

INVITATION TO BID

Haines Borough Library Building Controls Conversion

Issue Date: March 24, 2014



Bid Deadline: 2:00pm Thursday, April 10, 2014

NOTICE INVITING BIDS AND BIDDER INSTRUCTIONS
Haines Borough Library Building Controls Conversion
Issue Date: March 24, 2014

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NOTICE INVITING BIDS AND BIDDER INSTRUCTIONS
Haines Borough Library Building Controls Conversion

Issue Date: March 24, 2014

The Haines Borough is soliciting sealed bids from qualified and licensed contractors to perform the work for the **Haines Borough Library Building Controls Conversion** project.

RECEIPT OF BIDS / BID DEADLINE: Bids will be accepted until 2:00 p.m., Local Time, Thursday, April 10, 2014, at the Office of the Borough Clerk in the Borough Administration Building in Haines, Alaska. Bids must be mailed or hand-delivered and will not be accepted by email or fax.

Submit Bids to:

<u>Physical Address:</u> Office of the Borough Clerk Borough Administration Building 103 Third Ave S. Haines, Alaska	<u>Mailing Address:</u> Haines Borough Attn: Borough Clerk PO Box 1209 Haines, AK 99827
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BID OPENING: The bid opening will be shortly after 2:00 p.m. on the same date in the Borough Administration Building conference room.

BID DOCUMENTS: A Bid packet including instructions, forms, specs, and drawings is available on the Haines Borough website: www.hainesalaska.gov/rfps for viewing and printing.

If prospective bidders request that borough staff print the documents, the cost will be 25 cents per standard 8½x11 page and 50 cents per 11x17 page. (Each side of a page counts as one.)

QUESTIONS:

For questions regarding viewing and printing:

Attn: Michelle Webb, Interim Borough Clerk
103 Third Ave / P.O. Box 1209, Haines, AK 99827
Phone: 907-766-2231 ext.36
Email: mwebb@haines.ak.us

For technical questions:

Attn: Doug Murray
Murray and Associates, P.C.
907 Capitol Avenue
Juneau, Alaska 99802
Telephone: (907) 780-6151
Email: doug@murraypc.com

All technical communications and questions must be submitted in writing to the Project Engineer, Doug Murray. Questions and responses will be posted to the Haines Borough website at www.hainesalaska.gov.

DESCRIPTION OF WORK: The work consists of the replacement of the mechanical systems electronic controls at the Haines Borough Public Library with direct digital controls (DDC) type. The project is located in Haines, Alaska.

PROJECT SCHEDULE: The Haines Borough anticipates the following project schedule:

Request for Bids Issued	March 24, 2014
Receive and Open Bids	April 10, 2014
Borough Assembly Authorization	April 22, 2014
Notice of Intent to Award	April 23, 2014
Notice to Proceed	May 1, 2014 (approximate)
Project Completion	Substantial Completion: August 1, 2014 Final Completion: September 1, 2014

REQUIRED BID SUBMITTALS: To be considered, all bidders must include the following at the time of the bid opening:

- One copy of the Bid Form signed in ink by an authorized representative of the business;
- Non-Collusion Affidavit;
- Copy of a current Alaska business license;
- Copy of a current Haines Borough business license;
- Copy of an Alaska contractor's certificate of registration;
- Acknowledgement of all addenda;
- A bid bond of at least five-percent of the amount of the bid or a certified check drawn to the Haines Borough in like amount. Checks and bid bonds will be returned to unsuccessful bidders; and
- Sealed in an envelope clearly labeled with the bidder's business name and "*Haines Borough Library Building Controls Conversion.*"

BID MODIFICATIONS: Any bidder may modify a Bid by mail, telegram, email, or fax (**Fax: 907-766-2716**) up to the scheduled closing time for receipt of Bids, provided that such modification is received by the Haines Borough prior to the time set for opening of Bids. Bidders are strongly advised to telephone the Haines Borough (**Telephone: 907-766-2231**) to confirm the successful and timely transmission of all Bid modifications. A bid modification should not reveal the Bid price but should provide the addition or subtraction or other modification so that the final prices will not be known by the Borough until the sealed Bid is opened. Modifications shall include both the modification of the unit bid price and the total modification of each item modified. The Borough shall not be responsible for its failure to receive modifications, whether such failure is caused by transmission line problems, fax device problems, operator error or otherwise.

