on ISO Form CG 2010 (11/85), a CG 2037 (07/04) together with CG 2033 (07/04), or the equivalent, but will not use the following forms: CG 20 10 (10 93) or CG 20 10 (03 94).

12.5 Joint Venture. If the Contractor is a joint venture, the joint venture will be a named insured for the liability insurance policies.

12.6 Primary Coverage. The Contractor's insurance will be primary insurance coverage and may not seek contribution from any insurance or self-insurance carried by the Owner or the Architect or Engineer, including any property damage coverage carried by the Owner. Contractor's insurance will apply separately to each insured against whom a claim is made or suit is brought. The Contractor's insurance will not include any cross-suit exclusion or preclude an additional insured party from asserting a claim as a third party.

12.7 Contractor's Failure to Maintain Insurance. If for any reason the Contractor fails to maintain required insurance coverage, such failure will be deemed a material breach of the Contract and the Owner, at its sole

discretion, may suspend or terminate the Contract for cause pursuant to Article 15 of this Contract. The Owner may, but has no obligation to, purchase such required insurance, and without further notice to the Contractor, the Owner may deduct from the Contract Sum any premium costs advanced by the Owner for such insurance. Failure to maintain the insurance coverage required by this Article 12 will not waive the Contractor's obligations to the Owner.

12.8 Certificates of Insurance. The Contractor will supply to the Owner Certificates of Insurance for the insurance policies described in this Article 12 prior to the commencement of the Work and before bringing any equipment or construction personnel onto the Project site.

12.8.1 Additional Certificates. To the extent that the Contractor's insurance coverages are required to remain in force after final payment and are reasonably available, an additional certificate evidencing continuation of such coverage will be submitted with the final application for payment. Information concerning reduction of coverage because of revised limits or claims paid under the general aggregate, or both, will be furnished by the Contractor with reasonable promptness in accordance with the Contractor's information and belief.

12.8.2 Prohibition Until Certificates Received. The Owner will have the right, but not the obligation, to prohibit the Contractor and its Subcontractors from entering the Project site until the required certificates (or other competent evidence that insurance has been obtained in complete compliance with this Article 12) are received and approved by the Owner.

12.8.3 Deductibles/Self-Insured Retentions: Payment of deductibles or self-insured retention is a Cost of the Work and does not justify a Change Order. Satisfaction of all self-insured retentions or deductibles will be the sole responsibility of the Contractor.

12.9 Subcontractor Insurance. The Contractor will cause each Subcontractor to purchase and maintain in full force and effect policies of insurance as specified in this Article 12, except that the coverage limits shall be at least $1,000,000 combined single limit for each occurrence and in the aggregate. The Contractor will be responsible for the Subcontractors' coverage if the Subcontractors fail to purchase and maintain the required insurance. When requested by the Owner, the Contractor will furnish copies of Certificates of Insurance establishing coverage for each Subcontractor.

12.10 Limitations on Coverage.

12.10.1 No insurance provided by the Contractor under this Article 12 will be required to indemnify the Owner, the Architect or Engineer, or their employees or agents to the extent of liability for death or bodily injury to persons or damage to property caused in whole or in part by their own negligence, but will require indemnity to the extent of the fault of the Contractor or its agents, representatives, or Subcontractors.

12.10.2 The obligations of the Contractor under this Article 12 will not extend to the liability of the Architect or Engineer or its consultants for (a) the preparation or approval of maps, drawings, opinions, reports, surveys, Change Orders, designs, or specifications; or (b) the giving or failure to give directions or instructions to the extent that the directions, or failure to provide directions, are the cause of the injury or damage.

12.10.3 By requiring insurance, the Owner does not represent that coverage and limits will necessarily be adequate to protect the Contractor. Insurance in effect or procured by the Contractor will not reduce or limit the Contractor's contractual obligations to indemnify and defend the Owner for claims or suits that result from or are connected with the performance of the Contract.

12.11 Property Insurance

12.11.1 Builders Risk. Contractor, for the life of this Contract, shall effect and maintain Builders All Risk Insurance and fire insurance with extended coverage and malicious mischief coverage upon the structures on which the Work of this Contract is to be done to 100 percent (100%) of the insurable value thereof, protecting (1) Owner's interest; (2) Contractor's interest; and (3) the Subcontractor's interest in the Work. Contractor's interest and Subcontractor's interest, as used herein, means their property interests and the property interests of others for which they are responsible in the Project, in all materials and supplies entering into or used or destined for use therein, and in all expendable items of equipment that are used in or are incidental to but that do not become a part of the finished Project, located at the job Site at the time of loss or damage. Such insurance shall not exclude coverage for landslides, collapse, explosion, or loss due to the result of faulty workmanship. Such insurance will include coverage for soft costs or delay in opening.

12.11.1.1 Contractor and all Subcontractors shall be responsible for any loss or damage to their machinery and apparatus and nonexpendable items of their equipment.

12.11.1.2 Contractor shall provide adequate fire protection equipment and safeguards to protect Metro and Contractor's interests in accordance with Metro's insurance carrier's requirements.

12.11.1.3 Contractor will furnish copies of Certificates of Insurance establishing coverage prior to project start.

12.11.2 Contractor's Responsibility. Contractor must provide insurance for its own machinery, tools, equipment, or supplies that are not to become a part of the Project.

ARTICLE 13
MINORITY/WOMEN/EMERGING SMALL BUSINESS PROGRAM

13.1 Contractor shall comply with all pertinent provisions of Metro's MWESB Business Program that are contained in Metro Code 2.04.100 to 2.04.190 and that are by this reference expressly incorporated herein and made a part of this Contract.

13.2 Contractor shall not replace a minority, women-owned or emerging small business enterprise Subcontractor with another Subcontractor, either before Contract Award or during Contract performance, without prior written approval of Metro. In replacing a minority, women-owned or emerging small business Subcontractor, Contractor shall replace such minority, women-owned or emerging small business Subcontractor with another certified minority, women-owned or emerging small business Subcontractor or make good faith efforts to do so. Failure to do so shall constitute Contractor's default of this Contract, and Metro, at its option, may terminate this Contract under the procedures set out in Article 15.

13.3 Metro reserves the right, at all times during the period of this Contract, to monitor Contractor's compliance with the terms of the MWESB Business Program and enforce the program if Contractor should fail to so comply. Contractor shall be bound by any and all representations made concerning its compliance with the program prior to Contract Award and any and all representations made by Contractor concerning the replacement of a minority or women-owned business Subcontractor during the performance of this Contract.

13.4 MWESB Participation in the Contract.

13.4.1 It is Metro's policy that Contractor shall take reasonable steps to ensure that Minority Business Enterprises (MBE), Women Business Enterprises (WBE), and Emerging Small Businesses (ESB) have the opportunity to participate in the Work.

13.4.2 Termination and Substitution of MWESB. The Contractor shall notify Metro in writing and confer with Metro before terminating or replacing a MWESB that has a signed contract with the Contractor.

13.4.3 Changes in Work Committed to MWESB. Metro will consider the impact on MWESB participation in instances where Metro changes, reduces, or deletes Work contracted to MWESB firms at the time of Contract Award. In such instances, the Contractor shall not be required to replace the Work but is encouraged to do so. If the Contractor proposes any changes that involve a contracted MWESB, the Contractor shall notify the MWESB of the proposed change, reduction, or deletion of any Work committed at the time of Contract Award prior to executing the Change Order. The Contractor can choose to enable the affected MWESB to participate in the Change Order request and is requested to make every effort to maintain the contracted MWESB percentage.

13.4.4 Contractor Payments to Subcontractors. The Contractor shall maintain records of all subcontracts entered into with MWESB firms and records of materials purchased from MWESB suppliers. Such records shall show the name and business address of each MWESB subcontractor or vendor and the total dollar amount actually paid to each MWESB subcontractor or vendor. The Contractor shall pay each subcontractor for satisfactory performance of its contract no later than ten (10) Calendar Days from receipt of each payment the Contractor receives from Metro. The Contractor shall also return Retainage payments to each subcontractor within ten (10) Calendar Days after the subcontractor's work is satisfactorily completed. Any delay or postponement of payment from the above-referenced time frame may occur only for good cause following written approval of the Metro Project Manager. The Contractor shall submit a completed, signed original "Metro Monthly Subcontractor Payment and Utilization Report," available from Metro. The Contractor shall submit the form when a progress or final payment has been made to each subcontractor or supplier or when any held retainage is returned to a subcontractor or supplier. Contractor shall submit the form no later than the fifth day of each month. At the completion of the Project, Contractors shall submit a final form indicating the total amounts paid to all subcontractors and suppliers.

ARTICLE 14
MISCELLANEOUS STATUTORY RESPONSIBILITIES OF CONTRACTOR

Contractor shall keep itself fully informed of and shall fully comply with all federal, state, regional, and local laws, rules, regulations, ordinances, and orders pertaining in any manner to this Contract and those rules, regulations, and orders of any agency or authority having jurisdiction over the Work or those persons employed or engaged therein. Contractor shall pay all taxes, including federal, state, regional, county, and city, or taxes of any other governmental entity applicable to the Work performed or materials provided under this Contract.

ARTICLE 15
TERMINATION OR SUSPENSION OF THE WORK

15.1 Default of Contractor.

15.1.1 If Contractor should be adjudged bankrupt, or if Contractor should make a general assignment for the benefit of its creditors, or if a receiver should be appointed on account of insolvency, or if Contractor should refuse to or fail to supply enough properly skilled workers or proper materials for the efficient prosecution of the Work, disregard laws, ordinances, or the instructions of Metro, or otherwise be in violation of any provision of the Contract, Metro may, without prejudice to any other right or remedy and after giving Contractor and Contractor's surety on the Performance Bond prior written notice, terminate the Contract or any portion of the Contract, which termination shall be effective ten (10) days after service of such notice. Such notice shall contain the reasons for the termination and shall state that unless, within ten (10) calendar days of service of the termination notice on Contractor, Contractor or its surety on the Performance Bond shall have cured or shall have made, in Metro's opinion, appropriate arrangements for prompt cure of all of the cause(s) for termination cited in the notice of termination, the Contract shall terminate.

15.1.2 Upon termination, Metro may take possession of the premises and of all materials, tools, and appliances thereon, as well as all other materials whether on the premises or not, for which Contractor has received partial payment, and may finish the Work or the portion terminated by whatever method it may deem expedient.

15.1.3 In the event action as above indicated is taken by Metro, Contractor or Contractor's surety shall provide Metro with immediate and peaceful possession of all of the materials, tools, and appliances located on the premises, as well as all other materials whether on the premises or not, for which Contractor has received any progress payment. Upon termination, in the event that the surety does not complete the Contract, at the election of Metro, Contractor shall assign any and all subcontracts and material contracts to Metro or Metro's designee. Further, Contractor shall not be entitled to receive any further payment until the Work is completed. On completion of the Work, determination shall be made by Metro of the total amount Contractor would have been entitled to receive for the Work under the terms of the Contract had Contractor completed the Work. If the difference between said total amount and the sum of all amounts previously paid to Contractor, which difference will hereinafter be called the "unpaid balance," exceeds the expense incurred by Metro in completing the Work, including expense for additional managerial and administrative service, and all other costs, damages, and expenses incurred by Metro due to Contractor's failure to complete the Contract, such excess will be paid to Contractor, with the consent of the surety. If, instead, the described expenses incurred by Metro exceed the unpaid balance, the amount of the excess shall be paid to Metro by Contractor or its surety. If only a portion of the Contract is terminated, this Section shall be deemed to apply to that portion of the Work only.

15.1.4 In addition to the above-mentioned right, Metro shall have the right, at its option, to suspend all or part of Contractor's performance under the Contract should any of the events occur that give Metro the right to terminate the Contract as above described. In such event, Metro shall give Contractor and Contractor's surety prior written notice of such suspension and Contractor shall stop or cause to stop all such Work under the Contract immediately on receipt of such notice and shall not commence such Work under the Contract again unless and until Contractor shall receive written notice from Metro to proceed. Metro shall not be responsible or liable to Contractor or others for any costs or expenses of whatever nature related to Contractor's failure to stop Work as directed by Metro.

15.1.5 After receipt of a notice of termination or suspension, and except as otherwise directed by Metro, Contractor shall as it relates to those portions of the Contract terminated or suspended:

15.1.5.1 Stop Work under the Contract on the date and to the extent specified in the notice of termination or suspension.

15.1.5.2 Place no further orders or subcontracts, or suspend the same, as applicable, for materials, services, or facilities except as necessary to complete the portion of the Work under the Contract that is not terminated or suspended.

15.1.5.3 Terminate or suspend, as applicable, all orders and subcontracts to the extent that they relate to the performance of such Work terminated or suspended.

15.1.6 Metro may, at its discretion, avail itself of any or all of the above rights or remedies and its invoking of any one of the above rights or remedies will not prejudice or preclude Metro from subsequently invoking any other right or remedy set forth above or elsewhere in the Contract.

15.1.7 None of the foregoing provisions shall be construed to require Metro to complete the Work nor to waive or in any way limit or modify the provisions of the Contract relating to the fixed and liquidated damages suffered by Metro on account of failure to complete the Project within the time prescribed.

15.2 Termination in the Public Interest.

15.2.1 Metro may unilaterally terminate the Contract in whole or in part for convenience, when Metro determines it to be in the public interest.

15.2.2 When Metro decides to terminate a Contract for convenience, Metro will notify the Contractor and its sureties in writing of its intention to terminate the Contractor's right to proceed with the Work no less than seven (7) days in advance of the date of the actual termination. The date of termination, which is the date after which no Work is to be performed, must be stated in the notice. Notice will be deemed to have been given if sent to the Contractor's or any surety's last known address provided to Metro by the Contractor and its sureties. For purposes of computing time in this Section, the first day counted is the day that the notice is mailed by Metro.

15.2.3 After receipt of a notice of termination, and except as directed by Metro, the Contractor will immediately proceed with the following obligations:

15.2.3.1 Stop Work by the date as specified in the notice;

15.2.3.2 Award no further subcontracts and place no further orders for materials, services, or facilities, except as necessary to complete the continued portion of the Contract, if any;

15.2.3.3 Terminate all Subcontractors and orders to the extent that they relate to the Work terminated;

15.2.3.4 Assign to Metro, if directed by Project Manager, all right, title, and interest of the Contractor under the subcontracts terminated, in which case Metro will have the right to settle or to pay any termination settlement proposals arising out of those terminations;

15.2.3.5 With approval or ratification to the extent required by Metro, settle all outstanding liabilities and termination settlement proposals arising from the termination of subcontracts; the approval or ratification will be final for purposes of this clause;

15.2.3.6 As directed by Metro, transfer title and deliver to Metro (a) the fabricated or unfabricated parts, Work in process, completed Work, supplies, and other materials produced or acquired for the Work terminated, and (b) the completed or partially completed plans, drawings, information, and other property that, if the Contract had been completed, would be required to be furnished to Metro;

15.2.3.7 Take any actions that may be necessary, or that Project Manager may direct, for the protection and preservation of the property related to this Contract that is in the possession of the Contractor and in which Metro has or may acquire an interest; and

15.2.3.8 Use its best efforts to sell, as directed or authorized by Project Manager, any property of the type referred to in Section 14.2.3.6 above, except that the Contractor (a) is not required to extend credit to any purchaser and (b) may acquire the property under the conditions prescribed by, and at prices approved by, the Project Manager. The process of any transfer or disposition will be applied to reduce any payments to be made by Metro under this Contract, credited to the price or cost of the Work, or paid in any other manner directed by Project Manager.

15.2.4 Upon termination, Metro will pay the Contractor the following costs, and no other, as a result of the termination:

15.2.4.1 With regard to the Contract Work performed before the effective date of termination, the total (without duplication of any items) of the following costs:

15.2.4.1.1 The cost of this Work, as determined by the method of payment established by the Contract Documents;

15.2.4.1.2 The cost of settling and paying termination settlement proposals under terminated subcontracts that are properly chargeable to the terminated portion of the Contract if such costs are not included in Section 14.2.3.4; and

15.2.4.1.3 A sum as profit on Section 14.2.4.1.1 above, not to exceed ten percent of that amount, unless it appears that the Contractor would have sustained a loss on the entire Contract had it been completed. No profit, however, is permitted on costs compensated under Section 14.2.4.1.2.

15.2.4.2 The reasonable costs of settlement of the Work terminated, including:

15.2.4.2.1 Accounting, clerical, and other expenses reasonably necessary for the preparation of termination settlement proposals and supporting data, except that no allowance will be made for costs incurred as attorney fees;

15.2.4.2.2 The termination and settlement of Subcontractors (excluding the amounts of such settlements); and

15.2.4.2.3 Storage, transportation, and other costs incurred reasonably necessary for the preservation, protection, or disposition of the termination inventory.

15.2.5 No costs other than those allowed in Section 14.2.4 are to be paid. By way of example only, and not by way of limitation, costs that would not be allowed include anticipated profits on unperformed Work, consequential damages, post-termination overhead, Bid or Proposal preparation costs, costs for retraining employees, depreciation on idle equipment, cost of common items reasonably usable on the Contractor's other work, and costs unrelated to the Work performed prior to the date of termination.

15.2.6 Metro may deduct from any sums otherwise due the Contractor under Section 14.2.4 above the cost of advance payments made to the Contractor under the terminated portion of this Contract, any claim that Metro has against the Contractor whether or not arising from this Contract, and the agreed price of, or proceeds of sale of, materials, supplies, or other things acquired by the Contractor or sold under the provision of Section 14.2.3.8 and not recovered by or credited to Metro.

15.2.7 Payment from Metro is not due until the Contractor has submitted an itemization of its recoverable costs to Metro in writing, together with supporting documentation. The Contractor will supply additional supporting documentation on request by Metro in order to recover its costs.

15.2.8 The Contractor will maintain all records and documents relating to the termination until Metro and the Contractor resolve the amount of costs to be paid by Metro to the Contractor as a result of this termination. Such records must be made available to Metro within thirty (30) days of the request.

END OF SECTION

MERC CONTRACT NO. 305019

METRO GENERAL CONDITIONS - EXHIBIT 1

WARRANTY FORM

We the undersigned hereby warrant that the [DESCRIBE WORK PERFORMED OR MATERIALS SUPPLIED] that we have provided for [INSERT PROJECT NAME] has been done in accordance with the Contract Documents and that the Work as provided will fulfill the requirements of the warranty included in Article 7 of the Metro General Conditions.

We agree to correct or remove and replace any or all of our Work described in Specification Section 230923 and 230993, together with any other adjacent Work that may be displaced or affected by so doing, that may be defective in its workmanship or materials, or that may fail to conform to the requirements of the Contract Documents, within a period of one (1) year following the later of the date of substantial completion or the date described in Section 7.7 of the Metro General Conditions, without any expense whatsoever to Metro, normal wear and tear and mistreatment excepted.

We agree to correct or remove and replace any or all of our Work **other than that** described in Specification Section 230923 and 230993, together with any other adjacent Work that may be displaced or affected by so doing, that may be defective in its workmanship or materials, or that may fail to conform to the requirements of the Contract Documents, within a period of two (2) years following the later of the date of substantial completion or the date described in Section 7.7 of the Metro General Conditions, without any expense whatsoever to Metro, normal wear and tear and mistreatment excepted

In the event of our failure to comply with the above-mentioned conditions within twenty (20) calendar days after Metro notifies Contractor in writing, we collectively and separately do hereby authorize Metro to proceed to have said defects repaired and corrected at our expense, and we will honor and pay the costs to dispose of nonconforming materials and charges therefore upon demand. If Metro is required to enforce payment, it shall be entitled to recover its costs and reasonable attorney fees.

CONTRACTOR	SUBCONTRACTOR
By_____	By_____
Print Name_____	Print Name_____
Date_____	Date_____

MERC CONTRACT NO. 305019

METRO GENERAL CONDITIONS - EXHIBIT 2

SUBCONTRACTOR ASSIGNMENT OF ANTITRUST CLAIMS

Project: _____

Owner: Metro

General Contractor: _____

Subcontractor: _____

Release Date: _____

1. By entering into a contract with the General Contractor, subcontractor, for consideration paid to subcontractor under the subcontract, does irrevocably assign to Metro any claim for relief or cause of action that subcontractor now has or that may accrue to Subcontractor in the future, including at Metro's option, the right to control any such litigation on such claim for relief or cause of action, by reason of any violation of 15 USC Section 1 15, ORS 646.725, or ORS 646.730 in connection with any goods or services that are used, in whole or in part, for the purpose of carrying out subcontractor's obligations under its subcontract with the General Contractor.

2. Subcontractors irrevocably assigns to Metro, as a third-Party beneficiary of the subcontract, any right, title, or interest that has accrued or may accrue to the Subcontractor by reason of any violation of 15 USC Section 1 15, ORS 646.725, or ORS 646.730, including, at Metro's option, the rights to control any litigation arising hereunder, in connection with any goods or services provided to the Subcontractors or Suppliers by any person, in whole or in part, for the purpose of carrying out the Subcontractor's obligations as agreed to by Subcontractor in pursuance of the completion of the Contract .

3. It is an express obligation of Subcontractor that it will take no action that will in any way diminish the value of the rights conveyed or assigned hereunder to Metro. It is an express obligation of Subcontractor to advise the Office of Metro Attorney:

a. In advance, of its intention to commence any action on its own behalf regarding such claims for relief or causes of action;

b. Immediately, upon becoming aware of the fact that an action has been commenced on its own behalf by some other person or persons, of the impendency of such action; and

c. the date on which it notified the obligor(s) of any such claims for relief or causes of action of the fact of its assignment to Metro.

4. In the event that any payment under any such claim is made to Subcontractor, it shall promptly pay over to Metro its proportionate share thereof, if any, assigned to Metro herein.

SUBCONTRACTOR

By_____

Print Name_____

Date_____

MERC CONTRACT NO. 305019

METRO GENERAL CONDITIONS - EXHIBIT 3

AFFIDAVIT, AGREEMENT FOR INDEMNITY, LIEN WAIVER AND RELEASE

(General Contractor – Progress Payment)

This AFFIDAVIT, AGREEMENT FOR INDEMNITY, LIEN WAIVER AND RELEASE is entered into _____, by and between Metro, a Metropolitan Service District established pursuant to Oregon law and the Metro Charter ("Metro") and _____, (the "Undersigned") in accord with Metro Contract No. ____, dated _____, between Metro and the Undersigned for construction of _____ (the "Contract"). As a condition precedent to Metro's Progress Payment No.___ under the Contract in the amount of $_____, and in consideration thereof, the Undersigned agrees to make the following representations, warranties, covenants, agreements, and indemnities, and to fully and completely waive, release, and discharge Metro from all liabilities, obligations, and claims arising under the Contract, as follows:

1. The Undersigned hereby certifies, represents, and warrants as follows:

1.1 It has supplied labor, services, equipment, materials, and materials provided or transported to the construction of the _____ as General Contractor under the Contract (the "Project"), and has subcontracted with other persons and entities to so provide.

1.2 It has complied with all federal, state, and local laws, including social security laws, unemployment compensation laws, workers' compensation laws, and tax laws, insofar as applicable to the performance of the Contract work, and has paid all federal, state, and local taxes including excise, use, sales, and withholding taxes.

1.3 All subcontractors, laborers, service providers, equipment suppliers and material suppliers, and transporters for work, services, equipment, or materials supplied to the Project or to the Undersigned and used in the Project have been paid in full by the Undersigned through the period covered by previous progress payments made by Metro.

1.4 It either has paid in full, or within ten (10) business days of receipt of the above set forth Progress Payment, will pay in full all subcontractors, laborers, service providers, equipment suppliers and material suppliers, and transporters for work, services, equipment, or materials supplied to the Project or to the Undersigned connected with or used in the Project, through the period covered by said progress payment made by Metro.

1.5 It has delivered to Metro written releases of all rights to file claims on any bonds in connection with the Contract, signed by each subcontractor, service provider, and supplier who performed work or services, or furnished or transported materials or equipment in connection with the Contract, in accord with Article 9 of the Metro General Conditions to the Contract.

2. The Undersigned acknowledges and agrees that Progress Payments made by Metro up to the date hereof, in the sum of_____, plus Progress Payment No. _____, when paid, constitute payment in full of all amounts due to Undersigned for all labor, services, equipment, and materials provided or transported in connection with the Project up to and through _____, _____, as set forth in the Undersigned's payment application No. _____. The Undersigned agrees that, ***upon receipt of the above set forth progress payment,*** which is the full payment due and owing to Undersigned up to and through the date set forth in section 2, Undersigned will be paid in full for all labor (including contributions and benefits), services, equipment, supplies, and materials provided or transported in connection with the Project without exceptions, and that there are no other unsettled claims or demands therefore. The Undersigned agrees that, ***conditioned upon receipt of Payment of the above set forth progress payment,*** and in consideration thereof, the Undersigned hereby fully and unconditionally waives and releases Metro from all liability for payment, liens or claims of lien, rights to lien, bond claim rights, and any other claim for payment it now has or asserts or may have or assert for labor, services, equipment, materials, and materials provided or transported in connection with the Project through and up to said date, and further releases Metro, the Project land and improvements from any claim, cause of action, or demand whatsoever, arising out of or relating to the Project that arose on or before said date.

3. The Undersigned hereby agrees to promptly pay and obtain a release of claims on any bonds that may in the future affect the Project, and defend, indemnify, and save Metro harmless from any liability or expense because of any claim on any bond or any other claim related to the work under the Contract through and up to the date set forth in section 2.

4. The affiant signing below does hereby swear and attest that he/she has the full authority to sign this document on behalf of the Undersigned and that Metro may rely on this Affidavit, Agreement for Lien Waiver and Release in connection with remitting Progress Payment No. _____ to Undersigned.

Dated:_____ Affiant:_____Its:_____

STATE OF OREGON)
County of _____)
This instrument was acknowledged before me on _____ by _____ as _____
_____of_____

_____
Notary Public - State of Oregon

METRO GENERAL CONDITIONS - EXHIBIT 4

MERC CONTRACT NO. 305019

AFFIDAVIT, AGREEMENT FOR INDEMNITY, LIEN WAIVER AND RELEASE
(General Contractor – Final Closeout)

This AFFIDAVIT, AGREEMENT FOR INDEMNITY, LIEN WAIVER AND RELEASE is entered into _____, by and between Metro, a Metropolitan Service District established pursuant to Oregon law and the Metro Charter ("METRO") _____, (the "Undersigned") in accord with Metro Contract No. ____, dated _____, between Metro and the Undersigned for construction of the _____(the "Contract"). As a condition precedent to Metro's final payment under the Contract, in the amount of _____ (the "Final Payment"), and in consideration thereof, the Undersigned agrees to make the following representations, warranties, covenants, agreements and indemnities, and to fully and completely waive, release and discharge Metro from all liabilities, obligations, and claims arising under the Contract, as follows:

1. The Undersigned hereby certifies, represents and warrants as follows:

1.1 It has supplied labor, services, equipment, materials or materials transported to the construction of the _____ as General Contractor under Metro Contract No._____ (the "Project"), and has subcontracted with other persons and entities to so provide.

1.2 It has complied with all federal, state and local laws, including social security laws, unemployment compensation laws, workers' compensation laws, and tax laws, insofar as applicable to the performance of the Contract work, and has paid all federal, state and local taxes including excise, use, sales and withholding taxes.

1.3 All subcontractors, laborers, service providers, equipment suppliers and material suppliers and transporters for work, services, equipment or materials supplied to the Project or to the Undersigned and used in the Project have been paid in full by the Undersigned through the period covered by previous progress payments made by Metro.

1.4 It either has paid in full, or within ten (10) business days of receipt of the Final Payment, will pay in full all subcontractors, laborers, service providers, equipment suppliers and material suppliers and transporters for work, services, equipment or materials supplied to the Project or to the Undersigned connected with or used in the Project.

1.5 It has delivered to Metro written releases of all rights to file claims on any bonds in connection with the Contract, signed by each subcontractor, service provider and supplier who performed work, services or furnished or transported materials or equipment in connection with the Contract, in accord with Article 9 of the General Conditions to the Contract.

2. The Undersigned covenants and agrees that progress payments made by Metro up to the date hereof, in the sum of **$**_____, plus the Final Payment in the amount of _____**,** constitute full and final payment of all amounts due to Undersigned for all labor, services, equipment, and materials provided or transported in connection with the Project. The Undersigned agrees that, ***conditioned upon receipt of the Final Payment,*** and in consideration thereof, the Undersigned hereby fully and unconditionally waives, discharges and releases Metro from all liabilities, obligations and claims, including all liens, claims of lien, rights to lien, bond claim rights and any other claim for payment it now has or asserts or may have or assert for labor, services, equipment, materials provided or transported in connection with the Contract, and further releases Metro, the Project land and improvements from any claim, cause of action, or demand whatsoever arising out of or relating to the Project.

3. The Undersigned hereby agrees to defend, indemnify and hold Metro harmless from any liability or expense resulting from any claim on any bond or any other claim related to the Contract or work there under, in accord with Articles 9 and 1 of the General Conditions to the Contract.

4. The affiant signing below does hereby swear and attest that he/she has the full authority to sign this document on behalf of the Undersigned and that, ***except for the Final Payment,*** which is the full and final payment due and owing to Undersigned, that Undersigned has been paid in full for all labor (including contributions and benefits), services, equipment, supplies and materials provided or transported in connection with the Project without exceptions, and that there are no other unsettled claims or demands therefore. The Undersigned affiant further acknowledges that Metro may rely on this Affidavit, Agreement for Indemnity, Lien Waiver and Release in connection with remitting the Final Payment to Undersigned.

Dated: _____ Undersigned:_____

By:_____Its:_____

STATE OF OREGON)
) ss.
County of _____)

This instrument was acknowledged before me on _____ by _____ as _____
_____of_____

_____
Notary Public - State of Oregon

MERC CONTRACT NO. 305019

METRO GENERAL CONDITIONS - EXHIBIT 5

AFFIDAVIT, LIEN WAIVER AND RELEASE – CONDITIONAL FINAL
(Subcontractor - Closeout)

1. The undersigned, _____ ("Undersigned"), has provided labor, services, equipment, materials or materials transport to the construction of the improvements at _____ known as _____, as a Subcontractor to _____("Contractor"), Metro Contract No._____ (the "Project").

2. The Undersigned acknowledges and agrees that the sum of **$**_____ constitutes full and final payment of all amounts due to Undersigned for all labor, services, equipment, and materials provided or transported in connection with the Project (the "Final Payment"). The Undersigned agrees that, ***conditioned upon receipt of the Final Payment,*** and in consideration thereof, the Undersigned hereby fully and unconditionally waives and releases all liens, claims of lien, rights to lien, bond claim rights and any other claim for payment it now has or asserts or may have or assert for labor, services, equipment, materials provided or transported in connection with the Project, and further releases Metro, the Project land and improvements, and the Contractor from any claim, cause of action, or demand whatsoever arising out of or relating to the Project.

3. The Undersigned hereby certifies as follows:

3.1 It has complied with all federal, state and local laws, including tax laws, social security laws, unemployment compensation laws and workers' compensation laws, insofar is applicable to the performance of the subcontract work.

3.2 Its laborers, equipment suppliers and material suppliers have been fully paid through the period covered by previous progress payments made by Contractor except as explicitly noted in writing and attached hereto.

3.3 It either has paid in full, or within five (5) business days of receipt of the Final Payment, will pay in full for all labor, materials and equipment used in or furnished in connection with Project.

4. The affiant signing below does hereby swear and attest that he/she has the full authority to sign this document on behalf of the Undersigned and that, ***conditioned upon receipt of the Final Payment,*** which is the full and Final Payment due and owing to Undersigned, that Undersigned has been paid in full for all labor (including contributions and benefits), services, equipment, supplies and materials provided or transported in connection with the Project without exceptions, and that there are no other unsettled claims or demands therefore. The Undersigned affiant and further acknowledges that Metro and Contractor are relying on this Affidavit, Lien Waiver and Release in connection with processing the Final Payment.

Dated: _____ Undersigned | Subcontractor: _____

By: _____

Print Name: _____

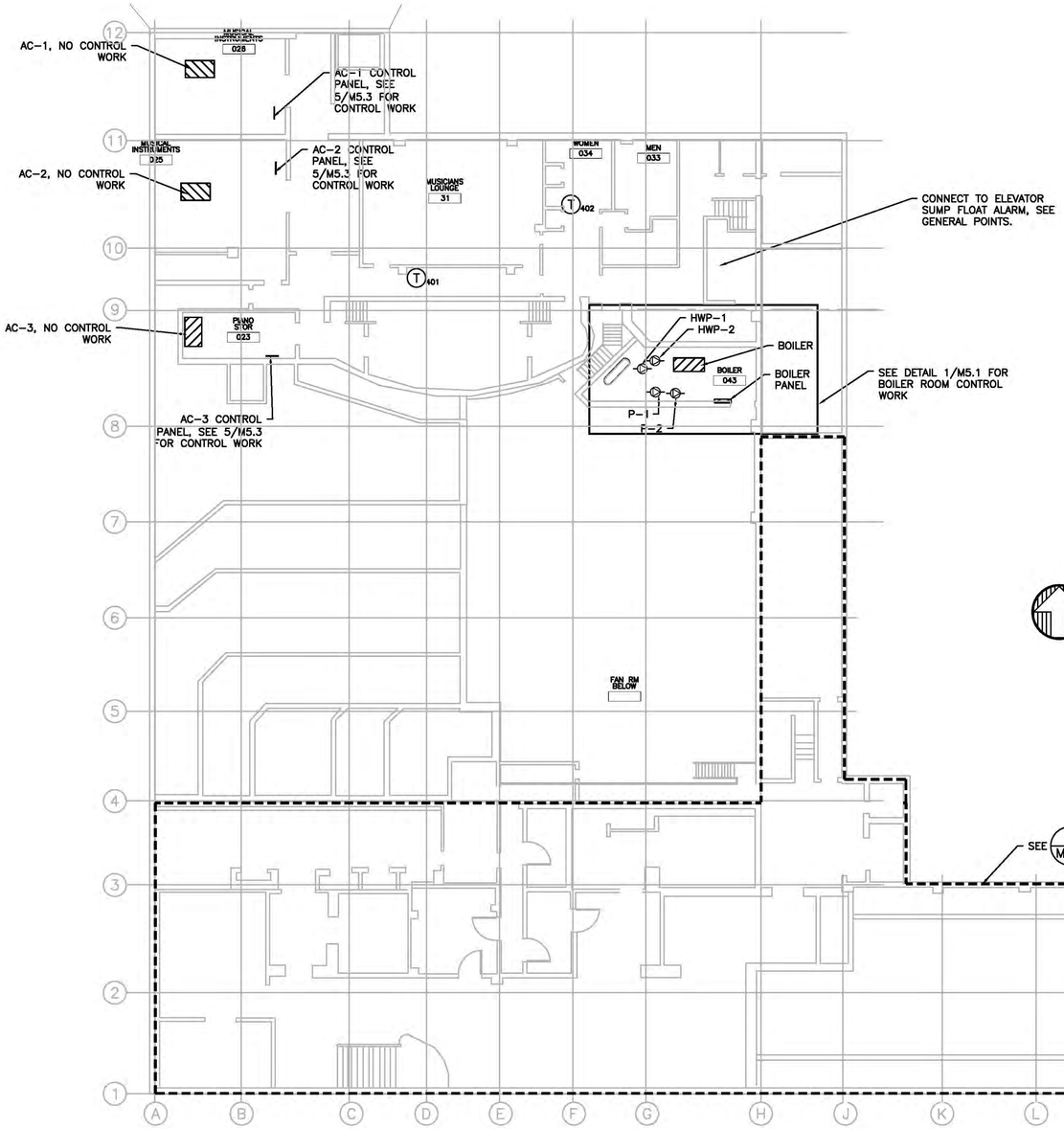
Its: _____

STATE OF OREGON)
) *ss.*
County of Multnomah)

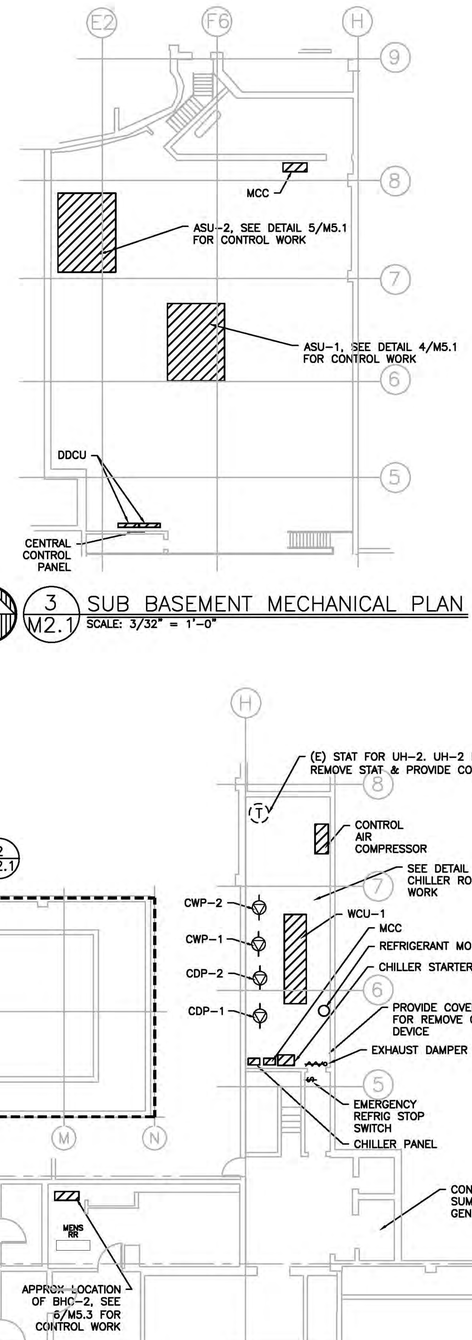
This instrument was acknowledged before me on _____ by _____ as _____ _____ of _____.

_____
Notary Public - State of Oregon

Notary Public - State of Oregon



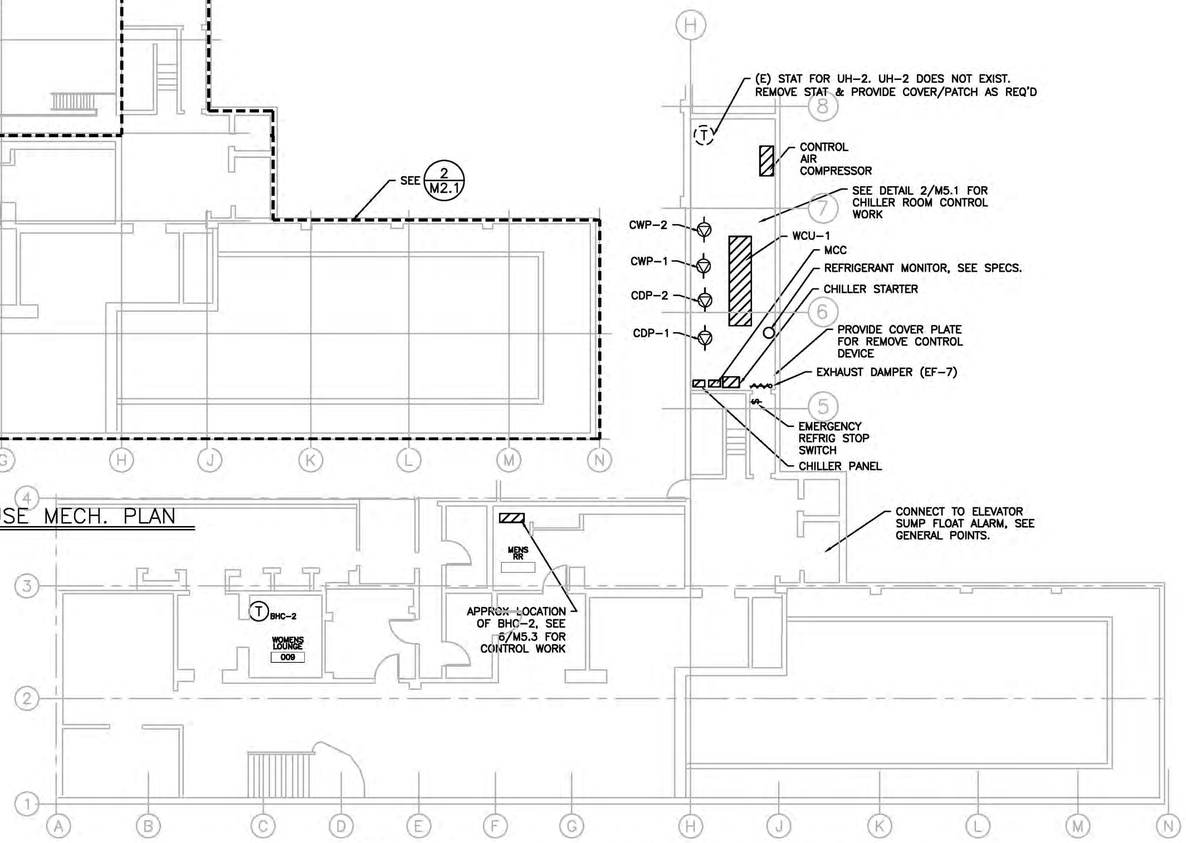
1/M2.1 LOUNGE LEVEL BACK OF HOUSE MECH. PLAN
SCALE: 3/32" = 1'-0"



3/M2.1 SUB BASEMENT MECHANICAL PLAN
SCALE: 3/32" = 1'-0"

GENERAL NOTES:

- REMOVE ALL PNEUMATIC CONTROL DEVICES/PANELS INCLUDING CABINETS, TUBING, COMPRESSORS & SENSORS NO LONGER USED. TUBING ABOVE HARD CEILINGS (ONLY RELAY) TO BE ABANDON IN PLACE
- FOR ALL CONTROL CABINETS. REMOVE ALL DEVICES THAT ARE NO LONGER BEING USED.
- EACH AIR HANDLER SHALL BE BALANCED. TOTAL AIRFLOW AND OUTSIDE AIRFLOW RATES SHALL BE RECORDED. REQUIRED RATES WILL BE PROVIDED BY THE ENGINEER DURING CONSTRUCTION. SEE SPECIFICATIONS FOR DETAILS RELATED BALANCING SERVICES. BALANCING OF INDIVIDUAL DIFFUSERS OR GRILLES IS NOT REQUIRED. RECORDING OF AIRFLOW PER ZONE FOR MULTI-ZONE UNITS IN BOTH FULL HEAT AND COOL MODE IS REQUIRED.



2/M2.1 LOWER LOUNGE LEVEL MECHANICAL PLAN
SCALE: 3/32" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER
OREGON
JULY 25, 1980
SCOTT W. MILLER
17884
EXPIRES: 31DEC16

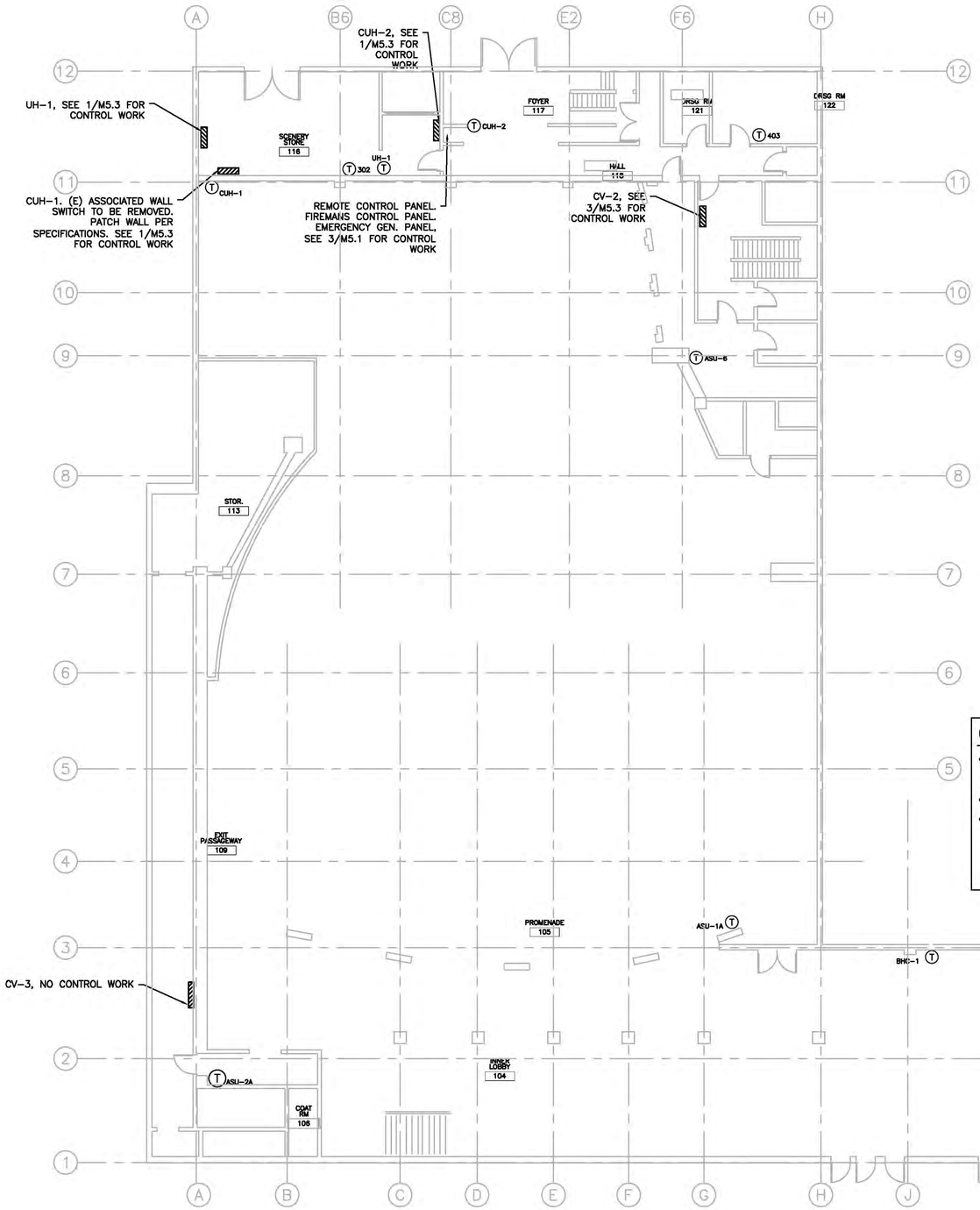
Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
Chkd By: SWM
DSGN By: SWM
Acad File:

PORTLAND'5 CENTERS FOR THE ARTS
ARLENE SCHNITZER
1037 SOUTHWEST BROADWAY

MECHANICAL PLAN

MFIA INC.
Consulting Engineers
2007 S.E. Ash St.
Portland, OR 97214
PHN: (503) 234-0548
FAX: (503) 234-0677
WWW.MFIA-ENG.COM

SHEET
M2.1
1 OF 11



GENERAL NOTES:

- REMOVE ALL PNEUMATIC CONTROL DEVICES/PANELS INCLUDING CABINETS, TUBING, COMPRESSORS & SENSORS NO LONGER USED. TUBING ABOVE HARD CEILINGS (ONLY RELAY) TO BE ABANDON IN PLACE
- FOR ALL CONTROL CABINETS. REMOVE ALL DEVICES THAT ARE NO LONGER BEING USED.
- EACH AIR HANDLER SHALL BE BALANCED. TOTAL AIRFLOW AND OUTSIDE AIRFLOW RATES SHALL BE RECORDED. REQUIRED RATES WILL BE PROVIDED BY THE ENGINEER DURING CONSTRUCTION. SEE SPECIFICATIONS FOR DETAILS RELATED BALANCING SERVICES. BALANCING OF INDIVIDUAL DIFFUSERS OR GRILLES IS NOT REQUIRED. RECORDING OF AIRFLOW PER ZONE FOR MULTI-ZONE UNITS IN BOTH FULL HEAT AND COOL MODE IS REQUIRED.

1 M2.2 MECHANICAL ORCHESTRA PLAN
SCALE: 3/32" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER
OREGON
17884
JULY 25, 1980
SCOTT W. MILLER
EXPIRES: 31DEC16

Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
Chkd By: SWM
DSGN By: SWM
Acad File:

PORTLAND'5 CENTERS FOR THE ARTS
ARLENE SCHNITZER
1037 SOUTHWEST BROADWAY

MECHANICAL PLAN

MFIA INC.