Unauthorized conditions, limitations, or provisos attached to the Bid will render it informal and cause its rejection as being non-responsive. The completed bid forms shall be without interlineations, alterations, or erasures in the printed text. All changes shall be initialed by the person signing the Bid. Alternative Bids will not be considered unless called for.

DISCREPANCIES IN BIDS: In the event there is more than one pay item in a Bid Schedule, the Bidder shall furnish a price for all pay items in the schedule, and failure to do so may render the Bid non-responsive and cause its rejection. In the event there are unit price pay items in a Bid Schedule and the "amount" indicated

for a unit price pay item does not equal the product of the unit price and quantity, the unit price shall govern and the amount will be corrected accordingly, and the Bidder shall be bound by said correction. In the event there is more than one pay item in the Bid Schedule and the total indicated for the schedule does not agree with the sum of the prices bid on the individual items, the prices bid on the individual items shall govern and the total for the schedule will be corrected accordingly, and the Bidder shall be bound by said correction.

WITHDRAWAL OF BID: The Bid may be withdrawn by the Bidder by means of a written request, signed by the Bidder or its properly authorized representative. Such written request must be delivered to the place stipulated in the Notice Inviting Bids for receipt of Bids prior to the scheduled closing time for receipt of Bids. Bids may not be withdrawn for sixty days following the date of opening.

QUALIFICATIONS OF BIDDERS: To demonstrate qualifications to perform the work, each Bidder must be prepared to submit evidence within 5 days after Bid opening, and upon the Borough's written request, such as financial data, previous experience, and present commitments. Nothing indicated herein will prejudice the Borough's right to seek additional pertinent information as evidence of Bidder's qualifications for the work prior to contract award.

EXAMINATION OF BID DOCUMENTS AND SITE: It is each Bidder's responsibility, before submitting a Bid, to:

1. Examine thoroughly the Bid Documents and other related data identified in the Bidding Documents (including "technical data" referred to below);
2. Inspect the site to become familiar with and satisfy Bidder as to the general, local, and site conditions that may affect cost, progress, performance, or furnishing of the work;
3. Consider federal, state, and local laws and regulations that may affect cost, progress, performance, or furnishing of the work;
4. Study and carefully correlate Bidder's knowledge and observations with the Bid Documents and such other related data; and
5. Promptly notify, in writing, the Borough Clerk or Director of Public Facilities of all conflicts, errors, ambiguities, or discrepancies which Bidder has discovered in or between the Bid Documents and such other related documents.

The submission of a Bid will constitute an incontrovertible representation by Bidder that Bidder has complied with every requirement of this section; that without exception the Bid is premised upon performing and furnishing the work required by the bidding Documents and applying the specific means, methods, techniques, sequences, or procedures of construction (if any) that may be shown or indicated or expressly required by the Bidding Documents; that Bidder has given the Haines Borough written notice of all conflicts, errors, ambiguities, and discrepancies that Bidder has found.

OWNER'S RIGHTS RESERVED: The Haines Borough reserves the right to reject any or all Bids, to waive any informality in a Bid, and to make award to the lowest responsive, responsible Bidder as it may best serve the interests of the Borough.

RETURN OF BID BOND: Within 14 days after award of the contract, the Borough will return the Bid securities accompanying such Bids not considered in making the award. All other Bid securities will be held until the Agreement has been executed. They will then be returned to the respective Bidders whose Bids they accompanied.