Consulting Engineers
2007 S.E. Ash St.
Portland, OR 97214
PHN: (503) 234-0548
FAX: (503) 234-0677
WWW.MFIA-ENG.COM

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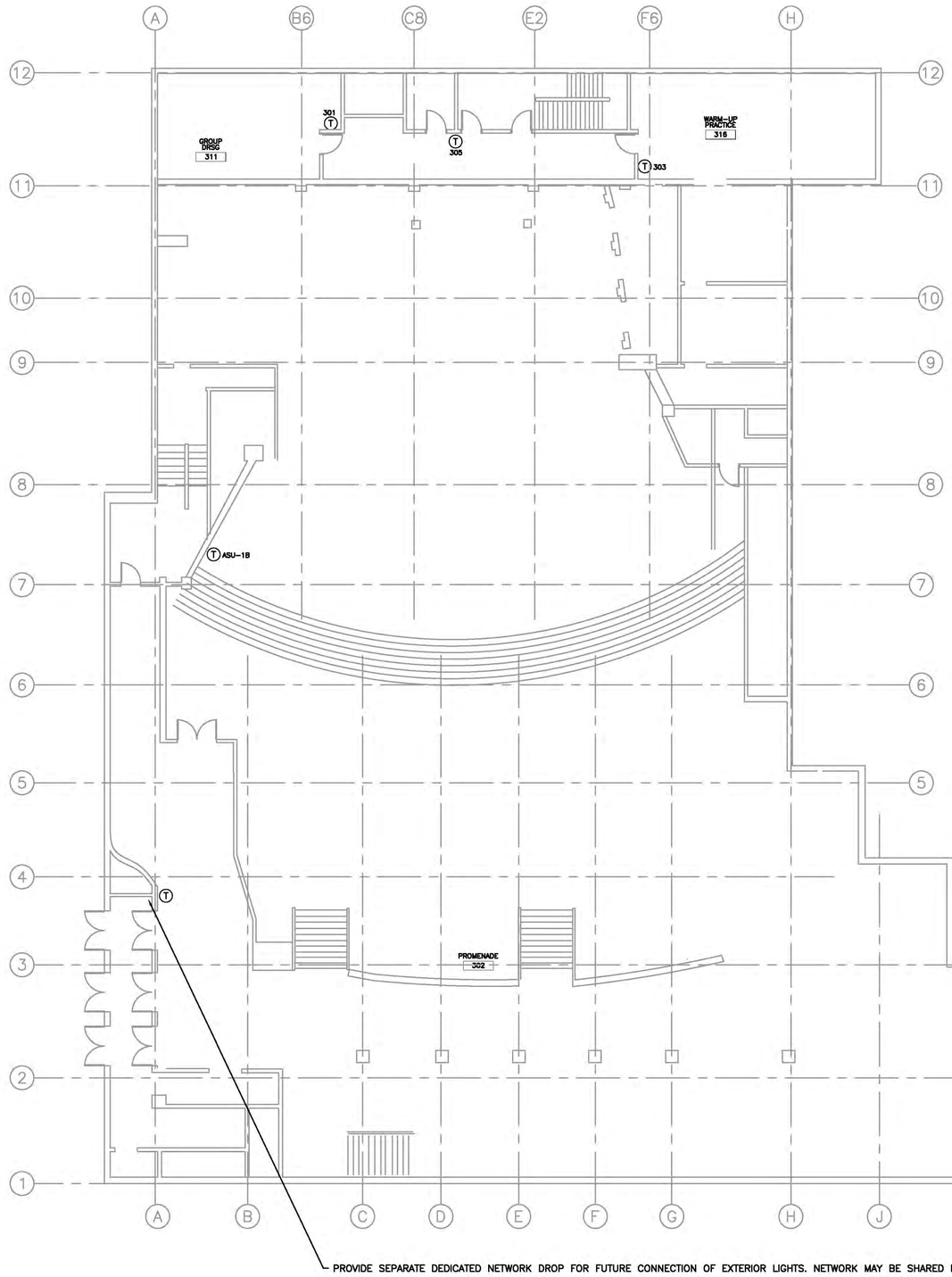
2 OF 11



PROVIDE SEPARATE DEDICATED NETWORK DROP FOR FUTURE CONNECTION OF EXTERIOR LIGHTS. NETWORK MAY BE SHARED BY BOTH LOCATIONS

GENERAL NOTES:

- REMOVE ALL PNEUMATIC CONTROL DEVICES/PANELS INCLUDING CABINETS, TUBING, COMPRESSORS & SENSORS NO LONGER USED. TUBING ABOVE HARD CEILINGS (ONLY RELAY) TO BE ABANDON IN PLACE
- FOR ALL CONTROL CABINETS. REMOVE ALL DEVICES THAT ARE NO LONGER BEING USED.
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1 M2.3 MECHANICAL MEZZANINE PLAN
SCALE: 3/32" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER
OREGON
17884
JULY 25, 1980
SCOTT W. MILLER
EXPIRES: 31DEC16

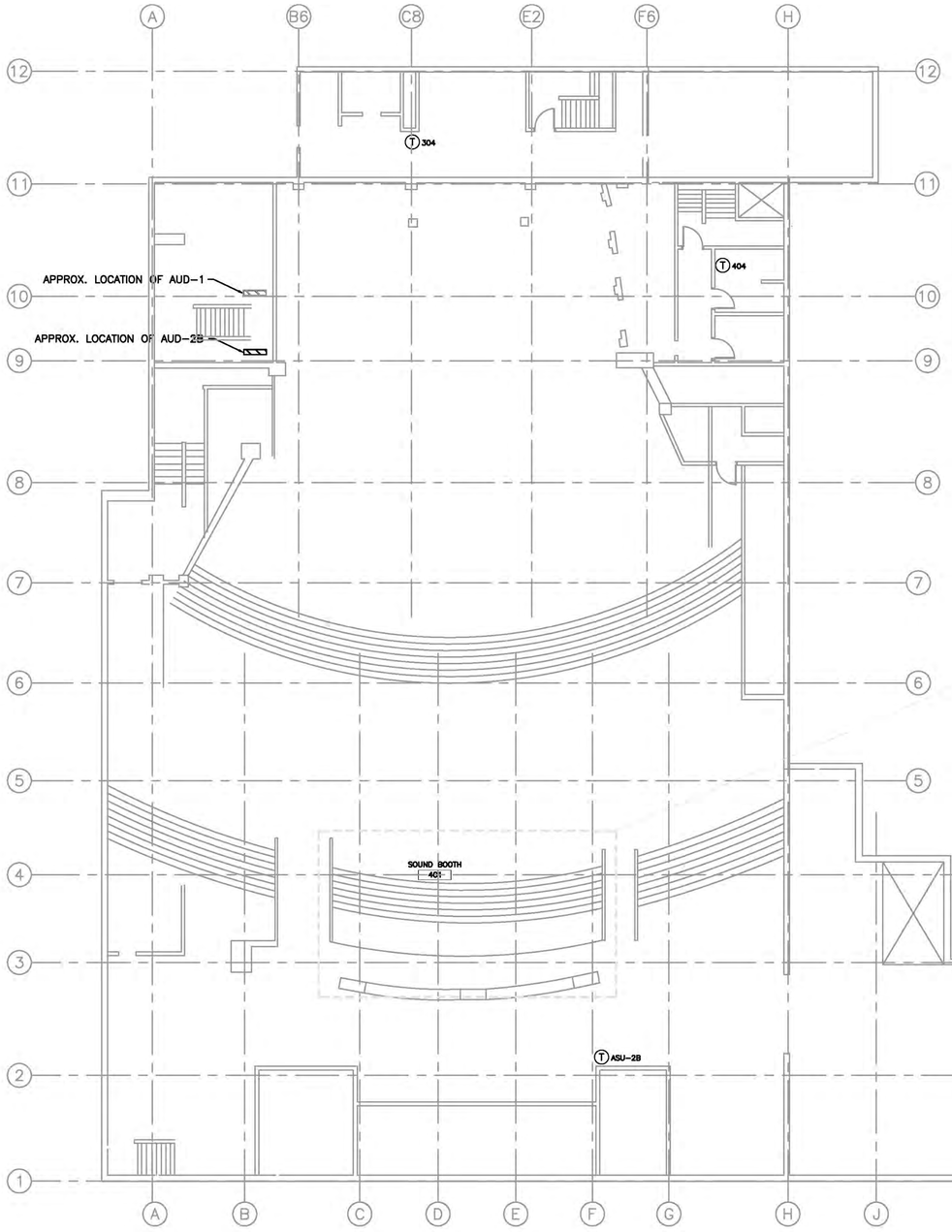
Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
Chkd By: SWM
DSGN By: SWM
Acad File:

PORTLAND'5 CENTERS FOR THE ARTS
ARLENE SCHNITZER
1037 SOUTHWEST BROADWAY

MECHANICAL MEZZANINE PLAN

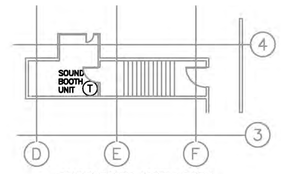
MFIA INC.
Consulting Engineers
2007 S.E. Ash St.
Portland, OR 97214
PHN: (503) 234-0548
FAX: (503) 234-0677
WWW.MFIA-ENG.COM

SHEET
M2.3
3 OF 11



GENERAL NOTES:

- REMOVE ALL PNEUMATIC CONTROL DEVICES/PANELS INCLUDING CABINETS, TUBING, COMPRESSORS & SENSORS NO LONGER USED. TUBING ABOVE HARD CEILINGS (ONLY RELAY) TO BE ABANDON IN PLACE
- FOR ALL CONTROL CABINETS. REMOVE ALL DEVICES THAT ARE NO LONGER BEING USED.
- EACH AIR HANDLER SHALL BE BALANCED. TOTAL AIRFLOW AND OUTSIDE AIRFLOW RATES SHALL BE RECORDED. REQUIRED RATES WILL BE PROVIDED BY THE ENGINEER DURING CONSTRUCTION. SEE SPECIFICATIONS FOR DETAILS RELATED BALANCING SERVICES. BALANCING OF INDIVIDUAL DIFFUSERS OR GRILLES IS NOT REQUIRED. RECORDING OF AIRFLOW PER ZONE FOR MULTI-ZONE UNITS IN BOTH FULL HEAT AND COOL MODE IS REQUIRED.



SOUND BOOTH ACCESS ROOM.
LOCATED BETWEEN FLOOR PLANS
FOR M2.4 AND M25.

1 / M2.4 LOWER BALCONY MECHANICAL PLAN
SCALE: 3/32" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER
OREGON
17884
JULY 25, 1980
SCOTT W. MILLER
EXPIRES: 31DEC16

Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
Chkd By: SWM
DSGN By: SWM
Acad File:

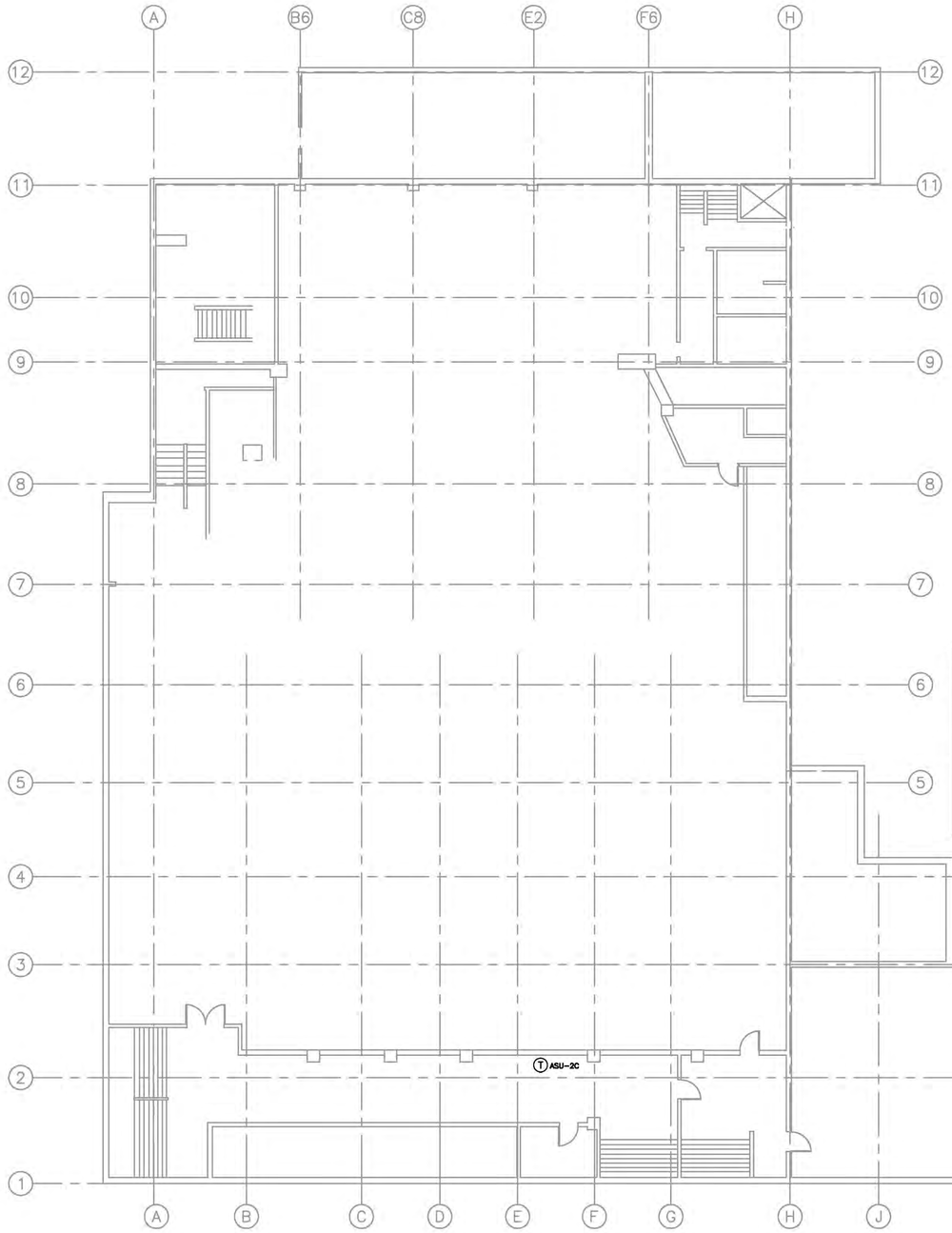
PORTLAND'5 CENTERS FOR THE ARTS
ARLENE SCHNITZER
1037 SOUTHWEST BROADWAY

LOWER BALCONY MECHANICAL PLAN

MFIA INC.

Consulting Engineers
2007 S.E. Ash St.
Portland, OR 97214
PHN: (503) 234-0648
FAX: (503) 234-0677
WWW.MFIA-ENG.COM

SHEET
M2.4
4 OF 11



GENERAL NOTES:

- REMOVE ALL PNEUMATIC CONTROL DEVICES/PANELS INCLUDING CABINETS, TUBING, COMPRESSORS & SENSORS NO LONGER USED. TUBING ABOVE HARD CEILINGS (ONLY RELAY) TO BE ABANDON IN PLACE
- FOR ALL CONTROL CABINETS. REMOVE ALL DEVICES THAT ARE NO LONGER BEING USED.
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1 M2.5 UPPER BALCONY MECHANICAL PLAN
SCALE: 3/32" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER
OREGON
17884
JULY 25, 1980
SCOTT W. MILLER
EXPIRES: 31DEC16

Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
Chkd By: SWM
DSGN By: SWM
Acad File:

PORTLAND'S CENTERS FOR THE ARTS
ARLENE SCHNITZER
1037 SOUTHWEST BROADWAY

UPPER BALCONY MECHANICAL PLAN

MFIA INC.
Consulting Engineers
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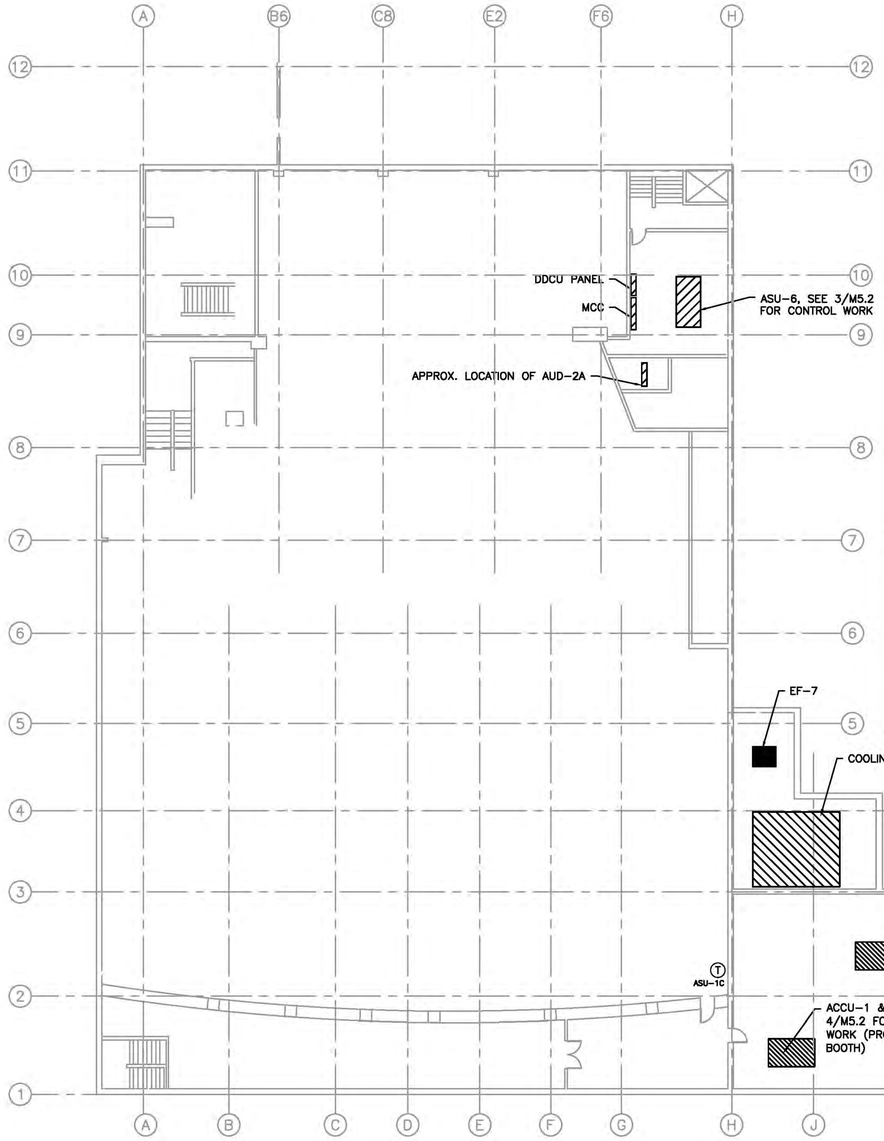
Portland, OR 97214
PHN: (503) 234-0548
FAX: (503) 234-0677
WWW.MFIA-ENG.COM

SHEET
M2.5
5 OF 11



GENERAL NOTES:

- REMOVE ALL PNEUMATIC CONTROL DEVICES/PANELS INCLUDING CABINETS, TUBING, COMPRESSORS & SENSORS NO LONGER USED. TUBING ABOVE HARD CEILINGS (ONLY RELAY) TO BE ABANDON IN PLACE
- FOR ALL CONTROL CABINETS. REMOVE ALL DEVICES THAT ARE NO LONGER BEING USED.
- EACH AIR HANDLER SHALL BE BALANCED. TOTAL AIRFLOW AND OUTSIDE AIRFLOW RATES SHALL BE RECORDED. REQUIRED RATES WILL BE PROVIDED BY THE ENGINEER DURING CONSTRUCTION. SEE SPECIFICATIONS FOR DETAILS RELATED BALANCING SERVICES. BALANCING OF INDIVIDUAL DIFFUSERS OR GRILLES IS NOT REQUIRED. RECORDING OF AIRFLOW PER ZONE FOR MULTI-ZONE UNITS IN BOTH FULL HEAT AND COOL MODE IS REQUIRED.

1 M2.6 BALCONY MECHANICAL PLAN
SCALE: 3/32" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER
OREGON
17884
JULY 25, 1980
SCOTT W. MILLER
EXPIRES: 31DEC16

Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
Chkd By: SWM
DSGN By: SWM
Acad File:

PORTLAND'5 CENTERS FOR THE ARTS
ARLENE SCHNITZER
1037 SOUTHWEST BROADWAY

BALCONY MECHANICAL PLAN

MFIA INC.

Consulting Engineers
2007 S.E. Ash St.
Portland, OR 97214
PHN: (503) 234-0548
FAX: (503) 234-0677
WWW.MFIA-ENG.COM

SHEET
M2.6
6 OF 12

GENERAL NOTES:

- REMOVE ALL PNEUMATIC CONTROL DEVICES/PANELS INCLUDING CABINETS, TUBING, COMPRESSORS & SENSORS NO LONGER USED. TUBING ABOVE HARD CEILINGS (ONLY RELAY) TO BE ABANDON IN PLACE.
- FOR ALL CONTROL CABINETS. REMOVE ALL DEVICES THAT ARE NO LONGER BEING USED.
- EACH AIR HANDLER SHALL BE BALANCED. TOTAL AIRFLOW AND OUTSIDE AIRFLOW RATES SHALL BE RECORDED. REQUIRED RATES WILL BE PROVIDED BY THE ENGINEER DURING CONSTRUCTION. SEE SPECIFICATIONS FOR DETAILS RELATED BALANCING SERVICES. BALANCING OF INDIVIDUAL DIFFUSERS OR GRILLES IS NOT REQUIRED. RECORDING OF AIRFLOW PER ZONE FOR MULTI-ZONE UNITS IN BOTH FULL HEAT AND COOL MODE IS REQUIRED.

1 M2.7 PROJECTION LEVEL MECHANICAL PLAN
SCALE: 3/32" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER
OREGON
17884
JULY 25, 1980
SCOTT W. MILLER
EXPIRES: 31DEC16

Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
Chkd By: SWM
DSGN By: SWM
Acad File:

PORTLAND'5 CENTERS FOR THE ARTS
ARLENE SCHNITZER
1037 SOUTHWEST BROADWAY

PROJECTION LEVEL MECHANICAL PLAN

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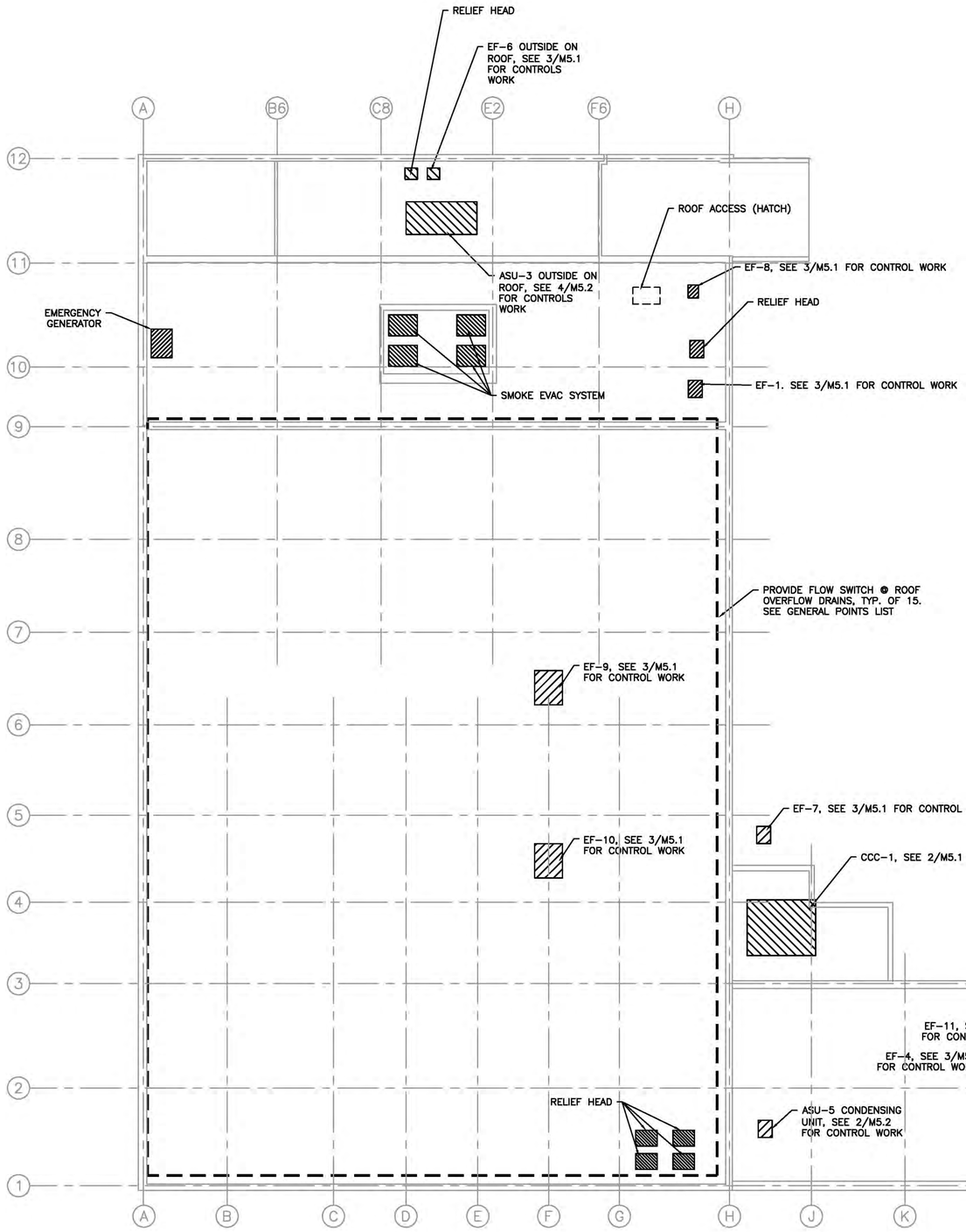

GENERAL NOTES:

- REMOVE ALL PNEUMATIC CONTROL DEVICES/PANELS INCLUDING CABINETS, TUBING, COMPRESSORS & SENSORS NO LONGER USED. TUBING ABOVE HARD CEILINGS (ONLY RELAY) TO BE ABANDON IN PLACE
- FOR ALL CONTROL CABINETS. REMOVE ALL DEVICES THAT ARE NO LONGER BEING USED.
- EACH AIR HANDLER SHALL BE BALANCED. TOTAL AIRFLOW AND OUTSIDE AIRFLOW RATES SHALL BE RECORDED. REQUIRED RATES WILL BE PROVIDED BY THE ENGINEER DURING CONSTRUCTION. SEE SPECIFICATIONS FOR DETAILS RELATED BALANCING SERVICES. BALANCING OF INDIVIDUAL DIFFUSERS OR GRILLES IS NOT REQUIRED. RECORDING OF AIRFLOW PER ZONE FOR MULTI-ZONE UNITS IN BOTH FULL HEAT AND COOL MODE IS REQUIRED.

1 M2.8 MECHANICAL ROOF PLAN
SCALE: 3/32" = 1'-0"

REGISTERED PROFESSIONAL ENGINEER 17884 OREGON JULY 25, 1980 SCOTT W. MILLER
EXPIRES: 31DEC16

Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
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Acad File:

PORTLAND'S CENTERS FOR THE ARTS
ARLENE SCHNITZER
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MECHANICAL ROOF PLAN

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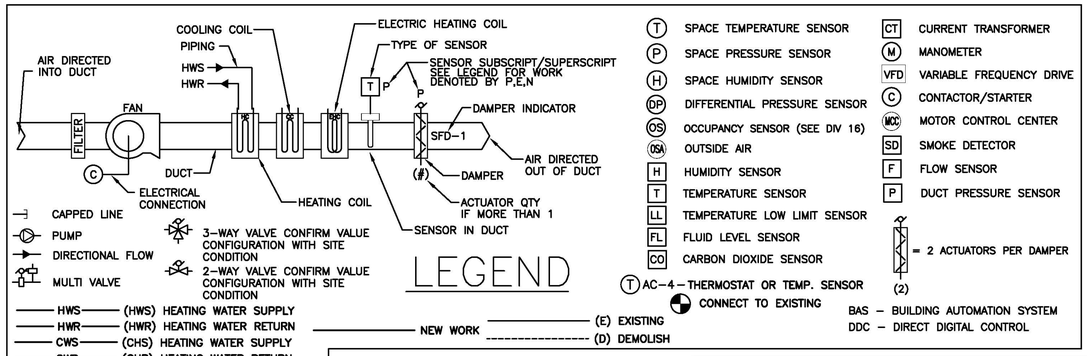


EQUIPMENT ABBREVIATIONS :

P – PUMP
SP – SUMP PUMP
BP – BOOSTER PUMP
HWP – HEATING WATER PUMP
CHP – CHILLED WATER PUMP
CWP – CONDENSING WATER PUMP
CSP – COOLING TOWER SUMP PUMP
HWRP – DOMESTIC HOT WATER RECIRCULATION
VFD – VARIABLE FREQUENCY DRIVE
CT – CONTACTOR
CC – CONTROL COMPRESSOR
CH – CHILLER
B – BOILER
EF – EXHAUST FAN
RF – RETURN/RELIEF FAN
AH – AIR HANDLER
VAV – VARIABLE AIR VOLUME DAMPER BOX
AD – AREA DAMPER
SD – SMOKE DAMPER
SFD – FIRE SMOKE COMBO DAMPER
H – HUMIDIFIER
V – VALVE
WH – WATER HEATER
BAS – BUILDING AUTOMATION SYSTEM
CW – COLD WATER
MZU – MULTI ZONE UNIT
CEU – CABINET EXH. UNIT
HVU – HEATING VENTILATION UNIT
CFU – CEILING FAN UNIT
REU – ROOF EXH. UNIT
HC – HEATING COIL
ST – STEAM
CD – CONDENSATE RETURN
HWS – HEATING WATER SUPPLY
HWR – HEATING WATER RETURN

PLUMBING ABBREVIATIONS:

HWS – HEATING WATER SUPPLY
HWR – HEATING WATER RETURN
HW – DOMESTIC HOT WATER
CW – DOMESTIC COLD WATER
GPM – GALLONS PER MINUTE
DB – DOUBLE VALVE OPERATOR

AIR FLOW ABBREVIATIONS

OSA – OUTSIDE AIR
RA – RETURN AIR
SA – SUPPLY AIR
EXH – EXHAUSTED AIR

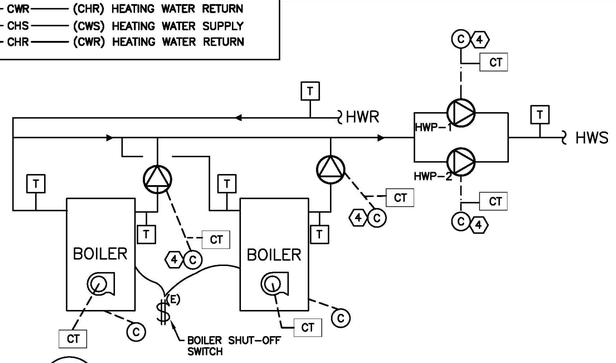
CONTROL SUBSCRIPTS AND SUPERSCRIPTS:

P – UNDER BASE BID: REMOVE (E) PNEUMATIC TYPE CONTROL DEVICE & REPLACE WITH DIGITAL CONTROL DEVICE. FOR ACTUATORS (VALVE OR DAMPER) PROVIDE E-TO-P & RETAIN PNEUMATIC DEVICE. PATCH CABINET/DUCT, CAP PIPE, ETC. IF NEW DEVICE CONNECTION POINT DIFFERS FROM (E). AT CONTRACTOR OPTION LOW LIMIT SENSORS OR LIKE DEVICES W/ CONTACT OPERATION FOR DIGITAL SIGNAL MAY BE RETAINED IF TESTED AND COMMISSIONED.

P – UNDER ALTERNATE #1: REMOVE (E) PNEUMATIC TYPE CONTROL DEVICE & REPLACE WITH DIGITAL CONTROL DEVICE. PATCH CABINET/DUCT, CAP PIPE, ETC. IF NEW DEVICE CONNECTION POINT DIFFERS FROM (E). AT CONTRACTOR OPTION LOW LIMIT SENSORS OR LIKE DEVICES W/ CONTACT OPERATION FOR DIGITAL SIGNAL MAY BE RETAINED IF TESTED AND COMMISSIONED.

CONTROL SUBSCRIPTS AND SUPERSCRIPTS:

E – ELECTRIC/ELECTRONIC CONTROL DEVICE MAYBE RE-USED AT CONTRACTOR'S OPTION. OR REPLACE WITH DIGITAL CONTROL SYSTEM COMPATIBLE DEVICE, UNLESS NOTED OTHERWISE.
N – NEW, IF DEVICE HAS NO SUPER SCRIPT DEVICE IS NEW
D – DEMO DEVICE AND PATCH DUCT



1 M5.1 BOILER CONTROL DIAGRAM
SCALE: SCHEMATIC

KEYED NOTES: (#)

1. (E) SMOKE DETECTOR TO REMAIN. PROVIDE CONNECTION TO DEVICE & TIE TO DDC FOR FAN SHUT-DOWN OPERATION AS REQ'D.
2. RE-CONFIGURE PIPING AS REQ'D FOR NEW BALL STYLE CONTROL VALVE TO REPLACE (E) GLOBE STYLE CONTROL VALVE. VALVE SIZE IS LISTED WHERE KNOWN. VALVE CONFIGURATION (2-WAY/3-WAY) IS SHOWN WHERE KNOWN. CONFIRM SIZE, PIPING & TYPE ON SITE PRIOR TO SUBMITTAL. SEE 2/M5.3.
3. REMOVE DEVICE & PATCH CABINET.
4. MODIFY (E) STARTER/CONTACTOR TO OPERATE FROM DIGITAL SIGNAL. EXISTING CONTROL FROM FIRE FIGHTERS CONTROL PANEL SHALL REMAIN AS PER EXISTING OPERATION.

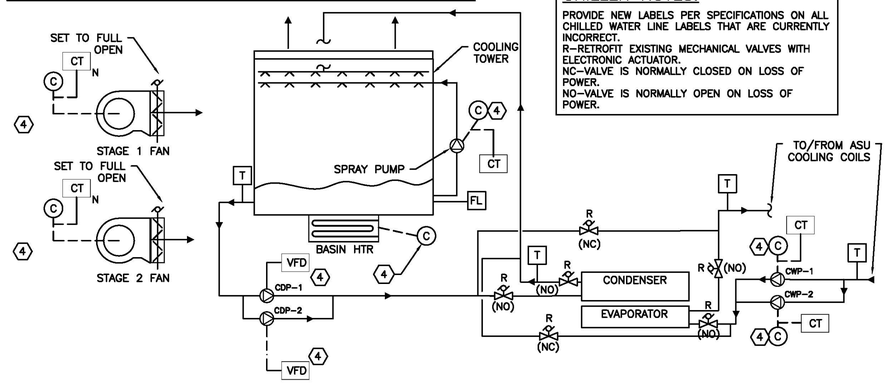
GENERAL NOTES:

ALL ZONES & DAMPER SIZES SHALL BE VERIFIED ON SITE PRIOR TO CONTROL SUBMITTAL

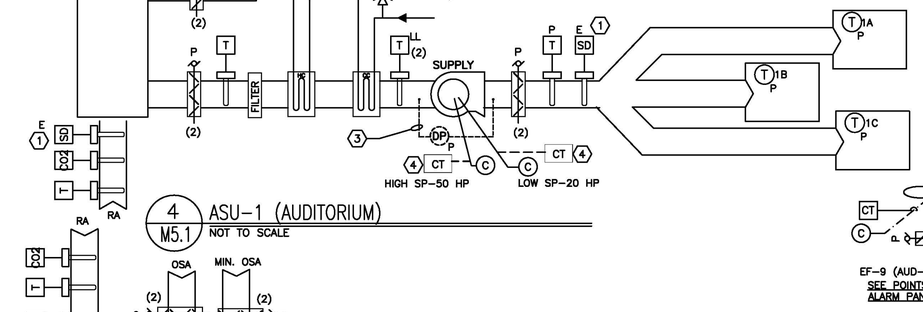
PROVIDE INSULATION ON ALL CHILLED LINES AT EACH SYSTEM THAT ARE MISSING. REPLACE EXISTING DAMAGED INSULATION. SEE SPECS FOR FURTHER INFORMATION

CHILLER NOTES:

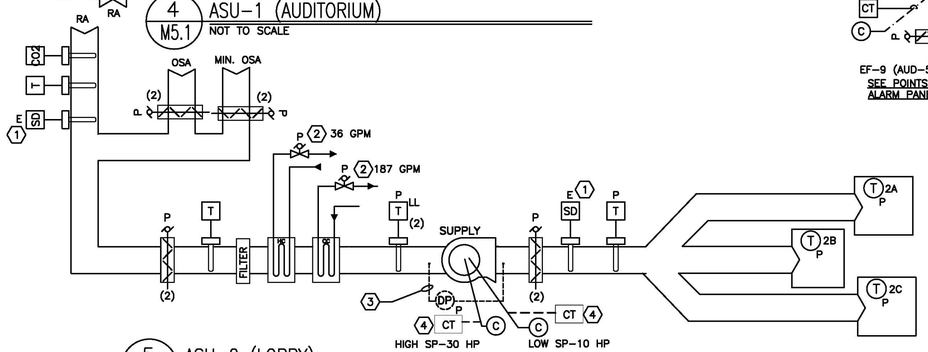
PROVIDE NEW LABELS PER SPECIFICATIONS ON ALL CHILLED WATER LINE LABELS THAT ARE CURRENTLY INCORRECT.
R-RETROFIT EXISTING MECHANICAL VALVES WITH ELECTRONIC ACTUATOR.
NC-VALVE IS NORMALLY CLOSED ON LOSS OF POWER.
NO-VALVE IS NORMALLY OPEN ON LOSS OF POWER.



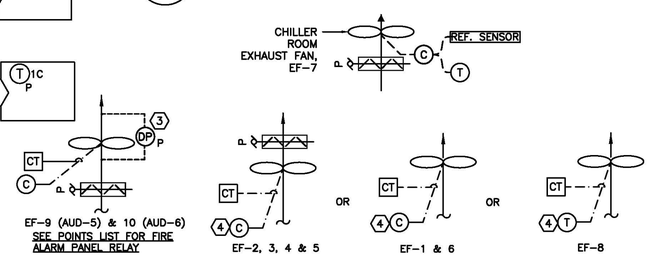
2 M5.1 CHILLER CONTROL DIAGRAM
SCHEMATIC



4 M5.1 ASU-1 (AUDITORIUM)
NOT TO SCALE

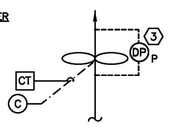


5 M5.1 ASU-2 (LOBBY)
NOT TO SCALE



FAN: LOCATION – SERVICE – ASSOC. AIR HANDLER

EF-1: MECH. 713 – DRSG TOWER – ASU-4
EF-2: MECH 709 – LOBBY TOILETS – ASU-2
EF-3: MECH 709 – PROJECTOR EXH – ASU-5
EF-4: ROOF – GRAND LOBBY – ASU-2
EF-5: MECH 709 – AUDITORIUM – ASU-1
EF-6: ROOF – STUIDIO TOILETS – ASU-3
EF-7: ROOF – CHILLER ROOM
EF-8: ROOF/MECH 714 – ELEV MACHINE RM
EF-9: ROOF – SMOKE EVAC.
EF-10: ROOF – SMOKE EVAC
EF-11: ROOF – SMOKE EVAC



SEE POINTS LIST FOR FIRE ALARM PANEL RELAY

3 M5.1 EXHAUST FANS
SCALE: DETAIL

CONTROLS FOR EXHAUST FANS, SEE 3/M5.1

POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
FAN MOTOR STATUS (CURRENT SENSOR) TYP ALL	X				X
START/STOP TYP OF ALL			X		
SPACE TEMP (TYP OF 2)		X			
REFRIGERANT SENSOR			X		
FIRE ALARM PANEL RELAY (#9/10/11 ONLY)			X		

CONTROLS FOR BOILER, SEE 1/M5.1

POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
BOILER ENABLE (TYP. 2)			X		
BOILER STATUS (TYP. 2)	X				X
PUMP START/STOP (TYP OF 4)			X		
PUMP STATUS (TYP OF 4)		X			X
RESET SIGNAL (FUTURE)				X	
SYSTEM INLET WATER TEMPERATURE		X			
SYSTEM OUTLET WATER TEMPERATURE		X			
BOILER INLET WATER TEMPERATURE (TYP OF 2)		X			
BOILER OUTLET WATER TEMPERATURE (TYP OF 2)		X			
BOILER SHUT-OFF SWITCH	X				X

CONTROLS FOR CHILLER SEE 2/M5.1

POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
CHILLER ENABLE/DISABLE			X		
FAN START/STOP (TYP. OF 2)			X		
FAN STATUS (TYP. OF 2)	X				X
OUTSIDE AIR TEMP		X			
CHILLER RESET SIGNAL		X			
CONDENSING WATER PUMP VFD START/STOP (TYP. 2)			X		
CONDENSING WATER PUMP VFD STATUS (TYP. 2)	X				X
CONDENSING WATER PUMP VFD SPEED (TYP. 2)	X			X	
CHILLED WATER PUMP START/STOP (TYP. OF 2)			X		
CHILLED WATER PUMP STATUS (TYP. OF 2)	X				X
DISCHARGED AIR DAMPER POSITION			X		
CHILLER ALARM		X			X
BASIN HEATER			X		
SPRAY PUMP			X		
CHILLED SUPPLY WATER TEMPERATURE		X			
CHILLED RETURN WATER TEMPERATURE		X			
CONDENSER SUPPLY WATER TEMPERATURE		X			
CONDENSER RETURN WATER TEMPERATURE		X			
BASIN LOW WATER SWITCH	X				X
MECH/WATER SIDE CLG SWITCHOVER VALVES (TYP. OF 6)			X		
REFRIGERATION ALARM	X				X

CONTROLS FOR ASU-1, SEE 4/M5.1

POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SUPPLY FAN STATUS (TYP. 2)	X				X
SUPPLY FAN S/S (TYP. 2)			X		
HEATING WATER VALVE				X	
CHILLED WATER VALVE				X	
SMOKE DETECTOR (TYP. 2)	X				X
LOW LIMIT (TYP. 2)	X				X
SPACE TEMP (TYP. 3)		X			
OUTSIDE AIR DAMPER (TYP. 2)				X	
MINIMUM OUTSIDE AIR DAMPER (TYP. 2)				X	
MIXED AIR DAMPER (TYP. 2)				X	
ISOLATION DAMPER (TYP. 4)				X	
DISCHARGE TEMP		X			
MIXED AIR TEMP		X			
RA TEMP		X			
RA CO2 LEVEL		X			X

CONTROLS FOR ASU-2, SEE 5/M5.1

POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SUPPLY FAN STATUS (TYP. 2)	X				X
SUPPLY FAN S/S (TYP. 2)			X		
HEATING WATER VALVE				X	
CHILLED WATER VALVE				X	
SMOKE DETECTOR (TYP. 2)	X				X
LOW LIMIT (TYP. 2)	X				X
SPACE TEMP (TYP. 3)		X			
OUTSIDE AIR DAMPER (TYP. 2)				X	
MINIMUM OUTSIDE AIR DAMPER (TYP. 2)				X	
MIXED AIR DAMPER (TYP. 2)				X	
ISOLATION DAMPER (TYP. 4)				X	
DISCHARGE TEMP		X			
MIXED AIR TEMP		X			
RA TEMP		X			
RA CO2 LEVEL		X			X

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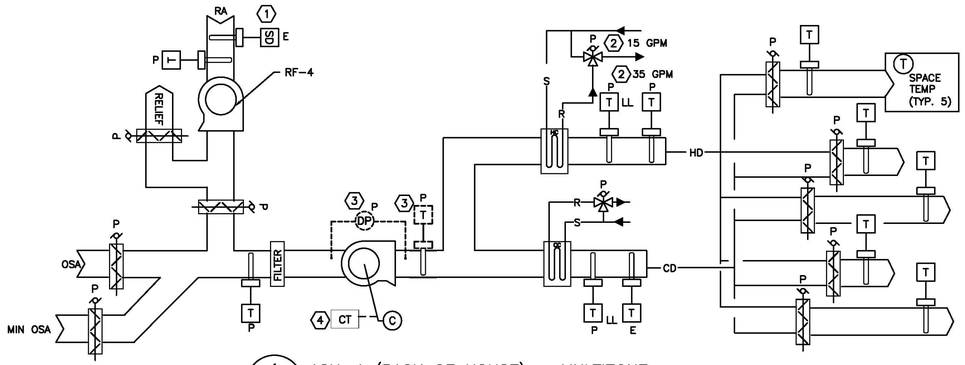
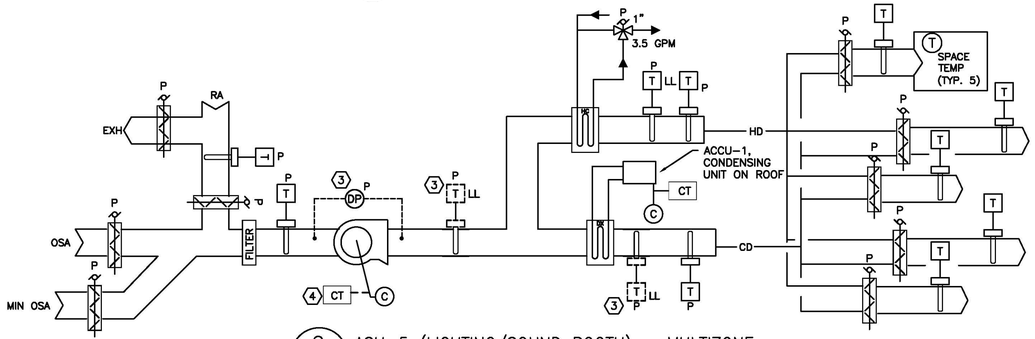
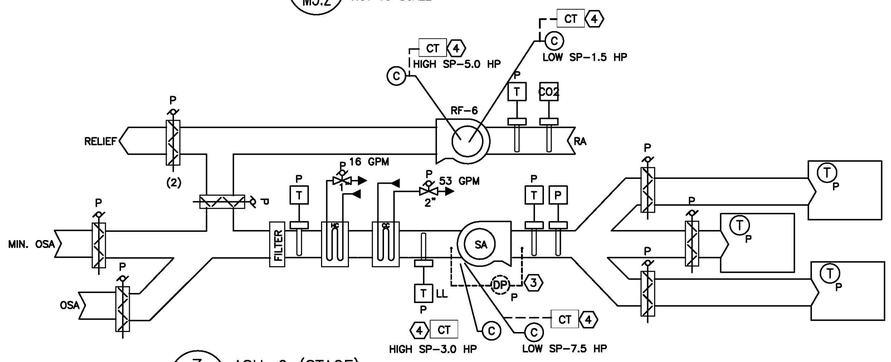


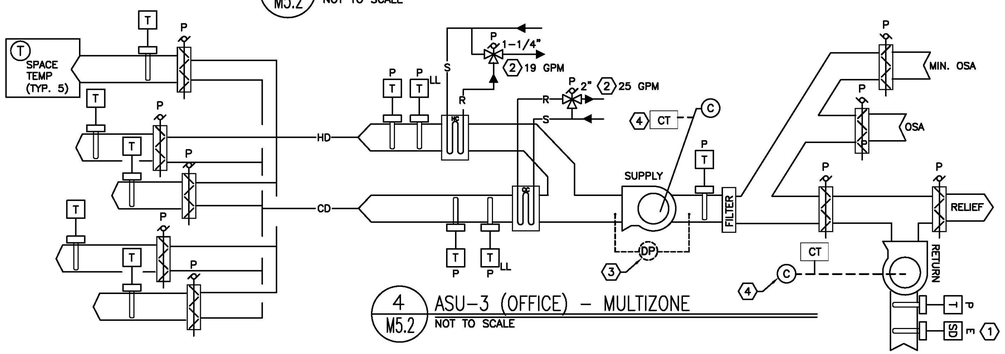
1 M5.2 ASU-4 (BACK OF HOUSE) – MULTIZONE
NOT TO SCALE



2 M5.2 ASU-5 (LIGHTING/SOUND BOOTH) – MULTIZONE
NOT TO SCALE



3 M5.2 ASU-6 (STAGE)
NOT TO SCALE



4 M5.2 ASU-3 (OFFICE) – MULTIZONE
NOT TO SCALE

GENERAL CONTROLS					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
OUTSIDE AIR TEMP		X			
OUTSIDE AIR HUMIDITY		X			

CONTROLS FOR ASU-4, SEE1/M5.2					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SUPPLY FAN STATUS	X				X
SUPPLY FAN S/S			X		
RETURN FAN STATUS	X				X
RETURN FAN S/S			X		
OUTSIDE AIR DAMPER (TYP. 2)				X	
MIXED AIR DAMPER				X	
RELIEF AIR DAMPER				X	
ZONE DAMPER (TYP. 5)				X	
ZONE DISCHARGE DAMPER (TYP. 5)				X	
RETURN AIR TEMP		X			
MIXED AIR TEMP		X			
COLD DECK TEMP		X			
HOT DECK TEMP		X			
HEATING WATER VALVE				X	
CHILLED WATER VALVE				X	
LOW LIMIT (TYP. 2)	X				X
ZONE DISCHARGE TEMP (TYP. 5)		X			

CONTROLS FOR ASU-5, SEE 2/M5.2					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SUPPLY FAN STATUS	X				X
SUPPLY FAN S/S			X		
MIXED AIR DAMPER				X	
OUTSIDE AIR DAMPER (TYP. 2)				X	
RELIEF AIR DAMPER				X	
MIXED AIR TEMP		X			
HOT DECK TEMP		X			
COLD DECK TEMP		X			
RETURN AIR TEMP		X			
SPACE TEMP (TYP OF 5)		X			
LOW LIMIT	X				X
COND. UNIT S/S			X		
HEATING WATER VALVE				X	
COND. UNIT STAT	X				X
ZONE DISCHARGE TEMP (TYP. 5)		X			
ZONE DAMPER (TYP. 5)				X	

CONTROLS FOR ASU-6, SEE 3/M5.2					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SUPPLY FAN STATUS (TYP. 2)	X				X
SUPPLY FAN S/S (TYP. 2)			X		
RETURN FAN STATUS (TYP. 2)	X				X
RETURN FAN S/S (TYP. 2)			X		
LOW LIMIT	X				X
MIXED AIR DAMPER				X	
OUTSIDE AIR DAMPER (TYP. 2)				X	
RELIEF AIR DAMPER (TYP. 2)				X	
MIXED AIR TEMP		X			
DISCHARGE TEMP		X			
RETURN AIR TEMP		X			
SPACE TEMP (TYP OF 3)		X			
COOLING WATER VALVE				X	
HEATING WATER VALVE				X	
ZONE DAMPER (TYP. 3)				X	
DUCT PRESSURE HIGH LIMIT SWITCH	X				X
RA CO2 LEVEL		X			X

CONTROLS FOR ASU-3, SEE 4/M5.2					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SUPPLY FAN STATUS	X				X
SUPPLY FAN S/S			X		
RETURN FAN STATUS	X				X
RETURN FAN S/S			X		
OUTSIDE AIR DAMPER (TYP. 2)				X	
MIXED AIR DAMPER				X	
RELIEF AIR DAMPER				X	
ZONE DAMPER (TYP. 5)				X	
ZONE DISCHARGE DAMPER (TYP. 5)				X	
RETURN AIR TEMP		X			
MIXED AIR TEMP		X			
COLD DECK TEMP		X			
HOT DECK TEMP		X			
HEATING WATER VALVE				X	
CHILLED WATER VALVE				X	
LOW LIMIT (TYP. 2)	X				X

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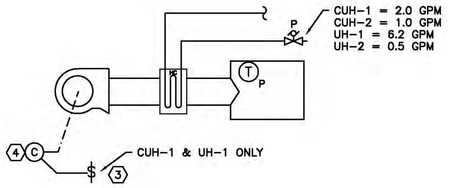
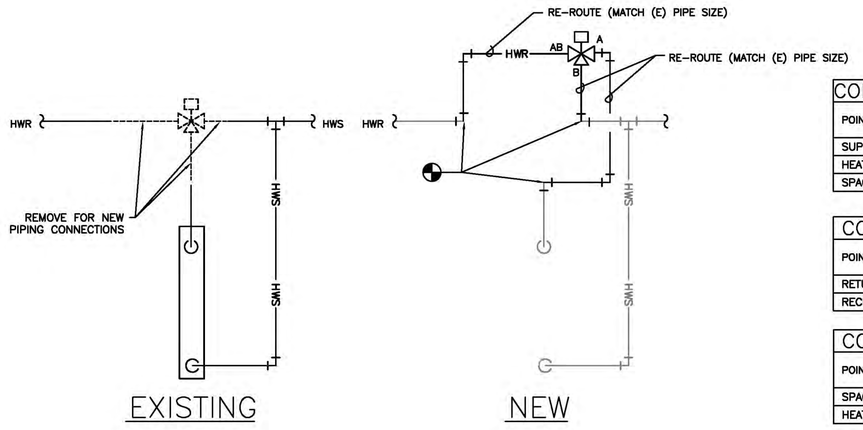


CUH-1 – SCENE STORAGE 116 (SEE FLOOR PLAN FOR REMOVAL OF WALL SWITCH)
CUH-2 – SCENE STORAGE 116
UH-1 – SCENE STORAGE 116 (SEE FLOOR PLAN FOR REMOVAL OF WALL SWITCH)
UH-2 – CHILLER ROOM

1 / M5.3 CUH-1, 2 & UH-1, 2
NOT TO SCALE



2 / M5.3 HEATING VALVE RE-PIPE DETAIL
SCALE: DETAIL

CONTROLS FOR CUH-1/2 & UH-1/2, SEE 1/M5.3					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SUPPLY FAN STATUS	X				X
HEATING VALVE				X	
SPACE TEMP		X			

CONTROLS FOR DOM. HOT WATER, SEE 3/M5.3					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
RETURN WATER TEMP		X			
RECIRC PUMP S/S			X		

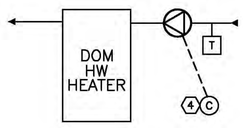
CONTROLS FOR CONVECTOR, SEE 4/M5.3					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SPACE TEMP		X			
HEATING WATER VALVE				X	

CONTROLS FOR DRAIN OVERFLOW, SEE 5/M5.3					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
DRAIN OVERFLOW STATUS (TYP. OF 15)*	X				X

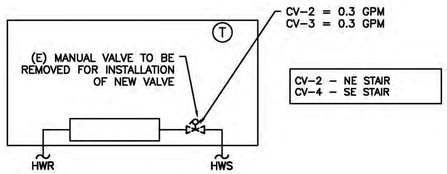
*SENSORS MAY BE WIRED IN PARALLEL IN 6 GROUPS TO MATCH (E) CONTROLS

CONTROLS FOR BOOSTER COILS, SEE 6/M5.3					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SPACE TEMP		X			
HEATING WATER VALVE				X	

CONTROLS FOR ELEV. SUMP PIT, SEE 7/M5.3					
POINT DESCRIPTION	INPUT		OUTPUT		ALARM
	DIGITAL	ANALOG	DIGITAL	ANALOG	
SUMP PIT OVERFLOW STATUS (TYP. OF 2)	X				X

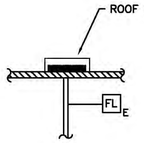


3 / M5.3 DOMESTIC HOT WATER
NOT TO SCALE



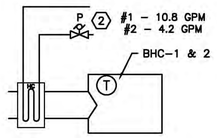
CV-2 – NE STAIR
CV-4 – SE STAIR

4 / M5.3 CONVECTOR – CV-2 & 3
NOT TO SCALE

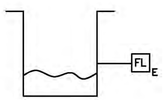


ROOF OVERFLOW DRAINS:
1. Studio Roof Zone (4 Switches)
2. Stage Roof Zone (2 Switches)
3. Auditorium Roof Zone (4 Switches)
4. West Canopy Roof Zone (1 Switch)
5. Grand Lobby & East Canopy Roof Zone (3 Switches
6. Upper Tunnel Roof Zone (1 Switch)

5 / M5.3 ROOF DRAIN OVERFLOW MONITORING
NOT TO SCALE



6 / M5.3 BOOSTER HEATING COIL (BHC-1 & 2)
NOT TO SCALE



7 / M5.3 ELEVATOR SUMP PIT MONITORING
NOT TO SCALE

REGISTERED PROFESSIONAL ENGINEER
OREGON
17884
JULY 25, 1995
J. SCOTT W. MILLER
EXPIRES: 31DEC16

Date: 2.27.15
Proj No: 8468
Drawn By: ARJ
Chkd By: SWM
DSGN By: SWM
Acad File:

PORTLAND'5 CENTERS FOR THE ARTS
ARLENE SCHNITZER
1037 SOUTHWEST BROADWAY

MECHANICAL CONTROLS

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SHEET
M5.3
11 OF 11

Portland'5 Centers for the Arts
HVAC Control Upgrades
Bid Documents

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3/2/15

EXP. 12/31/16

SECTION 23 05 00
HVAC MATERIALS AND METHODS

PART 1 GENERAL

1.01 DESCRIPTION

A. The provisions of the General Conditions 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. Complete control system for HVAC all systems.