GENERAL CONTRACT CONDITIONS

- **PRODUCT**: All Plans, original drawings, electronic files, specifications, reports, photographs, and other documents relative to a project which the respondent prepares or causes to be prepared in connection with services performed shall be delivered to and become the property of the Borough.
- **INSURANCE**: The professional services provider to whom a contract is awarded may be required to furnish to the borough evidence of insurance coverage(s) including general liability, professional liability, and workers compensation insurance, as appropriate.
- **INSURANCE NOT LIMITING CONTRACTOR'S LIABILITY**: The provisions of this contract requiring insurance shall not limit the liability of the Contractor or anyone acting on behalf of the Contractor.
- **INDEMNITY**: Contractor agrees to defend, indemnify and hold the Borough harmless from any and all claims, demands or liability for bodily injury or death of any person, or damage to property arising out of the Contractor's execution of the contractual duties of the Contractor, its agents, employees or assigns.
- **DAMAGE TO BUILDINGS OR EQUIPMENT**: Any problems, including building or equipment damage, caused by or discovered by the Contractor during the execution of the contractual duties of the Contractor should be reported immediately.
- **COMPLIANCE WITH LAWS**: The Contractor and all persons acting on behalf of the Contractor shall comply with all applicable laws and regulations of Federal, State or Local government agencies with respect to the activities of the Contractor or anyone acting on behalf of the Contractor. This includes minimum rates of pay for public improvement projects exceeding \$25,000.
- **LIENS AND ASSESSMENTS**: The Contractor agrees that it will pay all employment security contributions required to be paid as a result of any services performed for the Borough regardless of whether they are performed by the Contractor or someone engaged by the Contractor. The Contractor shall not allow any lien to be placed against the Borough by reason of non-payment of such contributions or any other reason, and shall indemnify the Borough against any such lien.
- **EXPENSES AND ATTORNEY'S FEES UPON DEFAULT**: Contractor agrees to pay all actual costs, expenses and actual attorney's fees incurred by the Borough upon an Event of Default.
- **DEFAULT**: The Contractor shall be declared in default of the contract if the Contractor fails to adequately perform the contract services. If, in the opinion of the Borough, the Contractor's services do not adequately fulfill the intent of the contract, the Borough Clerk shall notify the Contractor in writing of service deficiencies. If the Contractor fails to correct such deficiencies within ten days of receiving this written notice, or consistently fails to provide adequate services as documented in writing by the Borough, the contractor shall be in default of the contract and the Borough shall terminate the contract.
- **BILLING/PAYMENT**: Requests for payment for performed services shall be submitted to the Borough and will be processed for payment at the time of the next accounts payable check run.
- **INSURANCE**: Without limiting the Contractor's indemnification, the Contractor shall purchase at its own expense and maintain in force at all times during the performance of services under Contract the following policies of insurance. The Haines Borough shall be named as "additional insured." Where specific limits are shown, it is understood that they shall be the minimum acceptable limits. If the Contractor's policy contains higher limits, the Haines Borough shall be entitled to coverage to the extent of such higher limits. Failure to maintain insurance is a material breach and grounds for termination of the Contractor's services.

(a) Worker's Compensation Insurance: The Contractor shall provide and maintain, for all employees of the Contractor engaged in work under this Contract, Worker's Compensation Insurance as required by AS 23.30.045. The Contractor shall be responsible for Worker's Compensation Insurance for any subcontractor who directly or indirectly provides services under this Contract. If the Contractor does not have employees, this insurance requirement is waived.

(b) General Liability Insurance: The Contractor must maintain General Liability Insurance in an amount sufficient to cover any suit that may be brought against the Contractor. This amount must be at least five-hundred thousand dollars (\$500,000) combined single limit. The Contractor must assume all insurable risks and bear any loss or injury to property or persons occasioned by neglect or accident during the terms of this Contract, except for sole negligence on the part of the Borough.

(c) Comprehensive Automobile Liability Insurance: Covering all vehicles utilized in connection with this project with coverage limits not less than \$100,000 per person, \$300,000 per occurrence bodily injury, and \$50,000 Property damage.

- **CONDUCT OF THE WORK**: The conduct of the bid and the conduct of the Work will be governed by Haines Borough Code, the Contract Documents, and, where the contract documents are silent, the Standard General Conditions of the Construction Contract (available on the borough's website: www.hainesalaska.gov/rfps). Information obtained from an officer, agent or employee of the Borough or any other person shall not affect the risk or obligations assumed by the Contractor or relieve the contractor from fulfilling any of the conditions of the contract.
- **RATES OF PAY AND REPORTING PAYROLL**: This project is governed by Alaska Statute Title 36, Public Contracts. The Contractor is required to compensate employees in accordance with Alaska Department of Labor & Workforce Development Wage and Hour Administration Pamphlet No. 600 (available on the borough's website: www.hainesalaska.gov/rfps). The Contractor is required to report and certify payroll in accordance with instructions contained in the Pamphlet.