E. Advise subcontractor, suppliers, and vendors involved in the work specified in this Section of the applicable requirements.

1.02 QUALITY ASSURANCE

A. All work and materials shall conform to all applicable local and state codes and all federal, state and other applicable laws and regulations. All clarifications and modifications which have been cleared with appropriate authorities are listed under the applicable sections. All electrical products shall bear the label of a recognized testing laboratory such as UL or CSA.

B. Whenever the requirements of the Specifications or Drawings exceed those of the applicable code or standard, the requirements of the Specifications and Drawings shall govern.

C. Codes and Standards: Comply with the provisions of the following referenced codes, standards and specifications:

1. Federal Specifications (FS)
2. American National Standards Institute (ANSI)
3. National Electrical Manufacturer's Association (NEMA)
4. National Fire Protection Association (NFPA)
5. Underwriters Laboratories, Inc. (UL)
6. Factory Mutual (FM)
7. International Building Code (IBC) with State and Local Amendments
8. International Mechanical Code (IMC) with State and Local Amendments
9. Uniform Plumbing Code (UPC) with State and Local Amendments
10. American Society for Testing and Materials (ASTM)
11. Americans with Disabilities Act (ADA)
12. International Fire Code (IFC) with State and Local Amendments
13. Energy Policy Act (EPAct)
14. Manufacturers Standardization Society (MSS)
15. American Gas Association (AGA)

D. Each piece of equipment furnished shall meet all detailed requirements of the Drawings and Specifications and shall be suitable for the installation shown. Equipment not meeting all requirements will not be acceptable, even though specified by name. Where two or more units of the same class of equipment are furnished, use product of the same manufacturer; component parts of the entire system need not be products of same manufacturer. Furnish all materials and equipment, new and free from

defect and of size, make, type and quality herein specified or approved by the Project Manager. All materials shall be installed in a neat and professional manner.

E. All apparatus shall be built and installed to deliver its full rated capacity at the efficiency for which it was designed.

F. The Drawings and Specifications are complementary. What is called for by one shall be as though called for by both.

G. Drawings: Do not scale drawings for roughing-in measurements, nor use as shop drawings. Make field measurements and prepare shop drawings. Coordinate work with shop drawings of other specification divisions.

H. 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. Provide all necessary field wiring and devices from the point of connection as required. All equipment shall be installed in compliance with the Electrical Code and the equipment's UL listing. Bring to the attention of the Project Manager in writing, all conflicts, incompatibilities, and/or discrepancies prior to bid or as soon as discovered.

1.03 WORK OF OTHER CONTRACTS

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

1.04 WORK OF OTHER DIVISIONS

A. Work under this Division shall be conducted in a manner to cooperate with the installation of such equipment or items as specified in other Divisions.

B. 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.

C. All sections of Division 23 are interrelated and shall be considered in their entirety when interpreting any material, method, or direction listed in any section of Division 23. Individual sections are not written for specific subcontractors or suppliers but for the general Contractor.

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

A. Submit per direction from Project Manager and in accordance with General Conditions 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 Project Manager's attention in writing at the time of transmittal of the data.

H. Unless otherwise directed by General Conditions, submittal data shall be in a 3-ring plastic binder with a clear plastic sleeve and a project identification sheet inserted. Arrange submittals numerically with specification sections identified on divider tabs. All required sections shall be submitted at one time.

1.06 PRODUCT SUBSTITUTION

A. Materials other than those specified may be approved for this project providing a written request is submitted to the Project Manager 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 Project Manager, the material is not complete or if it is not an acceptable substitute, he may reject it. The Project Manager's evaluation will be based solely on the material submitted.

1.07 CHANGE ORDERS

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

1.08 RECORD DOCUMENTS

A. Project Record (As-Installed) Drawings:

1. Maintain a set of record drawings on the job site as directed in General Conditions.
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 Project Manager 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 Project Manager. 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 five (5) sets of 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, and any

additional equipment added by change order, bound in three-ring, vinyl or canvas covered, loose-leaf binders organized with index and thumb-tab markers for each classification of equipment or data. Comply with provisions of General Conditions where applicable to the mechanical work.

1.09 WARRANTY

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

B. Where the manufacturer's guarantee exceeds one year, the longer guarantee shall govern and include the Contractor's labor.

C. Extend warranty period to begin once all phases of construction are complete.

PART 2 PRODUCTS

2.01 GENERAL

A. General: Provide all new materials and equipment, identical to apparatus or equipment in successful operation for a minimum of two years. Provide materials of comparable quality omitted here but necessary to complete the work. Maximum allowable variation from stated capacities, minus 5% to plus 10% as approved in each case.

B. Compatibility: Provide products which are compatible with other portions of the work and provide products with the proper or correct power and fuel-burning characteristics, and similar adaptations for the project.

C. Storage and Handling:

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

2.02 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. Nameplates:

1. Engraved nameplates, 1/16" thick, laminated 2-ply plastic, bottom ply white, outer ply black, letters formed by exposing bottom ply.
2. Size: 2" by 4" nameplates with 1/4" high letters.

PART 3 EXECUTION

3.01 LAYOUT AND COORDINATION

A. Site Examination: Before starting work, carefully examine site and all Contract Drawings. Become thoroughly familiar with conditions governing work on this project. Verify all indicated elevations, building measurements, roughing-in dimensions and equipment locations before proceeding with any of the work.

B. 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. 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.

C. Discrepancies: Report immediately any error, conflict or discrepancy in Plans, Specifications and/or existing conditions. Do not proceed with any questionable items of work until clarification of same has been made. Should rearrangement or re-routing of piping be necessary, provide for approval the simplest layout possible for that particular portion of the work.

3.02 CONTINUITY OF EXISTING SERVICES

A. Existing water, power, heat, ventilation, air conditioning and other services shall remain in service during new construction work. Coordinate any interruption of these services with the Project Manager a minimum of seven days in advance. Arrange work to minimize number and extent of all interruptions.

B. Protect from damage active utilities existing and evident by reasonable inspection of the site whether shown or not on the Drawings. Protect, relocate or abandon utilities encountered in the work which are not shown on the Drawings or evident by inspection of the work as directed by the Project Manager**.** Maintain continuity of all utility services to existing buildings.

C. All necessary service interruptions of utilities shall be scheduled with the Owner. Minor interruptions will require a minimum of forty-eight (48) hours prior notification. Major shut down of any air handler system is to be scheduled a minimum of seven (7) days prior notice. **Requesting down time may not be grated at the requested time.** However the requested downtime will be grated within a 2 week window of the requested time. The Owner has contractual obligations that cannot be changed but will be as accommodating as possible.

D. The contractor shall establish the building control network **first** prior to any equipment being converted or taken off line. The intention is that once the system is taken off line for modification of control it shall be back on line **and** viewable / operational from the new control system. **Maximum down time between taking the unit off line and having it controllable from the BAS is 72 hours.**

3.03 EQUIPMENT REMOVAL

A. All removed mechanical equipment is the property of the Contractor unless indicated otherwise. Disconnect and remove all such equipment from the project property. Cap all piping in walls, below floors, and/or above ceilings in finished rooms.

B. Disable electrical circuits by disconnection of both ends and make safe with wire nuts or other approved methods. Remove wire and conduit to concealed locations.

C. Reused Equipment: Reconnect piping, wiring and/or controls to restore original equipment functions unless indicated otherwise.

3.04 MECHANICAL EQUIPMENT WIRING

A. Provide all mechanical equipment motors, and similar devices required, with wiring complete from power source.

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.

3.05 GENERAL INSTALLATION

A. Locating and Positioning Equipment: Observe all Codes, Regulations and good common practice in locating and installing mechanical equipment and material so that completed installation presents the least possible hazard. Maintain adequate clearances for repair and service to all equipment and comply with Code requirements.

B. Arrangement: Arrange piping parallel with primary lines of the building construction, and with a minimum of 7' overhead clearance in all areas where possible. Unless indicated otherwise, conceal all piping. Locate operating and control equipment properly to provide easy access, and arrange entire mechanical work with adequate access for operation and maintenance. Give right-of-way to piping which must slope for drainage. Set all equipment level or as recommended by manufacturer. Under no conditions shall beams, girders, footings or columns be cut for mechanical items. Casting of pipes into concrete is prohibited unless so shown on Drawings.

C. Adjusting: Adjust and calibrate all new mechanical equipment.

3.06 VALVE INSTALLATION

A. Insulated Valves: Install extended-stem valves in all piping specified as insulated, and arrange in the proper manner to receive insulation.

B. Valve Access: Provide access panels to all valves installed behind walls, in furring or otherwise inaccessible.

3.07 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.

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."

3.08 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.

3.09 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 project Manager, due to the pipe cutting/threading operation shall be repaired by the responsible trade.

3.10 CUTTING AND PATCHING

A. General: Comply with the requirements of General Conditions 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.

B. Precautions:

1. In the event insulated piping or equipment and/or sprayed or trowelled-on fireproofing, sprayed acoustical material, and similar materials are uncovered during the cutting, patching or demolition operation, notify the Project Manager immediately to investigate the possibility that it is asbestos-laden material. Do not damage or attempt to remove any material suspected of containing asbestos.
2. Do not proceed with the Work in such areas until so instructed by the Project Manager**.**

3.11 HVAC WORK CLOSEOUT

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

B. Record Drawings: Submit record set of drawings required in General Conditions as previously specified in this Section.

C. Closeout Equipment/Systems Operations: Sequence operations properly so that work of project will not be damaged or endangered. Coordinate with seasonal requirements. Operate each item of equipment and each system in a test run of appropriate duration with the Project Manager (or personnel designated by the Project Manager) present, and with the Owner's operating personnel present, to demonstrate sustained, satisfactory performance. Adjust and correct operations as required for proper performance. Clean and lubricate each system and replace dirty filters, excessively worn parts and similar expendable items of the work.

D. Operating Instructions: Conduct a walk-through instruction seminar for the Owner's personnel who are to be involved in the continued operation and maintenance of the HVAC equipment and systems. Provide written instructions outlining and explaining the identification system, operational diagrams, emergency and alarm provisions, sequencing requirements, seasonal provisions, security, safety, efficiency and similar features of the systems.

END OF SECTION

SECTION 23 05 90
TESTING, ADJUSTING AND BALANCING

PART 1 GENERAL

1.01 DESCRIPTION

A. Work Included: After completion of the work of installation, test and regulate all components of the new heating, air conditioning and ventilating systems to verify air volumes and heating-cooling flow rates indicated on the Drawings.

B. 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 Project Manager. 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.

D. Cost of sheave changes shall be reimbursed by the Owner at cost, plus installation labor as a change order.

1.02 QUALITY ASSURANCE

A. Balancing of the Heating and Air Conditioning Systems: Agency shall be a current member of NEBB or AABC specializing in the adjusting and balancing of systems specified with a minimum of 10 years documented experience.

B. Testing, adjusting, and balancing shall be performed under direct field supervision of a Certified NEBB Supervisor or a Certified AABC Supervisor.

1.03 SUBMITTALS

A. 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. CO2 controller set points – minimum CO2 setpoint (ppm), maximum CO2 setpoint (ppm)(setting for min OSA at full occupancy).
10. OSA intake damper settings at min CO2 and max CO2 set point.
11. Building pressure at each area.

1.04 DETAILED REQUIREMENTS

A. Preparation by Contractor:

1. Prior to requesting that the adjusting and balancing be performed, bring the work to a state of readiness for adjusting and balancing.
2. Have all systems in complete operation and all calibrations complete.
3. Furnish a mechanic to assist the balancing firm with the adjusting and balancing.
4. Requests to perform the balancing prematurely and/or requests to perform the balancing in a piece-meal manner at the Contractor's convenience shall be at the Contractor's expense.
5. Adjusting and Balancing:
   a. Mechanic's Duties: Include demonstrating that the system is functioning and operable, start and stop the fan, make drive changes, clear system blockages and repair any defective and/or leaking portions of the system which may affect system performance.

B. Adjusting and Balancing:

1. Prior to beginning the balancing work, obtain from the Architect the latest version of the mechanical drawings including addenda, revisions, change orders, etc.
2. 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.
3. Balancing data may be spot checked with instruments similar to that used by the balancing firm.
4. If, in the judgment of the Architect, the discrepancies warrant additional adjustment, readjust and rebalance the systems at no additional project cost.

END OF SECTION

SECTION 23 07 00
HVAC INSULATION

PART 1 GENERAL

1.01 DESCRIPTION

A. The requirements of this section apply to the insulation of mechanical equipment specified elsewhere in these specifications.

B. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

C. Work related to this section is only required where:
   1. Piping and valves are change/modified at the chiller in the Arlene Schnitzer Building.
   2. Piping and valves are change/modified at several air handlers at the Keller Auditorium.

1.02 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 and containing less than 0.1% by weight deca-PDE fire retardant.

C. Component Ratings of Accessories (Adhesives, Mastics, Cements, Tapes, Finishing Cloth for Fittings): Same as "B" requirements above and permanently treated. No water soluble treatments.

1.03 PRODUCT DELIVERY, STORAGE AND HANDLING

A. General: In addition to the requirements specified in Section 230500, 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.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Insulating Manufacturers: Johns Manville, Knauf, Armstrong, Owens-Corning, Pittsburgh Corning, Pabco, Imcoa or Certain Teed. Johns Manville products are listed unless indicated otherwise.

B. Adhesive Manufacturers: Foster, 3M, Insul-Coustic, Borden, Kingco or Armstrong.

2.02 PIPING INSULATION

A. Interior and Exterior Piping Systems 50 to 850 Deg. F: Glass fiber preformed pipe insulation with a minimum K-value of 0.23 at 75 Deg. F, a minimum density of 3.5 pounds per cubic foot within all-service vapor barrier jacket, vinyl or pre-sized finish and pressure sensitive seal. Johns Manville "Micro-Lok."

B. Interior Piping Systems 32 to 50 Deg. F: Glass fiber preformed pipe insulation with a minimum K-value of 0.23 at 75 deg. F, a minimum density of 3.5 pounds per cubic foot. Polymer vapor barrier jacket with pressure sensitive seal and wicking system to remove condensation from pipe surface. Owens Corning "VaporWick."

2.03 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

3.01 PIPING INSULATION

A. General: Do not insulate underground piping except at joints and fittings on preinsulated piping unless indicated otherwise.

B. Heating Water Piping: Insulate with glass fiber pipe covering:

Size	Thickness
1/2" to 1-1/2"	1-1/2"
2" to 3"	2"
4" and larger	2-1/2"

C. Chilled Water Piping: Insulate with glass fiber pipe covering:

Size	Thickness
1-1/2" and smaller	1-1/2"
2" and larger	1-1/2"

1. Fittings: PVC fitting covers with vapor-barrier and vapor wicking pipe wrap.
2. At Hangers: Preinsulated pipe supports as specified in Section 15090.

D. 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.

E. 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.

F. Insulated Piping: Comply with the following.

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits according to ASME B31.9.
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. Pipes NPS 8 (DN200) and Larger: Include wood inserts.
5. Insert Material: Length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

G. 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.

END OF SECTION

SECTION 23 09 23
DDC CONTROLS

PART 1 GENERAL SYSTEM DESCRIPTION

1.01 GENERAL REQUIREMENTS

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

1.02 BASIC SYSTEM

A. Building Automation System (BAS) system shall utilize DDC to control valve and damper actuators for all mechanical equipment as specified in the sequence of operation and in the drawings for all systems.

B. The control system shall be fully integrated and installed as a complete package of controls and instruments in a manor that provides maximum benefit to the end user.

C. The system shall include all computer software and hardware, control unit hardware and software, operator input/output devices, sensors, control devices, and miscellaneous devices required for complete operation and future modifications. Documentation for all software and hardware devices shall be provided.

D. Provide engineering, installation, calibration, commissioning, acceptance testing assistance, software programming, and checkout for complete and fully operational DDC.

E. All existing pneumatic and electric control devices not used, cabinets, valves, tubing, actuators, etc. are to be removed.

F. Scope:

1. The intent of this specification is to provide a system running the Niagara AX™ Framework.
2. System Architecture shall provide secure Web access using MS Internet Explorer from any computer on the Owner's LAN.
3. All control devices furnished with this Section shall be programmable directly from the Niagara-AX™ Workbench upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.
4. Any control vendor that must provide additional BMS server software shall be unacceptable. Only systems that utilize Niagara AX™ Framework shall satisfy the requirements of this section.
5. The BMS server shall host all graphic files for the control system.
6. OPEN NIC STATEMENTS - All NiagaraAX software licenses shall have the following NiCS: "accept.station.in=*"; "accept.station.out=*"and "accept.wb.in=*"and "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications.

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

A. Work under this section of the specification shall include, but not limited to, the following:

1. Furnish and install a complete sensor, actuator, wiring and piping system for all air handling and related equipment as shown on the plans and specified in this section. Install all necessary sensors and actuators as required by the plans and specifications and equipment schedules.
2. Label all sensors, control devices, and control units.
3. Furnish and install conduit, wire, branch circuit protection, etc. as required to bring 120 VAC power to control panel locations and equipment (actuators, sensors, control devices, etc.) as shown on the drawings and described in the specifications.
4. All line drivers, signal boosters, and signal conditioners etc. shall be provided as necessary for proper data communication.

5. Coordination as required with other sections of the specification for the proper and complete installation of the wiring system, control devices, dampers, valve, actuators, etc.
6. Furnish and install Direct Digital Control Equipment (DDC) as required by the point list, plans, and specifications including, control units, software, database development, check-out, and debugging. Provide points necessary for a complete and operable system.
7. Install the sequence of operations specified in the drawings and in this section.
8. Software testing requirements shall include testing in the field of all logic sequences including actual simulation of different processes and events and observing program response to the process or event. All deviations from the requirements of the sequence as specified on the drawings or this specification shall be corrected immediately at no additional cost to the Owner.
9. Provide documentation of software system testing before acceptance testing.
10. Provide staff for acceptance testing procedures. Modify hardware and software errors/problems at no additional cost to the Owner.
11. Provide a series of training classes for Owner staff.
12. Setup trending data before and after system acceptance.
13. Attend a series of meetings with the Engineer and Owner to agree on system setup and operating parameters.
14. Provide detailed documentation of system configuration including control units and all control devices.
15. Provide all software (with hardware connections) and software license for district computer as required.
16. Read this section in it entirety for specific details.
17. If the Control Contractor can not comply with any of these specifications, then the Control Contractor must explain in writing the reasons for non-compliance and provide an alternative approach that satisfies these requirements.
18. Provide all equipment and personnel to complete system commission per previous section and as listed further in specification.

1.04 QUALITY ASSURANCE AND SYSTEM OVERVIEW

A. The BAS system shall be designed, installed, commissioned, and serviced by qualified Contractor.

1. The Contractor shall have experience with the installation of the global and building level controls of at least 5 years.
2. The Contractor shall not be the only installing contractor of their respective systems within 60 miles of the job site. There shall be at least 2 others.
3. The control Contractor shall employ at least two full time programmers. These programmers shall carry training certification for the specified control system. They shall have at least 5 years of training and experience in the programming of the Honeywell WEBsAx system and 3 years of training and experience in the Tridium JACE system.

B. Acceptable Control System Contractors and Manufacturers: Honeywell WEBsAx in BACnet version.

C. A Tridium JACE NAC shall provide the interface between Internet and building level BACnet MS/TP communication bus. System shall use BACnet/IP on the internet side of the controller and shall use BACnet MS/TP at the building control network side. System shall utilize web based control and access. BACnet /IP communication to third party control devices (BACnet controllers for chillers and boilers) shall be allowed.

D. System shall communicate freely with Honeywell WEBsAx system installed in Hatfield Center. Data shall transfer seamlessly between systems and the existing human to system interface shall be used for the new system.

E. All products proposed for this Contract shall have been in continuous and successful use for at least two (2) year (not including beta testing).

F. 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.

G. 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.

H. System shall be web based. Existing standards for graphics, naming convention, alarms and security settings shall be used. Review specification for these elements in this document in the event the existing standards do not exist.

I. Equipment Cut-over / Down Time Allowances: See 230500.

1.05 CONTROL CONTRACTOR/MANUFACTURER QUALIFICATIONS

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

B. Proprietary programming tools are not allowed

C. All programming tools shall be supplied to the owner for future use.

D. See basic system requirements (1.02) for additional requirements

E. The Control Contractor's or Manufacturer's installer shall have successfully completed control manufacturer's classes on control systems and shall present for review the certification of training.

F. The Control Contractor's or Manufacturer's installer for this project shall be:

1. Identified by name.
2. The installer's previous work experiences shall not be less than five years.
3. The installer shall be technically proficient in both control systems and mechanical (air handling units, boiler, and chiller) systems.
4. Installer's references (including contact names and phone numbers) from all jobs during the past 12 months shall be presented.
5. If proposed installer does not meet minimum competency, the owner has the right to request a different installer and programmer.
6. No installer substitutions will be made without prior approval from the Owner.
7. The division of labor between installer and programmer is the responsibility of combination. No delay in providing a complete and operable system due to mis-coordination will be allowed.

G. Factory mounted controls are excluded from this section's requirements.

1.06 RELATED SECTIONS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions, Mechanical Special Conditions, Electrical Special Conditions and Division - 1 Specification.

B. Coordination with Other Trades:

1. This section specifies cooperation of the Control Contractor (the combination of installer and programmer hence forth) with other trades and including balancing firm to assure proper arrangement of control items. Control valves, dampers, wiring, thermostat wells, and other control devices that are to be built into the field assembled ductwork, piping, or wiring systems shall be furnished by the Control Contractor and installed under other sections of the specification

as directed by the Control Contractor and indicated in other portions of the specifications and drawings.

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

1.07 QUALITY CONTROL – CODES AND STANDARDS

A. All work, materials, and equipment shall comply with the rules and regulations of all codes and ordinances of the local, state, and federal authorities. Such codes, when more restrictive, shall take precedence over these plans and specifications, As a minimum, the installation shall comply with the current editions in effect 30 days prior to receipt of bids for the following codes:

1. National Electric Code (NEC)
2. Uniform Building Code (UBC), Oregon Structural Specialty Code
3. Uniform Mechanical Code (UMC), Oregon Mechanical Specialty Code
4. Underwriters Laboratories (UL)
5. National Electric Manufacturers' Association (NEMA)
6. National Fire Prevention Association (NFPA)
7. American Society Of Heating, Refrigeration, And Air Conditioning Engineers (ASHRAE)
8. Instrument Society Of America (ISA)
9. National Institute of Standards and Technology (NIST).

B. Meet all of the local authorities and State Fire Marshal code requirements for normal operating and smoke mode functions.

1.08 SUBMITTALS

A. Shop drawing submittals are required for the following, in accordance with Section 23 05 00. The Contractor shall not start the project until the Shop Drawings have been submitted and approved. Shop drawings shall include:

1. All submittals should be provided on paper (with legible font type and size).
2. All drawings should be labeled TC (temperature control) rather than being referenced within the mechanical or electrical divisions. Sheets shall be consecutively numbered
3. One drawing per air handler or system (e.g., boiler plant). Drawing should include point descriptors (DI, DO, AI, AO), addressing, and point names. Each point names should be unique (within a system and between systems). For example, the point named for the mixed air temperature for AH#1, AH #2, and AH #3 should not be MAT but could be named AH #1 MAT, AH #2 MAT, and AH #3 MAT. The point names could be logical and consistent between systems

and AHs. The abbreviation or short hand notation (e.g., MAT) should be clearly defined in writing by the Control Contractor. Naming standard will be decided on during meeting between Engineer, Control Contractor, and Owner. Convention shall match Phase I work.

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. Complete identification of all control devices (manufacturer's type, number, and function).
13. 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.
14. Provide NiCS showing devices communicating with JACE or through it are completely open with no restrictions.
15. 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.)
16. 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. C_v
d. Close off rating
e. Flow rate
f. Actuator spring range
g. Cavitation coefficient (where applicable)
h. Special construction features

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.

C. Operating and Maintenance Materials:

1. Provide Operation and maintenance data on all equipment requiring service or adjustment (prior to and after final acceptance).
2. Provide user guides and programming manuals for all hardware and software.
   a. A reference manual shall be furnished and shall contain, as a minimum, an overview of the system, its organization, the concepts of networking and central site/field hardware relationships. It shall be a complete guide to operating all aspects of the software system, including activating the system, use of the mouse, description of all menus, establishing setpoints and schedules, downloading or uploading information to or from field hardware, generating or collecting trends, alarms and reports, backing up system software and data files and interface with third party software.
   b. Manuals for advanced programming (for each controller type and for all workstations) shall be provided.
3. Provide a Bill of Materials with each schematic drawing. List all devices/equipment and match to schematic and actual field labeling. Provide quantity, manufacturer, actual product ordering

number, description, size, accuracy, operating ranges (voltage, temperature, pressure, etc.), input/output parameters, etc.

4. Field copies of wiring for Primary and Secondary Control Units. (Laminated and permanently affixed in or above controller).
5. For the equipment not manufactured by the Control Vendor, an alphabetical list of system components with the name, address and 24-hour telephone number of the company responsible for servicing each item during the first two years of operation shall be provided.
6. Operating and maintenance instructions for each piece of equipment that includes:
   a. Emergency procedures for fire or failure.
   b. Start-up, operation, maintenance, disassembly and shutdown procedures.
   c. Maintenance instructions for each piece of equipment.
   d. Proper lubricants and lubricating instructions.
   e. Cleaning, replacement and/or adjustment schedule.
   f. Product data on each piece of equipment, including damper and valve information noted earlier.
7. Points list shall include all physical input/output and virtual points. Points list shall be provided in hard copy and shall include:
   a. Name
   b. Address
   c. Scanning frequency
   d. Engineering units
   e. Offset calibration and scaling factor for engineering units
   f. High and low alarm values and alarm differentials for return to normal condition
   g. Default value to be used when the normal controlling value is not reporting.
   h. Message and alarm reporting as specified.
   i. Identification of all adjustable points
   j. Description of all points
8. Control Logic documentation shall include:
   a. Drawings documenting control logic for all aspects of the BAS including control units, controlled devices, sensors, etc.
   b. A detailed sequence of operation (see Part 6) should be submitted on separate sheets for each AH or HVAC system. The text description of the sequence of operation should include:
      1) Logic control statement (i.e., describe control loop process)
      2) Setpoints and throttling ranges, deadbands, and differentials for temperature and pressure variables, gains, reset schedules, etc.
      3) Limits/conditions and interlocks
      4) Measured variables (e.g., mixed air temperature)
      5) Variables to communicate to/from the network
   c. Control diagrams 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
      6) Definition of variables or point names (e.g., OAT = outside air temperature)
      7) Define values (e.g., 1 = on, 0 = off)
      8) Voltage, amperage, or resistance input/output signal for all sensors and controlled devices

D. Conformance Certificates: Upon substantial completion of the work, supply and turn over all required inspection certificates from governing authorities to certify that the work as installed conforms to the rules and regulations of the governing authorities.

E. Warranty Certificates:

1. Warrant all work as follows:
   a. Labor and materials for the control system specified shall be warranted free from defects for a period of 24 months after final completion and acceptance. Control system failures during the warranty period shall be adjusted, repaired, or replaced at no additional cost or reduction in service to the owner.
   b. The Control Contractor shall respond to the owner's request for warranty service within 24 hours during normal business hours.
   c. The Control Contractor shall respond to the owner's request for Emergency service during the warranty period within 4 hours.
2. Emergency service shall be available 8,760 hours per year.
3. Five (5) non-warranty emergency service calls shall be provided free of charge per year.
4. Emergency service rates for additional assistance shall be provided.
   a. The Contractor shall provide unlimited phone technical support to the owner during the warranty period. If the technical support location of the Contractor is outside of the toll free calling area for the customer, the Contractor shall have a toll free number or accept collect calls for the purpose of providing technical support.
   b. The Contractor shall provide technical support bulletin service (if available) for two years.
   c. During the warranty period and if required by the School District, parts for the DDC system shall arrive at the School District within 24 hours of placing an order.
   d. At the end of the final startup, testing, and commissioning phase, if equipment and systems are operating satisfactorily to the Engineer, the Engineer shall sign certificates certifying that the control system's operation has been tested and accepted in accordance with the terms of the specifications listed in Section 230923 (see 6.2 thru 6.3). The date of acceptance shall be the start of the warranty period.
   e. All work shall have a single warranty date, even when the owner has received beneficial use due to an early system startup.
   f. Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the Control Contractor shall be provided at no charge during the warranty period.
   g. Any hardware or software discovered to incorrectly process dates starting January 1, 2000 through the year 2040 shall be replaced by the Control Contractor at no cost to the owner.
   h. Control Contractor shall be available for a final check and adjustment of the DDC system before the warranty period ends. The final check will include input from the maintenance staff as well as the Engineer.

1.09 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.

1.10 DISCREPANCIES

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

PART 2 PRODUCTS

2.01 BASIC MATERIALS, CONTROL DEVICES, SENSORS

A. Installation of some of the equipment in this section may be the responsibility of other Contractors (see 1.5).

B. All sensors and equipment related to or connected to the DDC system shall be installed according to manufacturer's recommendations.

2.02 WIRING, CONDUIT, AND HANGERS

A. To supply, install and connect all conduits, boxes and wires between all the different components related in this section including all line voltage to the equipment.

B. Provide all necessary field wiring and devices from the point of connection indicated on the drawings. Bring to the attention of the Project Manager 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 Project Manager.
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 Project Manager. 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 manufacturers 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.
10. Wiring to all devices shall be new. The intention of these specifications is to provide the owner with the maximum flexibility in scheduling of the project by forcing the installation of parallel systems for bidding purposes. Installation of the new system to limit down time and cut over time is the intension. During construction if all of the below are true:
    a. if schedule permits.
    b. if at the owners discretion.
    c. if existing wiring to devices is tested and is sound.
    d. if existing wiring is installed per new wiring means and methods.
    e. the existing wiring may be reused.

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 48" 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 48".
   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.
   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, surface-mounted raceway (wire mold) is acceptable. No EMT is allowed in these locations. Provide samples for size and color selection.
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 hickeys 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 electrometalic tubing shall be compression type.
   f) A bushing shall be used where conduit enters a panel box. Bushing for No. 4 AWG or larger shall be insulated type with provisions for grounding as type "BL" made by O-Z Electric Company, or approved equal.
   g) Expansion fittings shall be provided at all conduits across the building expansion joints. Fittings shall be Type "AX" or "TX" as made by O-Z Electric Company, or approved equal. Provide copper bonding jumper at each expansion fitting.
   h) All ½'' conduit to be supported every 6', the supports will be located at the connector end of the conduit.
   i) Exposed conduit shall be securely fastened in place on maximum 5 ft. intervals for 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 Project Manager in writing immediately and not proceed without direction from the Project Manager.
4. Wedge type anchors shall be Hilti Kwik Bolt II. Adhesive anchors shall be Hilti HVA.

2.03 UNIT CONTROL PANELS (INSTALLATION AND FABRICATION)

A. Enclosed cabinet type with hinged door for mounting all relays, switches, thermometers, and miscellaneous controls not requiring direct mounting on equipment such as sensing elements, valves and damper motors. Provide cabinet for each control unit adjacent to each system.

B. Each panel shall have power conditioners on electrical supply, Crucial Power Product MI Series.

C. Control panels shall be fabricated to match the approved shop drawings submitted by the control Contractor. Fabrication shall be in a neat and workmanlike manner and shall facilitate repair, maintenance, and adjustment of the equipment contained therein.

D. Control panels shall be fabricated and laid out to incorporate the following features:

1. Identification of all internally and cover mounted devices. Cover mounted labels shall be engraved labels as specified in this section (5.10). Labels shall be mounted adjacent to the device they are associated with so that replacement of the device does not eliminate the label. Provide laminated control diagram at each panel.
2. Electrical wiring shall enter the panel from the top, bottom, and/or side of the left side of the panel or as required by the panel supplier to meet NEC requirements.
3. All wires entering or leaving the panel shall pass through a rail terminal strip. Where the wires are part of a current loop transmission circuit, the terminals shall be the disconnecting link type. Terminals shall be identified with a number that corresponds to the terminal number on the job wiring diagram. Rail terminal strip specifications include:
    a. General: Terminal rail assemblies shall be fabricated from components selected from the product line of one manufacturer. Sizes (heights, widths, and profiles) of each terminal shall be selected to be compatible with the other terminals on the rail. Terminal units located at the end of a rail or adjacent to terminals with a different profile (for example, where disconnecting terminals are located next to resistor terminals) shall be provided with end caps to completely close off the terminal unit interior components from the local environment. End stops shall be provided for on all rails to secure the terminals located on the rail in place.
4. All internal wiring and tubing shall be run inside plastic wiring/tubing duct as manufactured by Tyton. Wire duct shall be sized to hold the required number of wires and tubes without crimping the tubes and with sufficient space to allow wiring and tubing to be traced during troubleshooting operation.
5. Wires that pass from the panel interior to cover mounted devices shall be provided with a flex loop that is anchored on both sides of the hinge. Wiring running to cover mounted devices shall be bundled using cable ties.
6. Provide strain relief type cord and cable connectors for all cables that leave the panel as individual cables not in conduit.
7. All control panels shall be provided with removable sub panels to allow the panel enclosures to be installed at the job site during rough in while the panels are fabricated off-site for later installation.
8. Provide one under cabinet type fluorescent light with switch mounted internally in the control panel. Panels with external light hoods will also be acceptable if the light will illuminate the panel interior with the door open.
9. Provide one duplex outlet mounted inside the control panel and separately fused with a non-time delay fuse at 15 A at any panel location containing electronic or electrical control components. This receptacle may be served from the control panel 120 VAC power source.
10. Each control panel shall be provided with a control power disconnect switch located and wired so as to disconnect all control power in the panel. The leaving side of this switch shall be wired to the panel and field components through a fuse or fuses sized and applied to protect both the components of the system as well as the wire and as required for code compliance.
11. Power to the following equipment will be have a fuse rated for applicable current and voltage. Fuses will be on rail terminal strips. Equipment includes:
    a. Each control unit
    b. Control devices
    c. Panel light
    d. Receptacle loads (e.g., modems, laptops)
12. All control panels containing electrical equipment shall be NEMA rated for the location in which they are installed. Cover mounted components, tubing penetration, and conduit penetrations shall be made in a manner consistent with the NEMA rating.
13. All wiring leaving the panel shall be separated by classification; i.e., Class 1 circuits shall not be run with Class 2 circuits, etc. Segregation shall be maintained inside the panel to the fullest

extent possible. Where low voltage wires carrying low level ac and dc signals cross wires containing power and high level ac signals, the wires shall cross at a 90° angle.

E. Control panels shall be shop fabricated and tested prior to installation in the field. The panels shall be inspected and approved by the Engineer and Project Manager at the assembly location prior to installation in the field. The Engineer and Project Manager shall be given the opportunity to witness the testing of the panels.

F. Panel Location:

1. Each control panel is to be located for convenient servicing.
2. Mount panels adjacent to associated equipment on vibration isolation.

2.04 CONTROL DAMPER ACTUATORS

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 0-10 mA.
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.
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 devise travel (25% actuator stroke produces approximately 25% of the desired angular rotation required; 50% stroke produces 50% angular rotation). In addition, actuators should be installed to maximize force available for useful work over the entire stroke.

B. Control Valves and Actuators:

1. Provide adequate size and number of modulating or two-position action.
2. Provide positive positioning devices where shown or where sequencing cannot be accomplished by using standard spring ranges.

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. Screwed ends on valves 2-inches and smaller. Flanged ends on valves 2-21/2 inches and larger.
7. 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.

2.05 SENSORS

A. All sensing inputs shall be provided industry standard signals.

B. Temperatures, humidities, differential pressure signals, and all other signal inputs shall be industry standard variable voltage or amperage.

C. All signal inputs shall be compatible with the controllers used and with the requirement for readout of variables as specified.

D. If sensors are not linear, then software will linearize sensor output.

E. Controls and sensors for VAV boxes to be provided to VAV manufacturer for installation at the factory.

F. 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 50ºF
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	34ºF to 68ºF	± 1ºF

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

2.06 TEMPERATURE SENSORS/THERMOSTATS

A. All sensors shall be completely electronic.

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.

2.07 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 helic.
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.

2.08 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. Autorest with manual alarm reset.

E. Temperature sensing elements shall be thermally isolated from brackets and supports.

F. Reset temperature 5°F above setpoint.

2.09 TRANSFORMERS

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

2.10 CO_2 SENSORS

A. Sensor output shall be 4-20 mA which is proportional over the specified range.

B. The transmitter shall be capable of operating from an unregulated 18-30 VDC power supply.

C. Sensors shall be field adjustable via the DDC system.

D. Self-calibrating sensors are preferred. Manual calibrated sensors should not require annual calibration but may require calibration every 3 – 5 years. Allow for easy calibration with test gas.

E. Provide CO_2 calibration tool with system. Turn over to owner after calibration and provide instructions on use.

2.11 FLOW SENSOR FOR OVERFLOW DRAINS

A. Designed for pipe insertion mounting with contact closure to signal flow. Match existing configuration.

2.12 CURRENT SWITCHES

A. The status of all non–VFD fan and pump motors and all VFD fan and pump motors less than 20 HP shall ONLY be detected using current switches.

B. The current switch shall be provided for electrical equipment status applications only.

C. Switch should attach directly to the conductor and have a mounting bracket for installation flexibility.

D. The current switch shall be 100% solid state electronics.

E. The current switch shall be induce powered from the monitored load

2.13 CURRENT SENSORS/TRANSFORMERS

A. The status and amperage of all VFD motors for fan and pumps greater than 20 HP shall be detected using current sensors ONLY.

B. The Amp signal shall be provided on operator screen.

C. The scale used must be selected in order to obtain normal operating readings at the mid-point of the scale.

D. The scale used must be selected in order to detect changes in current flow resulting from motor belt or coupling loss, belt slippage, and other mechanical failures and should be able to distinguish low load conditions.

2.14 REFRIGERANT SENSOR

A. Micro-processor controlled infrared technology device enclosed.

B. Factory set for existing chiller refrigerant. Confirm with chiller refrigerant prior to submittal.

C. 5-1,000 ppm range with +/- 3% accuracy.

D. Continuous scanning with 4-20mA output signal.

E. Provide with sensor and two remote alarm and monitoring stations.

F. Honeywell 301 EM-20 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

3.01 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. PCPA Network: Used for communication between JACE Building Level Controller located in each building, and networked Operator Workstations located in selected building(s). This network will consist of using the world wide web with BACnet/IP protocol. BAS/DDC workstation(s) and the

JACE Building Level Controller Device shall employ native BACnet /IP protocol. Niagara AX Protocol, BACnet TCP/IP Protocal, 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.
4. 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 Owner's IT personnel for access, wiring and standards of installation if more restrictive than these specifications:

3.02 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. Device shall be a Tridium JACE Network area controller.

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.

3.03 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.
4. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

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 or Project Manager.
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).
    b. NiCS (Compatibility Statement) shall show no restrictions to conductivity. Provide devices with station compatibility in and out and tool compatibility in and out. Having a value of "all" for each.

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.

3.04 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.
3. The controller platform shall provide options and advanced system functions, programmable and configurable using Niagara AX Framework™, that allow standard and customizable control solutions required in executing the "Sequence of Operation".

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 Project Manager or 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

PART 4 DIRECT DIGITAL CONTROLS – SOFTWARE

4.01 SYSTEM SOFTWARE

A. OPEN NIC STATEMENTS – All NiagaraAX software licenses shall have the following NiCS: 'accept.station.in=*"; "accept.station.out=*"and "accept.wb.in=*"and "accept.wb.out=*". All open NIC statements shall follow Niagara Open NIC specifications.

B. 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.

4.02 SYSTEM OVERVIEW

A. The BAS Contractor shall provide system software based on server/thin-client architecture, 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 architecture 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-Window 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 TCPIP 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)

4.03 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.

4.04 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

5.01 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.

5.02 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.

5.03 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.

5.04 ALARMS

A. The Control Contractor in coordination with the Owner and Engineer shall specify values that trigger alarm conditions.

B. The Control Contractor in coordination with the Owner and Engineer shall specify the alarm level that requires on-screen operator acknowledgement.

C. Provide five alarm levels.

1. Level 1 alarm (smoke and/or fire)
2. Level 2 alarm (equipment failure/damage imminent)
3. Level 3 alarm (equipment requires hardware or software reset)
4. Level 4 alarm (equipment requires servicing and/or energy is being wasted)
5. Level 5 alarm (temperature setpoints are out of bounds)

D. Provide five locations for reporting of alarms.

1. Level 1: Send Level 1 alarm to F.A.C.P., to security monitor
2. Level 2: Send Level 2 alarm to central control monitor and on call maintenance person's cell phone.
3. Level 3: Send Level 3 alarm to central control monitor
4. Level 4: Send Level 4 alarm to central control monitor
5. Level 5: Send Level 5 alarm to central control monitor

E. All alarm reports shall include the point's English language description, point address, an alarm message to more fully describe the alarm condition and/or direct operator response, and the time and date of occurrence.

5.05 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) Heatering 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.

5.06 SCHEDULES

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

5.07 GRAPHIC SCREENS

A. Colorgraphic Operator Interface:

1. Provide dual or multiple function windowing to allow user to view two or more screen and toggle between simultaneous operations.
2. Update all point values a minimum of every 10 seconds.
3. Each colorgraphic terminal shall be driven by software allowing the operator to access any system information via a system penetration method.
4. System penetration shall allow the operator to begin at an entire site plan colorgraphic display and progressively select portions of the site plan to be chosen for closer inspection or selection of a more detailed colorgraphic display of a desired system without being required to enter any commands via the keyboard. Specifically,
   a. Graphics display screens shall include a system level graphic of either a map of facilities or an elevation of the building, a graphic of each building floor plan and graphics for each operating system or unit within each building. Entry to the zone and equipment level interface graphics shall be through area maps and/or floor plans to facilitate user orientation. Graphics shall be accessed by using a mouse or other pointer device. The system shall provide a visual indication of which building, floor and zone the user is accessing at any time.
5. Graphics shall be provided for all mechanical equipment and devices controlled by the DDC system. These graphics shall include:
   a. Flow diagram or graphic diagram showing all devices (e.g., valves, dampers, sensors, fans, pumps, boilers, etc.)
   b. Current status of all I/O points being controlled and applicable to each piece of equipment.
   c. Operating mode (occupied, unoccupied, warm-up, purge cycle, etc.)
   d. Time and date
   e. Percentage valve/damper open or closed (include "open" or "closed" on the screen
   f. Analog readouts in mA or VDC (for commissioning and can be located on a separate screen if needed to reduce screen clutter)
   g. All analogue and digital input and output points shall be settable from the screen.
   h. Place all values in appropriate engineering units and in appropriate locations on the graphic representation.
6. All colorgraphic screens shall be standardized for similar mechanical equipment and control devices. The type of points displayed will be the same for similar colorgraphic screens.
7. Graphics shall be enabled for convenient viewing from portable devices (Smart Phone, I-pad, Wi-Fi enabled lap top).

B. Other colorgraphic screens shall include:

1. Reset schedules for all AHU and boiler and chiller systems
2. VAV terminal boxes (DAT, Damper and valve positions, CFM, fan status)
3. Temperature setpoints for all rooms/zones
4. Operational mode for all AHU (occupied/unoccupied night purge, etc.)
5. All adjustable points
6. Overrides of AHU and CO2 Demand Controlled Ventilation

C. Global commands on other colorgraphic screens shall include:

1. Open all VAV dampers to maximum cooling flow rate (by AHU)
2. Open all VAV dampers to maximum heating flow rate(by AHU)
3. Open all hot water valves
4. Open all chilled water valves

D. Accessible System Information: Available for display or modification in any specific colorgraphic display shall include, but not be limited to:

1. Real-time value display of any connected point in the system

2. Alarm status condition of any desired system alarm point
3. Any software parameter such as setpoints for control sequences, minimum position adjustments, or throttling ranges

E. Centralized Scheduling and Modification: The colorgraphic terminal shall support operator access to the Scheduling Screens that allow the operator to review and modify any or all schedules as desired. The centralized Scheduling function shall allow modification of equipment and lighting operating schedules, modification of facility holiday schedules, and when desired allow assignment of temporary schedules for designated portions of the facility or specific equipment.

F. Host computers shall be located in the Hatfield Building server room

5.08 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

5.09 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 or Project Manager.

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.

E. See Drawings for building shut-off switch. Switch to shut off all air handling equipment.

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 #

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

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 or Project manager.

6.01 CONTROL TECHNICIAN MEETING REQUIREMENTS

A. During all pre-installation meetings with Owner / Engineer and separate meetings pertaining to the commissioning process, the control technician attending the meetings must be the same technicians that are/will install and program the DDC system.

B. The Control Contractor's installer and programmer must attend all the commissioning meetings. These meetings occur throughout the design and construction process.

C. First Meeting - discuss point naming and sequence of operation with Engineer and Owner

1. Prior to software and database installation and checkout but subsequent to software and database development, the Control Contractor shall meet with the Owner and the Engineer and

review the database and program code in detail on a point by point, sequence by sequence basis. The Control Contractor (using blueprints and this specification) shall provide the project point list and sequence of operation to initiate discussion.

2. Any necessary modifications required to make the database and sequence match the intent and requirements of the Contract documents shall be identified at this meeting including point names, descriptors, alarm setpoint, numeric setpoint requirements, access requirements, sequence adjustments, etc.
3. Successful completion of this review process will result in software and database approval for installation and start-up. Any software or database that is installed prior to this approval process shall be corrected to match the results of the approval process at no additional cost to the Owner.
4. The results of this meeting shall be documented in meeting minutes taken and issued by the Control Contractor. Documentation can be in the form of marked up data base forms and sequences of operation.

D. Second Meeting - graphic screen development shall be coordinated with the Owner through a series of meetings that will allow the functions described above (sequence of operation, alarms, etc.) and any other Owner's requirements to be incorporated into the graphic screens.

6.02 PRE-COMMISSIONING TESTING, ADJUSTING, AND CALIBRATION REQUIREMENTS

A. Prior to acceptance, the following steps will be used by the Control Contractor to produce a testing and pre-commissioning report by system to be submitted for approval by the Engineer 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 sub-Contractor 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 and Owner before system demonstration.

6.03 DEMONSTRATION

A. Prior to acceptance, the control system shall undergo a series of performance tests to verify operation and compliance with this specification. These tests shall occur after the Control Contractor has completed the installation, started up the system, and performed its own tests (outlined in 6.01 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 Engineer will be present to observe and review these tests. The 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 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 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 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 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 Engineer in setting up software on 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 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 6.01)

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 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 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 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.

6.04 ACCEPTANCE

A. All tests described in this specification shall have been performed to the satisfaction of both the 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 Owner accepts the system and provides this acceptance in written form to 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 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.

E. Allow one day up to six months after acceptance for opposite season test and verification with Engineer.

6.05 SPARE PARTS

A. The Control Contractor shall provide two spare fuses of the correct size and capacity for each fuseholder located in all the installed control systems and the Control Contractor's related equipment.

B. The Control Contractor shall provide two spare pilot lights for each control unit that contains one or more pilot lights.

6.06 TRAINING

A. Provide a minimum of four separate 4-hour on-site training sessions after system acceptance and at the Owner's request. The initial training session will occur after the as-built drawings and submittals have been provided and the Engineer has accepted the system. The other training sessions will occur up to 12 months after the first training session and at the Owner's request.

B. Training shall be a mix of classroom instruction, test exercises, and actual keyboard entry and screen viewing at the operator's terminal. Hands-on experience and problem solving shall be emphasized.

C. If during any training session, the trainer debugs more than two (2) items, the training session will be immediately terminated. The session will be rescheduled for another date. The re-scheduled training session will be carried out for the full four hours at no additional cost to the Owner.

D. The first training shall be oriented to making the Owner self sufficient in the day to day use and operation of the DDC system. Additionally, the training shall include:

1. System start-up, shutdowns, power outage and restart routines, alarms, security levels, changing setpoints, changing schedules and other parameters, overrides, freeze protection, manual operation, return to automatic operation, and resetting equipment.
2. All screens shall be discussed (allow time for questions).
3. Information specifically focused on showing the Owner methods of troubleshooting the mechanical systems using the BAS.
4. Use of laptop and hand-held operator interface device.
5. Creating, modifying, viewing, downloading, and reloading, trend logs. School District staff shall set up at least six trends during training.
6. Remote access to the system via Web, network, and/or phone lines.

E. The other training sessions shall be oriented toward answering specific questions from Maintenance staff.

F. The trainer must be well grounded in both DDC system operation and in mechanical systems service and should be the programmer.

G. The Owner may specify another site for training if desired.

H. Factory Training: Provide training at a Manufacturer's Factory Training Center on the operation of the system for one Maintenance staff. Minimum 4 days of training. This training should be considered the level of training provided to Contractor with franchise license for the digital control system installed. Control Contractor shall pay travel, lodging and meal costs, and registrations fees. Provide all documentation from presentation for Owner's future reference.

I. Factory training shall include, at a minimum:

1. Creating and modifying the sequence of operation.
2. Generating graphics.
3. Field programming
4. Programming and operation of the JACE device.

END OF SECTION

SECTION 23 09 93
SEQUENCE OF OPERATIONS FOR HVAC CONTROLS

PART 1 GENERAL

1.01 SUMMARY

A. This section describes the sequence of operations for HVAC control systems specified elsewhere in these specifications.

B. Related Work: The requirements of Section 23 05 00, Common HVAC Materials and Methods, also apply to this section.

C. All work under this section is related to the Hatfield Auditorium.

PART 2 PRODUCTS

2.01 NO PRODUCTS LISTED FOR THIS SECTION

PART 3 EXECUTION

3.01 SEQUENCE OF OPERATIONS

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

B. Object List:

1. The following points as defined for each piece of equipment are designated as follows:
   a. Binary Out (BO) - Defined as any two-state output (start/stop) (enable/disable), etc.
   b. Binary In (BI) - Defined as any two-state input (alarm, status), etc.
   c. Analog In (AI) - Defined as any variable input (temperature) (position), etc.
   d. Analog Out (AO) - Defined as any electrical variable output. 0–20mA, 4–20mA, 0–10VDC are the only acceptable analog outputs. The driver for analog outputs must come from both hardware and software resident in the controllers. Transducers will not be acceptable under any circumstance.