HAINES BOROUGH
Haines Borough Library Building Controls Conversion

BID SCHEDULE

Bid of _____ (hereinafter called *Bidder*), doing business as (underline one) a corporation, partnership or individual, to the Haines Borough (hereinafter called *Borough*). The Bidder agrees to furnish to the Haines Borough all information and data that may be requested to give evidence that the undersigned is properly qualified to carry out the obligations of the Contract Documents.

The undersigned Bidder agrees, if this bid is accepted, to furnish all tools, equipment, supplies, manufactured articles, labor, materials, services and incidentals, and to perform all work necessary to complete the work required under the Invitation to Bid by the completion dates and to accept as full payment the Contract Price stated on this Bid Form, and in the manner stipulated by the Request for Bids, subject to any negotiated changes in the work that might increase or decrease the contract amount. The Borough reserves the right to reject any and all bids and negotiate with the responsible bidder submitting the lowest bid amount.

Bidder accepts all of the terms and conditions of the Request for Bids and, if this bid is accepted, will furnish, within ten calendar days after the Notice of Intent to Award letter, the following documents required by borough code for this project:

1. *Contract document or Agreement;*
2. *[Proof of insurance: general liability, auto insurance, worker's compensation];*
3. *Any overdue unpaid debts owed the borough must be current prior to award;*
4. *Payment and Performance bonds, if applicable; and*
5. *Subcontractor report, if applicable.*

Bidder acknowledges receipt of the following addenda: Addendum #.____ Initials:____ Addendum #.____ Initials:____

Total BASE BID (Price in Digits): _____

BIDDER INFORMATION:

Principal Contact: _____

Business Name: _____

Business Physical Address: _____

Business Mailing Address, if different: _____

Phone: _____ Fax: _____ Email: _____

Bidder's Authorized Signature

Printed Name

Date

HAINES BOROUGH
Haines Borough Library Building Controls Conversion

NON-COLLUSION AFFIDAVIT

UNITED STATES OF AMERICA)

STATE OF ALASKA)

I, _____ of _____,
(Printed Name of Person Signing) (Printed Name of Business)

being duly sworn, so depose and state:

That I, or the firm, association or corporation of which I am a member, a BIDDER on the contract to be awarded, by the Assembly of the HAINES BOROUGH for the contract services designated as:

Haines Borough Library Building Controls Conversion

Located in Haines, Alaska, have not, either or indirectly, entered into any agreement, participate in any collusion, or otherwise taken any action in restraint of free competitive bidding in connection with such contract.

Signature Date

Subscribed and sworn to this ____ day of _____, 2014.

Notary Public _____

My Commission Expires: _____

HAINES BOROUGH
Haines Borough Library Building Controls Conversion
BID BOND

KNOW ALL MEN BY THESE PRESENTS, that we, the undersigned

_____ as Principal and

_____ as Surety,

are hereby held and firmly bound unto the HAINES BOROUGH, as OWNER, in the penal sum of _____ Dollars (\$_____) for the payment of which, well and truly to be made, we hereby jointly and severally bind ourselves, our heirs, executors, administrators, successors and assigns.

Signed this _____ day of _____, 2014.

The condition of the above obligation is such that whereas the Principal has submitted to the HAINES BOROUGH, ALASKA a certain BID, attached hereto and hereby made a part hereof to enter into a contract in writing, for:

Haines Borough Library Building Controls Conversion

NOW, THEREFORE

- (a) If said BID shall be rejected, or
- (b) If said BID shall be accepted and the Principal shall

execute and deliver a contract in the Form of Contract attachment hereto (properly completed in accordance with said BID) and shall furnish a BOND for faithful performance of said contract, and for the payment of all persons performing labor furnishing materials or equipment in connection therewith, and shall in all other respects perform the agreement created by the acceptance of said BID, then this obligation shall be void, otherwise the same shall remain in force and effect; it being expressly understood and agreed that the liability of the Surety of any and all claims hereunder shall in no event, exceed the penal amount of this obligation as herein stated.

The Surety, for value received, hereby stipulates and agrees that the obligations of said Surety and its BOND shall be in no way impaired or affected by an extension of the time within which the OWNER may accept such BID; and said Surety does hereby waive notice of any such extension.

IN WITNESS WHEREOF, the Principal and the Surety have hereunto set their hands and seals, and such of them as are corporations have caused their corporate seals to be hereto affixed and these presents to be signed by their proper officers, and day and year first set forth above. *Note: Surety companies executing BONDS must appear on the Treasury Department's most current list and be authorized to transact business in Alaska.*

Principal

(SEAL) BY: _____

Surety

(SEAL) BY: _____

SECTION 230510 - GENERAL MECHANICAL HVAC

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The Mechanical Work is governed by the entire Specifications and not just Division 23. The entire Specifications must be examined for requirements relating to the Work hereunder. The Work covered by this and all other Mechanical sections consists of furnishing labor, equipment, and materials in accordance with the Specifications or Drawings, or both, together with any incidental items not shown or specified which can be reasonably inferred or taken as belonging to the Work and necessary in good practice to provide a complete system described or shown as intended.
- B. Coordinate shutdown of systems with Haines Borough Maintenance Personnel. Contact name and phone number will be available through ARCHITECT.
- C. Demolition of and Connection to Existing Material, Equipment, and Systems: Where items are shown to be removed it is to be assumed that this includes the removal of the respective system including but not limited to supports, conduit, wiring, valves, and other related trim and appurtenances.

1.2 WORDING OF THE SPECIFICATIONS

- A. These Specifications are of the abbreviated or streamlined type and frequently include incomplete sentences. However, periods are used for clarity. Words such as "shall", "shall be", "the CONTRACTOR shall", and similar mandatory phrases shall be supplied by inference in the same manner, as they are required for the notes on the drawings.

1.3 CODES AND REGULATIONS

- A. All Work hereunder shall be strictly in conformance with applicable codes and regulations. All Work shall be in accordance with the 2009 Uniform Plumbing Code, 2009 International Mechanical Code, 2009 International Building Code, 2009 International Fire Code, the most recent edition of NFPA, Borough of Haines and State of Alaska code modifications insofar as minimum requirements are concerned, but the Drawings and Specifications shall govern in case the minimum requirements are exceeded. All electrical equipment shall bear the UL label.

1.4 SUBMITTALS

- A. General: Provide submittals according to Conditions of Contract, Division 01 Specifications Sections, and as required hereunder. Drawings and general provisions of the Contract, including General, Supplementary Conditions, and all Division 01 Specification Sections, apply to this Section. Approval of the data shall not eliminate responsibility for compliance with the Drawings or Specifications unless specific attention has been called in writing to proposed deviations at the time of transmittal of the data and such deviations have been approved, nor shall it eliminate the responsibility for freedom of errors of any sort in the data. All Mechanical

submittal data for Project construction is to be turned in for approval at the same time in order for an efficient review process. Partial submittals may be rejected until the full submittal is received.

- B. Specified Products: Trade names and catalog numbers of manufactured products included herein are intended to indicate the type, size, and grade of quality of equipment and materials required and such equipment and materials are approved for installation, subject to full compliance with the Specifications. Except where single manufacture is specified for standardization, requests for approval of other manufacturers than those specified must be accompanied by complete descriptions including overall dimensions, performance data, and, if catalog material, identification and marked for specific products or items proposed.

- C. Submittal Format: All data shall be submitted at one time in neatly bound loose-leaf three ring binders with pockets and tabulated in the same order of Specification Division section. All data shall be typed, minimum 10 point font, no exceptions. Data submitted that is not conforming to these specification requirements will be returned without reviewing and will need to be resubmitted at Contractors sole complete cost.
 - 1. Each binder shall have a set of separators with index tabs A to Z. Tabs are to be printed type. Slip-in tabs not acceptable.
 - 2. The first page shall be a cover sheet with project name, address, date, submittal product name, all applicable contractors and contact information, and all applicable consultants and contact information.
 - 3. Second page shall be a submittal manual index of all project Specification sections with respective tab numbers, and respective book number, if applicable.
 - 4. The first page of each manuals section shall be an index of that respective project Specification section and number with each product name, manufacturer name and model number.
 - 5. Each manuals section shall be labeled and certified by mechanical Subcontractor that the data presented is in accordance with project Specifications. Index sheet in front of completed binder listing each piece of equipment or material submitted.
 - 6. Product Data to be utilized shall be flagged and noted and all other data shall be crossed out or otherwise flagged that it is not in the project.
 - 7. Data shall be inserted in binders in order of Specification number. Specification number shall be clearly labeled on each submittal page.