C. Occupancy and Performance Time Periods:

1. Occupied Period is signaled automatically by adjustable settings at DDC server, Building Controller, Application Controller and also, at each zone when zone bypass timer is activated.
2. Warm-up period occurs one hour before occupied start time or as calculated by Building Controller based on system performance history and outside air temperature.
3. Unoccupied period occurs whenever Occupied, Warm-up, and Cool-down are not in effect.

PART 4 SEQUENCE OF OPERATION

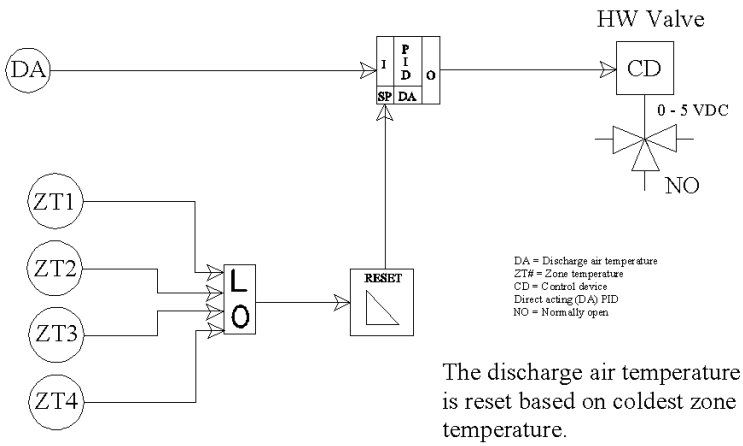
4.01 LEVEL OF DETAIL

A. Major changes in provided sequence of operation must be approved of in writing by the Project Manager 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
      6) Definition of variables or point names (e.g., OAT = outside air temperature)
      7) Define values (e.g., 1 = on, 0 = off)
   c. See figure below for example of logic diagram).



4.02 STANDARDIZATION

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

4.03 PROGRAMMING GUIDELINES

A. All adjustable setpoints shall be developed as software points stored at memory locations so that setpoints can be changed by recommending the data stored at the memory location rather than by entering the program and changing parameters and lines in program code.

B. Where reset schedules are specified or required the schedules shall be set up so that the operator enters the following points into memory locations.

1. Two points for the independent variable on the reset schedule.
2. Two points for the dependent variable on the reset schedule.

The computer system shall then use these values as input parameters to the appropriate program or programs and calculate the reset schedule based on these values.

C. Where several analog outputs are to be controlled in sequence by one control loop, software shall be arranged so that the sequence is guaranteed regardless of the spring range of the actuators and to prevent simultaneous heating and cooling.

D. Programs controlling several pieces of equipment as one system shall reside in one control unit. Where programs use data points that reside in other control units the programs shall employ logic (either in software, firmware, hardware, or a combination of all three) to detect loss of communications with the remote control units containing the required data. When such a failure is detected, the program logic shall revert to a safe operating mode that will allow the controlled systems to remain in operation until normal system communication resumes. A pilot light on the control unit shall be illuminated when such a failure mode exists. In addition, an alarm shall be sent to the HOST computers (alarm level 4). The software shall track this type of alarm and report if communication failure is higher than expected (this condition shall generate an alarm level 3, with descriptive text, at the HOST computer). All safe operating modes shall be approved by the Engineer or Project Manager prior to implementation.

E. Control sequences that use outdoor air conditions to trigger certain specific operating modes shall use data generated by one outdoor air temperature sensor and one outdoor humidity sensor. In other words, the data from one pair of sensors shall be shared by the entire system.

F. All safety circuits shall be hard wired circuits using standard snap acting electric or pneumatic switches as required by the function, and shall be totally independent of the DDC system controllers. This includes interlocks that return dampers and valves to some normal, fail-safe position when the system they are associated with shuts down. It is the intent of this paragraph that the systems have the capability to be operated manually complete with safeties and fail safe interlocks even if the DDC system is off line.

G. Provide hours of operation accumulation and lead/lag sequencing of equipment based on hours of operation for all equipment with proof of operation inputs.

H. Global point name changing:

1. The system shall provide an easy means to allow the operator to change a point name such that the point will automatically be referenced everywhere in the system by the new name.
2. If a point name is removed from the database, any program code where the name appears must show an appropriate error signal for undefined point when the program is viewed, edited, or printed.

I. Synchronization of real-time clocks between all control panels shall be provided.

4.04 GENERAL SEQUENCE OF OPERATION GUIDELINES

A. Control of all central fan systems, boilers, DX units, heaters, and pumping stations shall be based on run requests, heating requests or cooling requests from zone controls.

B. Reset of supply air temperature and hot water temperature shall be based on zone temperature conditions via the zone's percentage of heating or cooling load.

C. Unless otherwise indicated, all control loops will use PID loops. The coefficient for the derivative component is zero (0) unless otherwise indicated.

D. All HVAC system controls shall be designed such that simultaneous heating and cooling, reheating, and recooling are minimized. This applies as well to non-mechanical treatment of mixed air (e.g. outside air, heat recovery, etc.) which must then be mechanically reheated or recooled.

E. Alarms: Except as directed otherwise by the Project Manager, all alarms will be registered at the building operator's terminal as well as at the Maintenance Building remote operator's station. Alarms are to be registered with a message explaining the nature of the alarm and which building/location the alarm is in.

F. Whenever a setpoint is referred to as "adjustable" in these standards, the setpoint is to be easily and directly adjustable at the operator's terminal and Maintenance Building remote operator's station, and is not to require any code modification. This may require assigning virtual points to all adjustable setpoints. Frequently adjusted points, including space temperature setpoints, shall be adjustable from the graphics screen (e.g., floor plan screen).

G. There are many interlocks and limits within each control loop or algorithm that may not be obvious or stated in this specification. The Control Contractor is responsible for identifying and programming these interlocks and limits into the software. The CO_2 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 too: moving actuators a couple fractions of a degree every second or so in response to some infinitesimal change in a measured variable or repeatedly turning equipment on/off within a short time period. The Control Contractor will avoid these problems by incorporating time delays, dead bands, and other programming techniques into the sequence of operation.

I. Programmable time-of-day (start/stop) control shall be implemented for all HVAC equipment, except for:

1. equipment that is interlocked with other equipment under direct start/stop control (e.g. exhaust fans interlocked with an air handling unit)
2. equipment that must run continuously for reasons of safety
3. as otherwise noted in these standards

J. Auto-tuning algorithms will not be used to initially tune control loops.

4.05 SEQUENCE OF OPERATION GUIDELINES

A. This specification is intended to refine or elaborate on the sequence of operations provided by the Engineer. Note: there are many issues that may make any of these standard sequences inapplicable to a specific situation: thus, the Control Contractor should obtain written approval by the Engineer and Project Manager 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 Project Manager 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 Project Manager and Engineer for his/her written approval.

D. The Control Contractor is responsible for accurately controlling and communicating with all packaged fan units or air handling units.

4.06 SEQUENCE OF OPERATION – SCHEDULING

A. The system will have the three (3) schedules that will be utilized based on the type of event selected by the building operator. The operator will be able to select the desired schedule to be actively used and select the equipment group to be associated with each schedule (equipment selection is user adjustable). Equipment grouping and default schedules and times are as follows:

Selectable Equipment Groups	
Equipment Grouping Selection	**Equipment Group**
1 – Auditorium	ASU-1
2 – Lobby	ASU-2
3 – Offices	ASU-3
4 – Back of House	ASU-4
5 – Projection/Control	ASU-5
6 - Stage	ASU-6

Selectable Schedules	
Schedule	**Occupied Times (Default, Adjustable)**
Standard Schedule	8:00 - 17:00
Rehearsal Schedule	8:00 - 17:00
Event Schedule	8:00 - 23:00
Dark	All equipment remains in unoccupied mode.

B. Occupancy Override: The building operator shall be able to initiate occupancy (occupied operation) from the building operator's workstation (overriding any non-occupied sequences) for each individual air handling system. Override will last for eight (8) hours (adjustable) and then revert back to the current operating mode. Operator will be able to release override at any time during the override period.

4.07 SEQUENCE OF OPERATION –TWO SPEED VARIABLE AIR VOLUME AIR SUPPLY UNIT WITH HOT AND CHILLED WATER COILS (ASU-1, ASU-2, ASU-6)

A. Space Temperature Setpoints:

1. Controlled Temperature Selection: The building operator shall be able to select between three (3) types of space temperature calculations for the controlled input.
   a. Option 1: Maximum space temperature is used.
   b. Option 2: Minimum space temperature is used.
   c. Option 3: Average space temperature.
2. Default Setpoints:
   a. Occupied Heating Setpoint: 68 °F (adjustable)
   b. Occupied Cooling Setpoint: 72 °F (adjustable)
   c. Unoccupied Heating Setpoint: 55 °F (adjustable)
   d. Unoccupied Cooling Setpoint: 85 °F (adjustable)
3. Space Setpoint Adjustment: Setpoint adjustments shall be made at the operator workstation. Local setpoint adjustment is not applicable for this unit.

B. Discharge Air Temperature Limiting (Occupied Mode Only): For occupant comfort purposes discharge air temperature shall be limited. When the system is in full heating or cooling (100% demand) these set points determine the maximum and minimum temperatures that the system should be discharge from the air handler. Economizer control is not limited by this sequence.

1. Discharge Air Temperature Limits:
    a. Discharge Air Temperature High Limit Set Point: 85 °F (Adjustable)
    b. Discharge Air Temperature Low Limit Set Point: 53 °F (Adjustable)

C. Mixed Air Temperature Setpoint Reset (Occupied Mode Only):

1. Control Set Point: Mixed air temperature set point shall reset based on the economizer control setpoint and a proportional/integral (PI) control algorithm. This setpoint is calculated by averaging the occupied heating and cooling space temperature set points.
2. Mixed Air Temperature Limits:
    a. Mixed Air Temperature High Limit Set Point: Return Air Temperature
    b. Mixed Air Temperature Low Limit Set Point: 50 °F (Adjustable)

D. Supply Fan Control:

1. High Speed Fan Staging: Start low speed fan and operate for 30 seconds. Stop low speed fan and start high speed fan immediately after the startup period. Low speed and high speed operation should not occur simultaneously at any time.
2. Occupied Mode:
    a. High Speed Fan: Stage to high speed fan during cooling and heating modes.
    b. Cooling/Heating Mode: The system is considered to be in cooling/heating mode when the space temperate(s) is outside of the cooling/heating setpoints or space temperature heating and cooling control loops are greater than 0%.
    c. Low Speed Fan: Operate low speed fan when the space temperature(s) is within the dead band region (space temperature values are between the heating and cooling set points or both heating and cooling control loops are at 0%).
3. Staging Minimum Cycle Time: Cycle time for fan staging shall be a minimum of 10 minutes (adjustable).
4. Night Low Limit, Night High Limit, Optimal Start, Night Purge, Occupied Purge Mode: Stage on high speed fan.
5. Unoccupied Mode, Low Limit Freeze Mode and Smoke Detector Alarm: Low and high speed fans are off.
6. Low Limit Freeze Lockout: If the freeze thermostat (device automatically resets) indicates a low limit condition three (3) times (adjustable) within 15 minutes (adjustable) the fans shall be lockout (software). Lockout reset shall occur at the building operator's workstation.

E. Return Fan Control: Return fan shall operate based on supply fan operation. For ASU-1, 2 and ASU-6 in Smoke Purge mode the return fan shall be off.

F. Heating Valve Control:

1. Occupied, Occupied Purge Mode: Heating valve to modulate to maintain space temperature heating setpoint subject to discharge air temperature limiting.
2. Night Low Limit, Optimal Start and Low Limit Freeze Conditions: Heating valve shall modulate fully open.
3. Unoccupied and Night High Limit Mode: Heating valve to modulate fully closed.
4. Night Purge Mode: When night purge mode has been initiated, the heating valve shall not be enabled to operate for a minimum of 4 hours (adjustable) from the occupied time. If the space temperature is 2°F less than the occupied heating set point during the lockout time, heating valve modulation is allowed.
5. Heating Valve Lockout: Heating valve shall not modulate when the outside air temperature is above 65 °F (Adjustable).
6. Considerations: Modulating the heating valve simultaneously with cooling valve and economizer operation is not is not permitted except during demand ventilation control. Oscillation between heating valve, cooling valve and economizer operation is also not permitted.

G. Cooling Valve Control:

1. Occupied, Occupied Purge Mode: Cooling valve to modulate to maintain space temperature setpoint subject to discharge air temperature limiting.
2. Unoccupied, Night Low Limit, Night High Limit, Optimal Start, Night Purge and Low Limit Freeze Modes: Cooling valve to modulate fully closed.
3. 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.
4. Cooling Valve Lockout:
   a. Cooling valve shall not modulate when the outside air temperature is below 55 °F (Adjustable).
   b. If economizer operation is enabled cooling valve operation is not allowed until economizer is at 100% for five (5) minutes. Economizer to maintain 100% while cooling valve is operational unless it is disabled based on return air.
5. Considerations: Modulating the cooling valve simultaneously with the heating valve operation is not permitted. Oscillation between heating valve and cooling valve modulation is also not permitted.

H. Economizer Damper Control:

1. Occupied Mode: Economizer dampers (Outside Air, Return Air and Relief Air) modulate to maintain mixed air temperature set point.
2. Unoccupied, Night Low Limit, Optimal Start and Low Limit Freeze Conditions: Dampers to modulate to full recirculation (0% Outside Air).
3. Night High Limit, Smoke Purge, and Night Purge, Occupied Purge Modes: Dampers to modulate to full ventilation (100% Outside Air).
4. Economizer Lockout: If the outside air temperature is greater than the return air temperature, modulate economizer to the minimum position.
5. Demand Ventilation Control (DVC) (ASU-2, ASU-3, ASU-5 Only): During occupied mode the outside air dampers shall modulate to maintain return air CO2 levels at or below 1000 ppm (Adjustable). DVC shall occur when levels begin to exceed the CO2 set point.
6. Outside Air Damper Modulation (OSA/Min OSA Dampers): Minimum outside air and outside air dampers will modulate proportionally based on the economizer control function output (PI algorithm) as described in the schedule below.

Min OSA/OSA Damper Position		
Economizer Control Output (%)	Minimum OSA Damper Position (%)	OSA Damper Position (%)
0	0	0
20	100	0
100	100	100

I. Discharge Damper Control (ASU-6 Only):

1. Occupied, Occupied Purge Mode: Discharge air dampers will have three (3) separate user mode selections based on the following schedule.

Discharge Air Damper Posion Based on Mode Selection			
Mode	**AUD-1**	**AUD-2A**	**AUD-2B**
Rehearsal or Roadhouse	0%	100%	100%
Concert Shell	100%	0%	0%
Normal*	50%*	50%*	50%*

* 50% setting may be adjusted up/down due to balancing requirements.

2. Night Purge Modes, Night Low Limit, Night High Limit and Optimal Start Modes: Dampers associated with zones that are actively applicable to these modes shall modulate fully open. Zones that are not actively applicable to these modes shall be set to 50%.
3. Unoccupied: Dampers to modulate fully open.
4. Smoke Purge Mode: AUD-1 shall be full open AUD-2A and 2B shall be full closed.

J. Intake/Discharge Damper Control: Isolation dampers shall be open when fans are operational. Fan operation is not allowed before the damper is fully opened. Damper shall remain closed when fans are off.

K. Optimal Start Control (Heating Mode):

1. Optimal Start (General): The intent of the optimal start sequence is that the air handling system be started early enough so that all served spaces reach occupied heating setpoint no more than 20 minutes prior to or 10 minutes after scheduled occupancy.
2. Air handling systems may be started under the optimal start mode no more than 3 hours (adjustable) prior to scheduled occupancy.
3. Optimal Start Lockout: This optimal start sequence will be locked out when the 3 hour rolling average outdoor air temperature is greater than setpoint (initial setpoint, 55°F, adjustable). If locked out, the ASU will start 10 minutes (adjustable, maximum of 30 minutes) before the occupied time period.
4. Optimal Start Calculation:
   Air handling systems will be optimally started as a function of:
   a. Current Outdoor air temperature
   b. Current space temperature
   c. Time until start of scheduled occupancy
   d. Historical heating performance as a function of a, b, and c above.
5. Optimal Start Not Achieved: If the occupancy period starts and the system has not achieved the optimal start setpoint(s) then the system shall continue to operate in this mode (and with full recirculation) until the percent heating load greater than –75% (adjustable) or for 30 minutes (adjustable) at which time the system will revert to the normal occupied cycle or stand-by mode.
6. Optimal Start Enable/Disable: The optimal start sequence shall be enabled/disabled from the operator workstation.

L. Night Low Limit Mode:

1. Night low limit mode is initiated during unoccupied times (mode), when the space temperature falls below the unoccupied heating setpoint.
2. When all spaces served by the system are above the unoccupied heating setpoint plus the dead band setpoint (initial 5°F, adjustable), the system will revert to the unoccupied mode.
3. If the minimum hourly outside air temperature is less than 20°F (adjustable) in Western Oregon for the previous 12 (adjustable) consecutive hours, then the AHU will remain in operation during the unoccupied period. The system will maintain a setpoint temperature 10°F (adjustable) less than occupied setpoint. All outside air dampers will remain closed during the unoccupied period.

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 temperatrue.
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 Mode:

1. This sequence is initiated before occupancy during the cooling season.
2. Night purge will be enabled when the following conditions are true:
   a. The average space temperature is above 80º F (adjustable).
   b. Outside air temperature is greater than setpoint (initial setpoint, 45°F, adjustable).
   c. Outside air relative humidity is less than 50%.
   d. Outside air temperature is at least 10°F (adjustable) less than the average space temperature
   e. Occupancy period occurs within 3 hours (adjustable).
3. Night purge will be disabled when average space temperature is within 3°F (adjustable) of the outside air temperature or the average space temperature has reach the occupied heating set point.

O. Occupied Purge Mode (ASU-1 and 6 Only):

1. The intent of this sequence is to provide a way for the operator to be able to evacuate particulate matter in the air produced by special effects during events. This sequence will be initiated from the operator's workstation and will only function during occupied times. When activated the system will operate in this mode for fifteen (15) minutes (adjustable) and then revert to the current operating mode.

P. ASU-2 Only: Operate heating valve to one of two zones with the lowest demand. Operate zone valve for other zone.

4.08 SEQUENCE OF OPERATION – CONSTANT VOLUME MULTI-ZONE AIR SUPPLY UNIT WITH HOT AND CHILLED WATER COILS (ASU-3 AND 4)

A. Space Temperature Setpoints:

1. Default Setpoints:
   a. Occupied Heating Setpoint: 68 °F (adjustable)
   b. Occupied Cooling Setpoint: 72 °F (adjustable)
   c. Unoccupied Heating Setpoint: 55 °F (adjustable)
   d. Unoccupied Cooling Setpoint: 85 °F (adjustable)
2. Space Setpoint Adjustment: Setpoint adjustments shall be made at the operator workstation. Local setpoint adjustment is not applicable for this unit.
3. Space Temperature Setpoint Change Over: When the outside air temperature falls below 60 °F (adjustable) zones shall utilize the occupied heating set point for space temperature control. When the outside air temperature rises above 68 °F (adjustable) zones shall utilize the occupied cooling set point for space temperature control. This switch over sequence shall always be active to make adjustments as outside air temperatures change.

B. Hot Deck Discharge Air Temperature Setpoint Reset: Setpoint shall linearly reset based on the maximum zone heating demand proportional/integral (PI) control value. Setpoint reset is based on the following schedule.

Hot Deck Reset Schedule	
Maximum Zone Heating Demand (%)	Hot Deck Temperature Setpoint (F)
100	120
0-10	65

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:

1. Occupied, Night Low Limit, Night High Limit, Optimal Start, Night Purge Mode: Fan turns on for continuous operation.
2. Unoccupied Mode, Low Limit Freeze Mode and Fire Alarm (General): Fan remains off during these conditions.
3. Low Limit Freeze Lockout: If the freeze thermostat (device automatically resets) indicates a low limit condition three (3) times (adjustable) within 10 minutes (adjustable) the fans shall lockout (software). Lockout reset shall occur at the building operators workstation.

F. Return Fan Control: Return fan shall operate based on supply fan control.

G. Heating Valve Control:

1. Occupied Mode: Heating valve shall modulate to maintain hot deck temperature setpoint.
2. Night Low Limit, Optimal Start and Low Limit Freeze Conditions: Heating valve shall modulate fully open.
3. Unoccupied and Night High Limit Mode: Heating valve to modulate fully closed.
4. Night High Limit: Valve operation permitted to prevent zones (not applicable to these modes) from falling below the occupied space temperature set point.
5. Night Purge Mode: When night purge mode has been initiated, the heating valve shall not be enabled to operate for a minimum of 4 hours (adjustable) from the occupied time. If the space temperature(s) is 2°F less than the occupied heating set point during the lockout time, heating valve modulation is allowed. Valve operation permitted to prevent zones (not applicable to these modes) from falling below the occupied space temperature set point.
6. Heating Valve Lockout: Heating valve shall not modulate when the outside air temperature is above 65 °F (Adjustable) or the maximum zone heating demand is less than 10% (adjustable).

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 than32°F (adjustable) and the system is unoccupied, modulate cooling valve fully open. Also see cooling system sequences regarding this sequence.

I. Economizer Control:

1. Occupied Mode: Economizer dampers (Outside Air, Return Air and Relief Air) modulate to maintain mixed air temperature set point.
2. Night Low Limit, Optimal Start: Economizer operation permitted to prevent zones (not applicable to these modes) from exceeding the occupied space temperature set point.
3. Unoccupied, Low Limit Freeze Conditions: Dampers to modulate to full recirculation (0% Outside Air).
4. Night High Limit, Smoke Purge, and Night Purge Modes: Dampers to modulate to full ventilation (100% Outside Air).
5. Economizer Lockout: If the outside air temperature is greater than the return air temperature, then modulate dampers to the minimum position.
6. Outside Air Damper Modulation (OSA/Min OSA Dampers): Minimum outside air and outside air dampers will modulate proportionally based on the economizer control function output (PI algorithm) as described in the schedule below.

Min OSA/OSA Damper Position		
Economizer Control Output (%)	Minimum OSA Damper Position (%)	OSA Damper Position (%)
0	0	0
20	100	0
100	100	100

J. Zone Damper Control:

1. Occupied Mode: Zone dampers modulate based on individual space heating and cooling demands. Heating and cooling proportional/integral (PI) control loops shall be used for each zone and will control to the active space temperature set point. A single control loop with 50% bias may also be used. Designation heating and cooling demand should be interpreted accordingly for discharge air temperature reset in this case.

Zone Damper Control Schedule		
Zone Cooling Demand (%)	Zone Heating Demand (%)	Damper Position (%)
0-100	0	50% - 100%
0	0-100	50% - 0%

0% Damper Position - Fully Open to Hot Deck, closed to cold deck.
100% Damper Position - Fully Open to Cold Deck, closed to hot deck.

2. Night Low Limit, Optimal Start Modes: Applicable zone dampers shall modulate fully open to the hot deck (designated as 0% damper position). Zones not associated with these modes shall modulate as normal to prevent spaces from exceeding the occupied space temperature set point.
3. Night High Limit: Applicable zone dampers shall modulate fully open to the cold deck (designated as 100% damper position). Zones not associated with these modes shall modulate as normal to prevent spaces from falling below the occupied space temperature set point.
4. Unoccupied and Night Purge Modes: Zone damper modulate fully open to the cold deck (designated as 100% damper position).

K. Optimal Start Control (Heating Mode):

1. Optimal Start (General): The intent of the optimal start sequence is that the air handling system be started early enough so that all served spaces reach occupied heating setpoint no more than 20 minutes prior to or 10 minutes after scheduled occupancy.
2. Air handling systems may be started under the optimal start mode no more than 3 hours (adjustable) prior to scheduled occupancy.
3. Optimal Start Lockout: This optimal start sequence will be locked out when the 3 hour rolling average outdoor air temperature is greater than setpoint (initial setpoint, 55°F, adjustable). If locked out, the ASU will start 10 minutes (adjustable, maximum of 30 minutes) before the occupied time period.
4. Optimal Start Calculation:
   Air handling systems will be optimally started as a function of:
   a. Current Outdoor air temperature
   b. Current space temperature
   c. Time until start of scheduled occupancy
   d. Historical heating performance as a function of a, b, and c above.
5. Optimal Start Not Achieved: If the occupancy period starts and the system has not achieved the optimal start setpoint(s) then the system shall continue to operate in this mode (and with full recirculation) until the percent heating load greater than –75% (adjustable) or for 30 minutes (adjustable) at which time the system will revert to the normal occupied cycle or stand-by mode.
6. Optimal Start Enable/Disable: The optimal start sequence shall be enabled/disabled from the operator workstation.

L. Night Low Limit Mode:

1. Night low limit mode is initiated during unoccupied times (mode), when the space temperature falls below the unoccupied heating setpoint.
2. When all spaces served by the system are above the unoccupied heating setpoint plus the dead band setpoint (initial 5°F, adjustable), the system will revert to the unoccupied mode.
3. If the minimum hourly outside air temperature is less than 20°F (adjustable) in Western Oregon for the previous 12 (adjustable) consecutive hours, then the AHU will remain in operation during the unoccupied period. The system will maintain a setpoint temperature 10°F (adjustable) less than occupied setpoint. All outside air dampers will remain closed during the unoccupied period.

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:

1. This sequence is initiated before occupancy during the cooling season.
2. Night purge will be enabled when the following conditions are true:
   a. The average space temperature is above 80º F (adjustable).

b. Outside air temperature is greater than setpoint (initial setpoint, 45°F, adjustable).
c. Outside air relative humidity is less than 50%.
d. Outside air temperature is at least 10°F (adjustable) less than the average space temperature
d. Occupancy period occurs within 3 hours (adjustable).

3. Night purge will be disabled when average space temperature is within 3°F (adjustable) of the outside air temperature or the average space temperature has reach the occupied heating set point.

4.09 SEQUENCE OF OPERATION – CONSTANT VOLUME MULTI-ZONE AIR SUPPLY UNIT WITH HOT AND DX COOLING COILS (ASU-5)

A. Space Temperature Setpoints:

1. Default Setpoints:
   a. Occupied Heating Setpoint: 68 °F (adjustable)
   b. Occupied Cooling Setpoint: 72 °F (adjustable)
   c. Unoccupied Heating Setpoint: 55 °F (adjustable)
   d. Unoccupied Cooling Setpoint: 85 °F (adjustable)
2. Space Setpoint Adjustment: Setpoint adjustments shall be made at the operator workstation. Local setpoint adjustment is not applicable for this unit.
3. Space Temperature Setpoint Change Over: When the outside air temperature falls below 60 °F (adjustable) zones shall utilize the occupied heating set point for space temperature control. When the outside air temperature rises above 68 °F (adjustable) zones shall utilize the occupied cooling set point for space temperature control. This switch over sequence shall always be active to make adjustments as outside air temperatures change.

B. Hot Deck Discharge Air Temperature Setpoint Reset: Setpoint shall linearly reset based on the maximum zone heating demand proportional/integral (PI) control value. Setpoint reset is based on the following schedule.

Hot Deck Reset Schedule	
Maximum Zone Heating Demand (%)	Hot Deck Temperature Setpoint (F)
100	120
0-10	65

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:

1. Occupied, Night Low Limit, Night High Limit, Optimal Start, Night Purge Mode: Fan turns on for continuous operation.
2. Unoccupied Mode, Low Limit Freeze Mode and Fire Alarm (General): Fan remains off during these conditions.
3. Low Limit Freeze Lockout: If the freeze thermostat (device automatically resets) indicates a low limit condition three (3) times (adjustable) within 10 minutes (adjustable) the fans shall lockout (software). Lockout reset shall occur at the building operators workstation.

F. Return Fan Control: Return fan shall operate based on supply fan control.

G. Heating Valve Control:

1. Occupied Mode: Heating valve shall modulate to maintain hot deck temperature setpoint.
2. Night Low Limit, Optimal Start and Low Limit Freeze Conditions: Heating valve shall modulate fully open.
3. Unoccupied and Night High Limit Mode: Heating valve to modulate fully closed.
4. Night High Limit: Valve operation permitted to prevent zones (not applicable to these modes) from falling below the occupied space temperature set point.
5. Night Purge Mode: When night purge mode has been initiated, the heating valve shall not be enabled to operate for a minimum of 4 hours (adjustable) from the occupied time. If the space temperature(s) is 2°F less than the occupied heating set point during the lockout time, heating valve modulation is allowed. Valve operation permitted to prevent zones (not applicable to these modes) from falling below the occupied space temperature set point.
6. Heating Valve Lockout: Heating valve shall not modulate when the outside air temperature is above 65 °F (Adjustable) or the maximum zone heating demand is less than 10% (adjustable).

H. Cooling System Control:

1. Occupied Mode: Condensing unit shall be staged to maintain cold deck temperature setpoint.
2. Unoccupied, Night Low Limit, Night High Limit, Optimal Start, Night Purge and Low Limit Freeze Modes: Condensing unit off.
3. Cooling Lockout: Cooling shall not operate 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 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.

I. Economizer Control:

1. Occupied Mode: Economizer dampers (Outside Air, Return Air and Relief Air) modulate to maintain mixed air temperature set point.
2. Night Low Limit, Optimal Start: Economizer operation permitted to prevent zones (not applicable to these modes) from exceeding the occupied space temperature set point.
3. Unoccupied, Low Limit Freeze Conditions: Dampers to modulate to full recirculation (0% Outside Air).
4. Night High Limit, Smoke Purge, and Night Purge Modes: Dampers to modulate to full ventilation (100% Outside Air).
5. Economizer Lockout: If the outside air temperature is greater than the return air temperature, then modulate dampers to the minimum position.
7. Outside Air Damper Modulation (OSA/Min OSA Dampers): Minimum outside air and outside air dampers will modulate proportionally based on the economizer control function output (PI algorithm) as described in the schedule below.

Min OSA/OSA Damper Position		
Economizer Control Output (%)	Minimum OSA Damper Position (%)	OSA Damper Position (%)
0	0	0
20	100	0
100	100	100

J. Zone Damper Control:

1. Occupied Mode: Zone dampers modulate based on individual space heating and cooling demands. Heating and cooling proportional/integral (PI) control loops shall be used for each zone and will control to the active space temperature set point. A single control loop with 50% bias may also be used. Designation heating and cooling demand should be interpreted accordingly for discharge air temperature reset in this case.

Zone Damper Control Schedule		
Zone Cooling Demand (%)	Zone Heating Demand (%)	Damper Position (%)
0-100	0	50% - 100%
0	0-100	50% - 0%

0% Damper Position - Fully Open to Hot Deck, closed to cold deck.
100% Damper Position - Fully Open to Cold Deck, closed to hot deck.

2. Night Low Limit, Optimal Start Modes: Applicable zone dampers shall modulate fully open to the hot deck (designated as 0% damper position). Zones not associated with these modes shall modulate as normal to prevent spaces from exceeding the occupied space temperature set point.
3. Night High Limit: Applicable zone dampers shall modulate fully open to the cold deck (designated as 100% damper position). Zones not associated with these modes shall modulate as normal to prevent spaces from falling below the occupied space temperature set point.
4. Unoccupied and Night Purge Modes: Zone damper modulate fully open to the cold deck (designated as 100% damper position).

K. Optimal Start Control (Heating Mode):

1. Optimal Start (General): The intent of the optimal start sequence is that the air handling system be started early enough so that all served spaces reach occupied heating setpoint no more than 20 minutes prior to or 10 minutes after scheduled occupancy.
2. Air handling systems may be started under the optimal start mode no more than 3 hours (adjustable) prior to scheduled occupancy.
3. Optimal Start Lockout: This optimal start sequence will be locked out when the 3 hour rolling average outdoor air temperature is greater than setpoint (initial setpoint, 55°F, adjustable). If locked out, the ASU will start 10 minutes (adjustable, maximum of 30 minutes) before the occupied time period.
4. Optimal Start Calculation:
   Air handling systems will be optimally started as a function of:
   a. Current Outdoor air temperature
   b. Current space temperature

c. Time until start of scheduled occupancy
d. Historical heating performance as a function of a, b, and c above.

5. Optimal Start Not Achieved: If the occupancy period starts and the system has not achieved the optimal start setpoint(s) then the system shall continue to operate in this mode (and with full recirculation) until the percent heating load greater than –75% (adjustable) or for 30 minutes (adjustable) at which time the system will revert to the normal occupied cycle or stand-by mode.
6. Optimal Start Enable/Disable: The optimal start sequence shall be enabled/disabled from the operator workstation.

L. Night Low Limit Mode:

1. Night low limit mode is initiated during unoccupied times (mode), when the space temperature falls below the unoccupied heating setpoint.
2. When all spaces served by the system are above the unoccupied heating setpoint plus the dead band setpoint (initial 5°F, adjustable), the system will revert to the unoccupied mode.
3. If the minimum hourly outside air temperature is less than 20°F (adjustable) in Western Oregon for the previous 12 (adjustable) consecutive hours, then the AHU will remain in operation during the unoccupied period. The system will maintain a setpoint temperature 10°F (adjustable) less than occupied setpoint. All outside air dampers will remain closed during the unoccupied period.

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:

1. This sequence is initiated before occupancy during the cooling season.
2. Night purge will be enabled when the following conditions are true:
   a. The average space temperature is above 80º F (adjustable).
   b. Outside air temperature is greater than setpoint (initial setpoint, 45°F, adjustable).
   c. Outside air relative humidity is less than 50%.
   d. Outside air temperature is at least 10°F (adjustable) less than the average space temperature
   d. Occupancy period occurs within 3 hours (adjustable).
3. Night purge will be disabled when average space temperature is within 3°F (adjustable) of the outside air temperature or the average space temperature has reach the occupied heating set point.

4.10 BOILER OPERATION

A. System Enable/Disable: Enable boiler and lead pump when any two (2) (adjustable) valves being open more than 20% (adjustable). Disable boiler when all valves are closed more than 5% (adjustable) or the outside air temperature is above 65°F (adjustable). Boiler control panel to modulate boilers based on remote setpoint. Establish run status of main loop pump prior to all boiler operation. Note: Boiler outside air lockout is redundant due to individual unit heating valve lockouts however it provides a way to globally lockout out heating when demand is not a concern.

B. Building Heating Demand Calculation: Building heating demand will be calculated by taking the sum of all the heating control valve positions, weighted by the scheduled valve flow rate and averaged by the total combined flow rate for all of the valves.

$$Heating\ \ Demand_{Building} = \frac{\sum_{i=1}^{total\ \#\ of\ valves}\left(Heating\ Valve\ Postion_i \times \frac{1}{100} \times Scheduled\ \ Flow\ Rate_i\right)}{Total\ Flow\ Rate}$$

C. Boiler Supply Water Setpoint Reset: Supply water temperature setpoint shall linearly reset based on the building heating demand as described in the following schedule:

Boiler Supply Water Reset Schedule	
Building Heating Demand (%)	Supply Water Set Point (F)
0	120
>75	180

**All reset values shall be adjustable through the operator's workstation.

D. Heating Control Valve: Valve shall modulate to maintain supply water temperature setpoint. Minimum valve position is 10% (adjustable) to ensure flow through the boiler at all times during operation. Valve to modulate to 100% (fully open to system) when boiler operation is disabled to remove heat during pump rundown cycle.

E. Pump Disable: Main loop pumps shall operate for five (5) minutes after boiler operation has been disabled to avoid boiler damage.

F. Minimum System Cycle Time: Once boilers/pumps have been disabled the system shall remain disabled for a minimum of fifteen (15) minutes to prevent shot-cycling by allowing demand to build when transitioning between heating and cooling modes.

G. Pump Lead/Lag: Operate pumps based on lead/lag. On failure of lead pump, operate lag pump and send alarm. Switch lead operation every one hundred (100) (adjustable) hours of run time. Lead selection shall also be selectable from the operator's workstation, resetting the current run-hours-until-switch when used. When switching from lead pump to lag pump allow both pumps to operate a minimum of fifteen (15) seconds before disabling the lead pump.

H. System Lockout: If each pump fails three (3) times during an operational period the system shall lockout and an alarm sent to the workstation. Lockout is resettable from the operator's workstation.

I. Low Outside Air Temperature Loop Pre-Heat: When the outside air temperature is less than 32°F (adjustable, dead band: 3°F) and the system is not in operation (0% building heating demand) the system shall be enabled, and operate the boiler and lead pump at maximum heating capacity until the return water temperature is 140°F. The boiler will then cycle off (pumps continue to operate) until the return water temperature falls below 120°F. Cycle will continue until the system is enabled based on the building heating demand schedule or outside air temperatures rise above the setpoint plus the dead band.

4.11 SEQUENCE OF OPERATION - CHILLER

A. Building Cooling Demand Calculation: Building cooling demand shall be calculated by taking the sum of all the cooling control valve positions, weighted by the scheduled valve flow rate and averaged by the total combined flow rate for all of the valves.

$$Cooling\ \ Demand_{Building} = \frac{\sum_{i=1}^{total\ \#\ of\ valves}\left(Cooling\ Valve\ Postion_i \times \frac{1}{100} \times Scheduled\ \ Flow\ Rate_i\right)}{Total\ Flow\ Rate}$$

B. Chiller Supply Water Setpoint Reset: Supply water temperature setpoint shall be linearly reset based on the building cooling demand as described in the following schedule:

Chiller Supply Water Reset Schedule	
Building Cooling Demand (%)	Supply Water Set Point (F)
0	55
>75	45

**All reset values shall be adjustable through the operators workstation.

C. Tower Operation: cooling tower low water alarm/lockout, cooling tower heat trace and pan heater, and sump pump are controlled by tower controller package controller. Enable / disable on signal from chiller. Operate slow speed and high speed motors on tower fan to maintain the system leaving water temperature setpoint (85°F (adjustable)). First stage of operation at the tower is opening of the discharge dampers and operation of the pan pump. Second stage shall operate the fan motor as noted above. Close dampers when tower is disabled. Pan heater and condensing water heat trace operation shall remain under the control of the tower's control panel.

D. Condenser Pump Control: When pump is enabled, VFD shall modulate from minimum speed (25% adjustable) to maintain system static pressure. Enable lag pump if lead is at full speed for more than 5 (adj.) minutes. Disable lag if both pumps have operated for 5 minutes at less than half speed. When pumps are disabled, VFD speed is set to 0%.

E. Chilled Water Pump Enable/Disable (CWP-1, CWP-2): Lead pump operation will be enabled if any two (2) (adjustable) valves are open more than 20% (adjustable). Operate to maintain system static pressure. Enable lag pump if lead is at full speed for more than 5 (adj.) minutes. Disable lag if both pumps have operated for 5 minutes at less than half speed. Disable chilled water pump five (5) minutes after chiller operation has been disabled.

F. Chiller Enable/Disable: Chiller shall be enabled when lead pump run status is proven. Disable chiller when all valves are closed more than 5% (adjustable) or the outside air temperature is below 55°F (adjustable). Chiller will maintain remote supply water setpoint internally.

G. Pump Lead/Lag (CDP-1/CDP-2, CWP-1/CWP-2): Operate pumps based on lead/lag. On failure of lead pump, operate lag pump and send alarm. Switch lead operation every one hundred (100) (adjustable) hours of run time. Lead selection shall also be selectable from the operator's workstation, resetting the current run-hours-until-switch when used. When switching from lead pump to lag pump allow both pumps to operate a minimum of fifteen (15) seconds before disabling the lead pump.

H. System Lockout: If any system critical pump fails three (3) times during an operational period the system shall lockout and an alarm sent to the workstation. If the LWT exceeds 110°F (adjustable) during an operational period system shall lockout and an alarm sent to the workstation. Lockout(s) is resettable from the operator's workstation.

I. Refrigerant Monitoring Alarm: If the refrigerant monitoring alarm is active, send alarm to the operator workstation and disable all chilled and condensing water equipment from operation. Minimum wait time before restarting equipment is five (5) minutes regardless of alarm status.

4.12 EXHAUST FANS (EF-1 THROUGH EF-9)

A. Mechanical Room Exhaust Fan (EF-7, EF-8): Operate when space temperature exceeds 80º F (adjustable). Scheduling not associated with this unit.
1. Automatic Damper Control (EF-7/AUD-7, EF-8/AUD-8): Open damper when associated exhaust fan is in operation.

B. General Exhaust (EF-1, EF-2, EF-4, EF-5, and EF-6): Operate with ASU-4, ASU-2, ASU-2, ASU-1, and ASU-3 respectively, based on building schedule. See mechanical control diagram. Enable in Smoke Purge mode of associated air handler.

C. Smoke Evacuation Fans (EF-9, 10 and 11): Fans shall be enabled when the fire alarm (general) is active. This control is through the existing fireman's control panel.

D. Projection Room Fan (EF-3): Fan is permitted to operate during occupied times based on the fan enable switch status. Fan is disabled during unoccupied times regardless of switch status. Operate on with Smoke Purge mode for ASU-5.

4.13 UNIT HEATERS (UH-1, UH-2 AND CUH-1)

A. General Operation: Operate units with associated unit based on the following schedule. Heater control temperature shall not initiate night low limit, night high limit, optimal start, night purge sequences.

(Cab) Unit Heater Sequence Interlock Schedule	
Unit	Operate with associated unit sequences
CUH-1	ASU-4
UH-1	Operation permitted with ASU-4. Unit enabled/disabled based on space mounted switch.
UH-2	N/A

B. Fan and Heating Valve Operation: When associated unit heating sequences (night low limit, optimum start and occupancy) are active valve shall modulate to maintain space heating setpoint, 68º F (adjustable). Operate fan when unit heating demand is greater than 5%.

4.14 DOMESTIC RECIRCULATION SYSTEM

A. When the current selected schedule is active operate domestic hot water recirculation pump based on return water temperature set point (120°F, adjustable). Provide 3°F (adjustable) dead band for pump operation.

4.15 ENGINEERS AND FIREMANS CONTROL PANEL

A. Existing fireman's control panel operation and interlocks shall remain in place. All BMS control system interlocks should not affect control panel operation.

B. The 24 volt power supply to both the engineers and fireman's control panel shall remain for operation of the fire fireman's panel. Remove the building engineer's panel and all wiring associated with it that is not necessary for the fireman's panel.

C. The existing fire alarm input signal to the fireman's panel shall remain unaltered.

D. The 24 volt control voltage derived from the air handler starter to the fireman's panel as an input under normal operation shall be retained.

E. Monitor position of 5 fireman's panel switches or output value. On signal that existing switch is in manual position signal associate air handler OSA damper 100% open. One switch each controls ASU-1, 2, 6.

F. Fans with two speed operation to operate high speed fan per current control of starter. Fans with VFD operation to be under static pressure control with no reset and VAV terminals 100% open.

G. Fireman's control has ultimate control per current sequence. Temperature control, freeze protection, high pressure limit control, etc. shall be in operation but shall not disable fan operation under operation alarm.

4.16 MISCELLANEOUS

A. Elevator Sump Pit: Alarm on sensor witnessing water.

B. Roof Drains: Alarm on sensor witnessing water.

4.17 CONTROL SYSTEM USER ACCOUNT DATABASE ACCESS CONFIGURATION

A. Full Access: Two (2) customer user accounts shall be configured with full viewing and editing access to all objects within the system.

B. Low Level Access: Three (3) customer user accounts shall be configured with access to full viewing, setpoint changes, user entry overrides, software lockout resets, scheduling time changes (excluding equipment schedule interlocks). Manual overrides, programming, database and graphics manipulation is restricted.

C. Read Only Access: One (1) customer user account shall be configured with access to full viewing only (all graphics, programming and database objects). All other access is restricted.

4.18 DIAGNOSTICS

A. In addition to the standard alarm limits specified for all sensed points, BAS shall provide the following diagnostics for each AH and VAV terminal box where applicable.

B. A level 4 alarm message should be sent if: The mixed air temperature is less than 55°F or greater than 80°F

Level 4 alarm message is "Energy waste: An unexpected mixed air temperature at (AH). indicates a possible problem with the economizer damper controls. Please check for faulty dampers or controls"

C. A level 4 alarm message should be sent if: The mixed air temperature, discharge air temperature, and the outside air temperature are not equal when the system is operating at 100% outside air and the heating and cooling valve coils have been fully closed for at least two hours (adjustable). Note: Include in comparison the temperature difference caused by fan energy as it relates to discharge air temperature. If differential between sensors is greater than 5.0ºF, then send alarm.

Level 4 alarm message is "Mixed air temperature, discharge air temperature, and the outside air temperature are out of calibration at (AH)."

D. A level 4 alarm message should be sent if: Any equipment operates for 24 consecutive hours.

Level 4 alarm message is "The has operated 24 consecutive hours. Check software and manual overrides."

E. A level 4 alarm message should be sent if: Any VFD controlled motor operates at full speed for 24 consecutive hours.

Level 4 alarm message is "The motor has operated 24 consecutive hours at full speed. Check software and manual overrides."

F. A level 4 alarm message should be sent if: The temperature difference between the refrigerant supply and return is greater than 8°F (set value using manufacturer documentation).

Level 4 alarm message is "The refrigerant charge should be check to help avoid compressor failure or lost efficiency."

G. A level 4 alarm message should be sent if: CO2 levels rise above the alarm setpoints (10% above control setpoint).

Level 4 alarm message is "CO2 levels have exceeded operational limits by 10%. Check device and outside air damper operation"

H. A level 4 alarm message should be sent if: Low Limit Freeze Lockout is active.

Level 4 alarm message is "[Unit Tag] is locked out due to multiple low limit freeze conditions. Check device and heating valve operation".

I. A level 4 alarm message should be sent if: Duct over pressurization lockout is active.

Level 4 alarm message is "[Unit Tag] is locked out due to multiple duct over pressurization instances. Check device and supply side damper operation".

END OF SECTION

SECTION 23 21 00
HYDRONIC PIPING AND PUMPS

PART 1 GENERAL

1.01 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.

C. Work related to this section is only required where:
   1. Piping and valves are change/modified at the chiller in the Arlene Schnitzer Building.
   2. Piping and valves are change/modified at several air handlers at the Keller Auditorium.

1.02 QUALITY ASSURANCE

A. General: ASTM and ANSI Standards are indicated. In addition, special standards are referenced where neither ASTM nor ANSI Standards are applicable.

B. Labeling: All piping shall be continuously and legibly labeled on each length as required by codes and standards and including as a minimum, country of origin, manufacturers identification marking, wall thickness designation, and applicable standards and approvals. Fittings shall be labeled as required by the referenced standard.

C. Definitions: Where piping fluid is not indicated in the following paragraphs, provide similar piping materials for similar fluids.

1.03 STORAGE AND HANDLING

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

1.04 SUBMITTALS

A. Submit catalog data, construction details, performance characteristics for all equipment.

B. Submit operating and maintenance data.

PART 2 PRODUCTS

2.01 PIPING MATERIALS

A. Black Steel Pipe:

   1. Applications:
      a. Heating water
      b. Chilled 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.
      e. Facing and Gasketing: Selected for service pressures and temperatures. Full-faced for cast iron and raised face for steel flanges.

6. Grooved Fittings: For above ground liquid installations only, of grooved or shouldered end designed to accept grooved mechanical couplings without field preparation. Match gaskets for service and temperature indicated.
   a. Malleable Iron: ASTM A-47.
   b. Ductile Iron: ASTM A-536.
   c. Fabricated Steel: ASTM A-53, 3/4" to 1-1/2" Type F; 2"-20" Type E or S, Grade B.
   d. Steel: ASTM A-234, (A-106, Gr. B) (11"-24" 45 degree and 90 degree elbows).
   e. Manufacturers: Victaulic, or accepted substitute.

2.02 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Insulating (Dielectric) Fittings: Provide standard products recommended by the manufacturer for use in the service indicated, and which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and reduce corrosion. Victaulic "Clear Flow."

B. Welding Materials: Provide welding materials as determined by the installer to comply with installation requirements.

C. 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.

D. 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.

E. Strainers: "Y-pattern," iron or bronze body (depending on pipe system) rated for pressures indicated with blow-off connection and 20 mesh stainless steel screen.

F. Valves up to 12":

1. Ball (to 2"): Two-piece, cast bronze body, full port, 600 psi WOG, T/S 585-70.
2. Butterfly: Ductile iron body, aluminum bronze disc, 200 psi WOG, Lugged body – LD-2000, Wafer body – WD-2000, Grooved body – GD-4765.

2.03 HEATING AND CHILLED WATER SPECIALTIES

A. Air Vents: Install at all system high points whether shown or not; 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 Taco, Bell & Gossett, Armstrong, Dunham-Bush approved substitute.

B. Flow Limiting Balance Valve: Install where shown on plans, flow metering fittings complete with quick disconnect, flow meter valves, with safety shut-off valves and with size and series identification tags. Install as recommended by manufacturer, Griswold or approved substitute.

C. Circuit Setter and Balancing Valves: Calibrated ball valve style balancing fitting with differential pressure taps, brass or bronze body and trim. Bell & Gossett, Taco, or approved substitute. At Contractor's option, balancing valves 3" and larger may be butterfly style valves**.** Use only on small systems.

PART 3 EXECUTION

3.01 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.

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.

3.02 PIPING JOINTS

A. General: Provide joints of the type indicated in each piping system, and where piping and joint as manufactured form a system, utilize only that manufacturer's material.

B. Ferrous Threaded Piping: Thread pipe in accordance with ANSI 82.l; 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. 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.
4. 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".
5. 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.
6. Do not weld out piping system imperfections by tack-welding procedures; refabricate to comply with requirements.
7. Install forged branch-connection fittings wherever branch pipe is indicated, or install regular "T" fitting at Contractor's option.

D. 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.

E. Grooved Pipe Joints: Comply with fitting manufacturer's instructions for making grooves in pipe ends. Remove burrs and ream pipe ends. Assemble joints in accordance with manufacturer's instructions.

F. Insulating (Dielectric) Fittings: Comply with manufacturer's instructions for installing unions or fittings. Install in a manner which will prevent galvanic action and stop corrosion where the "joining of ferrous and non-ferrous piping" is indicated.

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

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

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

J. Expansion: Provide loops, swing joints, anchors, runouts and spring pieces to prevent damage to piping or equipment.

3.03 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.

3.04 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.

3.05 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 and Chilled Water Piping Systems:

1. Clean cutting oil and threading debris from piping as installed.
2. Circulate entire system for four (4) hours.
3. Clean strainers at all coils whether work was conducted at units, chillers, boilers, etc., or not.
4. Test heating and chilled water for proper pH and other chemical treatment. Bring treatment to industry standard levels. Provide documentation of work conducted.
5. If cleaning and treating work is not completed as noted above, services shall be provided as listed below.
    a. Drain entire system and add cleaning chemical in proper concentration to clean system of manufacturing and installation contamination and residue.
    b. 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.
    c. Test for pH and add sufficient amount of the cleaning chemical to obtain a pH between 7 and 8.
    d. Clean all strainers after the system has operated for one week.

3.06 TEST

A. General:

1. Minimum duration of two hours or longer, as directed for all tests. Furnish report of test observation signed by qualified inspector. Make all tests before applying insulation, backfilling, or otherwise concealing piping or connecting fixtures or equipment. Where part of the system must be tested to avoid concealment before the entire system is complete, test that portion separately, same as for entire system.
2. Provide all necessary temporary equipment for testing, including pump and gauges. Remove control devices before testing and do not use piping system valves to isolate sections where test

pressure exceeds valve pressure rating. Fill each section with water and pressurize for the indicated pressure and time.

3. Observe each test section for leakage at end of test period. Test fails if leakage is observed or if pressure drop exceeds 5% of test pressure.

B. Repair:

1. Repair piping system sections which fail the required piping test by disassembly and re-installation, using new materials to the extent required to overcome leakage. Do not use chemical stop-leak compounds, solder, mastics, or other temporary repair methods.
2. Drain test water from piping systems after testing and repair work has been completed.

END OF SECTION