- D. As-built Drawings: As-built drawings shall be required from all Subcontractors and shall accurately show all changes from Contract Documents for all piping, ductwork, and equipment. As-built drawings shall show all underground piping whether changed or not, dimensioned from building lines. As-built drawings shall be updated daily and available for inspection on-site by the ARCHITECT.

- E. Operating and Maintenance Data: See Division 1 for the number of sets of data to be provided for submittal and additional requirements. Provide a minimum of four (4) copies. The following data shall be provided to the ARCHITECT for approval 30 days prior to the request for Commissioning or Substantial Completion inspection, whichever comes first. Except for the valve directory and nameplate directory, the data shall be provided complete at one time. Partial or separate data will be returned for completion. The valve directory and nameplate directory may be provided for approval previous to the other data. The first section of the O&M manual shall be as listed in the following subparagraphs in order presented hereunder. All of the following subparagraphs sections shall be furnished with permanent plastic see through

covers. See requirements under 1.4.C for additional submittal and formatting requirements.

1. Cover and Index sheets as in 1.4.C. above.
2. Description of systems and operating instructions: The Contractor shall prepare a brief type written description of all new and modified systems, explaining how the systems operate and indicating the proper settings of controls and switches. The instructions are to include all information required for the proper settings of controls and switches. The instructions are to include all information required for the proper operation of the systems. Technical knowledge on controls or adjustments requiring specialized technicians should not be included in the instructions.
3. Nameplate directory: List of all new pumps, control panels, and other equipment nameplates, giving manufacturer's nameplate data, nameplate designation, location of equipment, area served, switch location, and normal position of the switch. Motor data must include the horsepower, voltage, full load amperage, phase, etc.
4. Manufacturers' literature: Manufacturers' instructions for operation and maintenance of all mechanical equipment and specialties, including replacement parts lists, capacity curves or charts, equipment data sheets, manufacturers' literature on the equipment, and as-built wiring diagrams and control drawings, all suitable for side binding to 8-1/2 x 11 inch size. All data not applicable to the job is to be crossed out or deleted. Manuals turned in for review with non-applicable data not crossed out shall be returned to the Contractor.
5. Maintenance instructions: Typewritten instructions for the maintenance of the systems, listing each service required on all of the mechanical equipment, including inspections, lubrication, cleaning, checking, and all other operations required. The list is to include all types of bearings installed on the equipment and the type of lubricant required.

F. Guide Documents: Sample operating and maintenance instructions and maintenance schedule may be obtained from the ARCHITECT upon request, to assist in properly setting up the data.

G. Instructions To Personnel and Training: The mechanical Subcontractor shall instruct operating personnel in the operation and maintenance of the systems before accepting the responsibility of operation and maintenance of the systems. Each training session shall be signed off by Project Manager.

H. Submit prior to Substantial Completion Inspection and Final Inspection a detailed list of equipment and systems that will not be completed for the completion date. Include status and information of deficiencies from all previous inspection reports.

I. Submit prior to Re-inspections of Substantial Completion Inspections, if applicable, and the Final Inspection a marked copy of the previous Engineers Inspection Reports detailing all items that have been completed and all items that have not been completed with reasons thereof. Re-inspection or Final Inspection will not occur until receipt of this list.

1.5 QUALITY ASSURANCE

A. Perform Work in conformance with all applicable codes, regulations, local ordinances, contract documents, and generally accepted good practice. If discrepancies exist between Specifications and Contract Drawings then the solution that provides the Owner with the highest quality of product or installation shall be deemed as intended by the Contract Documents.

1.7 FIELD MEASUREMENTS

- A. See Division 01 for specific requirements.
- B. Verifications: All measurements shall be verified at the site and prior to fabrications of equipment and systems. The existing conditions shall be fully observed before beginning the Work hereunder, and the Work hereunder executed in full coordination with the existing conditions observed.
- C. Changes: Variations apparently necessary due to existing conditions shall be made only on approval in writing by the ARCHITECT.

1.8 WARRANTY

- A. See Division 1 for specific requirements regarding: Product warranties and product Bonds.
- B. The contractor shall provide continuous and generally trouble-free operation of the mechanical systems for the time period listed in Division 01 or for one year after Substantial Completion whichever time period is longer. The operation and maintenance of systems other than incidental operations such as room thermostat settings or changing of air filters, shall be the sole responsibility of the contractor and shall be addressed by the contractor immediately if deficiencies are present. Control settings, noise problems, and other deficiencies resulting in unsatisfactory environmental conditions shall be addressed immediately.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230510

SECTION 23 0926 - BUILDING AUTOMATION SYSTEM AND AUTOMATIC CONTROLS

PART 1 - GENERAL

1.1 OVERVIEW

- A. Furnish all labor, materials, equipment, and service necessary for a HVAC control system for the Haines Borough Library. Work includes a complete Direct Digital Control (DDC) Building Automation System (BAS). This specification describes the primary products and performance of the connection and addition to the direct digital control system. Associated schematic control diagrams detail the scope of WORK for this project.

1.2 REFERENCES

- A. Section 230510 - GENERAL MECHANICAL.

1.3 QUALITY ASSURANCE

- A. All WORK described in this section shall be installed, wired, circuit tested and calibrated by factory trained electricians and mechanics qualified for this WORK. The installing office shall have a minimum of five years of installation experience with the manufacturer and shall provide documentation in submittal package verifying that installation experience. Installation shall not be subcontracted. Supervision, calibration and checkout of the system shall be by personnel with documented experience with specified manufacturer.
- B. All materials and equipment used shall be standard components, of regular manufacture for this application. All systems and components shall have been thoroughly tested and proven in actual use.
- C. The automatic control system shall be installed by trained, qualified personnel and commissioned by factory-trained technicians.
- D. Perform work in accordance with NFPA 70.
- E. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.4 SYSTEM DESCRIPTION

- A. Scope of WORK:
 - 1. This specification describes the primary products and performance of the automatic control system. DDC system shall be viewed and interfaced through a computer workstation with graphics with connection to internet.
 - 2. The work also includes connection to an uninterruptible power system (UPS) battery back-up system for GCM and Microzone controllers. UPS for distributed controllers such as for dampers, and valve actuators are not required. Coordinate with Electrical.
 - 3. The control system shall be designed such that each mechanical system will be able to

- operate under stand-alone control. In the event of a network failure, or the loss of any other controller, the control system shall continue to operate under independent control.
4. Include installation and calibration, supervision, adjustments, and fine tuning necessary for complete and fully operational system.
 5. Provide supervisory specialists and technicians at the job site to assist in all phases of system installation, startup, and inspection.
 6. Provide necessary temporary equipment and connections required for the various Work phases in order for occupied areas to remain functional.
 7. Provide a comprehensive operator and technician training program as described herein.
 8. Provide as-built documentation, operator's terminal software, diagrams, and all other associated project operational documentation including technical manuals, on approved media, the sum total of which accurately represents the final system.

1.5 SYSTEM PERFORMANCE

A. Performance Standards. The system shall conform to the following:

1. Graphic Display. The system shall display a graphic with 20 dynamic points/objects with all current data within 10 seconds.
2. Graphic Refresh. The system shall update a graphic with 20 dynamic points/objects with all current data within 8 seconds
3. Object Command. The maximum time between the command of a binary object by the operator and the reaction by the device shall be less than 2 seconds. Analog objects should start to adjust within 2 seconds
4. Object Scan. All changes of state and change of analog values will be transmitted over the high-speed Ethernet network such that any data used or displayed at a controller or workstation will have been current within the previous 2 seconds
5. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed 45 seconds
6. Program Execution Frequency. Custom and standard applications shall be capable of running as often as once every 1 second. The Contractor shall be responsible for selecting execution times consistent with the mechanical process under control
7. Performance. Programmable controllers shall be able to execute DDC PID control loops at a frequency of at least once per second. The controller shall scan and update the process value and output generated by this calculation at this same frequency
8. Multiple Alarm Annunciation. All workstations on the network must receive alarms within 5 seconds of each other
9. Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in Table 1
10. Stability of Control. Control loops shall maintain measured variable at setpoint within the tolerances listed in Table 2

TABLE 1: Reporting Accuracy

<i>Measured Variable</i>	<i>Reported Accuracy</i>
<i>Space Temperature</i>	$\pm 0.5^{\circ}\text{C}$ [$\pm 1^{\circ}\text{F}$]
<i>Ducted Air</i>	$\pm 0.5^{\circ}\text{C}$ [$\pm 1^{\circ}\text{F}$]
<i>Outside Air</i>	$\pm 1.0^{\circ}\text{C}$ [$\pm 2^{\circ}\text{F}$]
<i>Dewpoint</i>	$\pm 1.5^{\circ}\text{C}$ [$\pm 3^{\circ}\text{F}$]

<i>Water Temperature</i>	$\pm 0.5^{\circ}\text{C}$ [$\pm 1^{\circ}\text{F}$]
<i>Delta-T</i>	$\pm 0.15^{\circ}\text{C}$ [$\pm 0.25^{\circ}\text{F}$]
<i>Water Flow</i>	$\pm 5\%$ of full scale
<i>Water Pressure</i>	$\pm 2\%$ of full scale (see Note 1)
<i>Electrical (A, V, W, Power factor)</i>	5% of reading
<i>Carbon Dioxide (CO2)</i>	± 50 ppm
<i>Note 1: For both absolute and differential pressure</i>	

TABLE 2: Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
<i>Airflow</i>	$\pm 10\%$ of full scale	-
<i>Temperature</i>	$\pm 0.5^{\circ}\text{C}$ [$\pm 1.0^{\circ}\text{F}$]	-
<i>Fluid Pressure</i>	± 10 kPa [± 1.5 psi]	0-1 kPa [1-150 psi]
<i>“ “ differential</i>	± 250 Pa [± 1.0 " w.g.]	0-12.5 kPa [0-50" w.g.]

1.6 ACCEPTABLE MANUFACTURERS

- A. Alerton (ATS)
- B. Delta Controls (AIS)
- C. Siebe Environmental Controls (INVENSYS).
- D. Siemens
- E. Johnson

1.7 COORDINATION

- A. Equipment: Control Contractor shall supply control equipment for installation by equipment suppliers and mechanical Subcontractor where required. This includes all control equipment installed in piping systems such as thermostat wells and automatic valves. Control Subcontractor shall also coordinate locations of control equipment, including, but not limited to, thermostats, and valve actuators, thermostat bulbs and averaging elements.

1.8 SUBMITTALS

- A. Product Data and Shop Drawings: Meet requirements of Section 01 on Shop Drawings, Product Data, and Samples. In addition, Contractor shall provide shop drawings or other submittals on all hardware, software, and installation to be provided. No work may begin on any segment of this project until submittals have been reviewed and approved for conformity with the design intent. Six copies are required. All drawings shall be done in DXF format and provided on magnetic/optical disk and as full-size 22x34 drawings. When manufacturer's cut sheets apply to a product series rather than a specific product, the data specifically applicable to the project

shall be highlighted or clearly indicated by other means. Each submitted piece of literature and drawings shall clearly reference the specification and/or drawing that the submittal is to cover. General catalogs shall not be accepted as cut sheets to fulfill submittal requirements. Submittals shall be provided within 12 weeks of contract award. Submittals shall include:

1. Direct Digital Control System Hardware:
 - a) A complete bill of materials of equipment to be used shall be listed indicating quantity, manufacturer, model number, and other relevant technical data.
 - b) Manufacturer's description and technical data, such as performance curves, product specification sheets, and installation/maintenance instructions for the items listed below and other relevant items not listed below:
 - i. Direct Digital Controller (controller panels)
 - ii. Transducers/Transmitters
 - iii. Sensors (including accuracy data)
 - iv. Actuators
 - v. Relays/Switches
 - vi. Control Panels
 - vii. Power Supply
 - viii. Batteries
 - ix. Operator Workstation Equipment
 - x. Wiring
 - c) Wiring diagrams and layouts for each control panel. Show all termination numbers
2. Schematic diagrams for all field sensors and controllers. Provide floor plans of all sensor locations and control hardware. Central System Hardware and Software
 - a) A complete bill of material of equipment used indicating quantity, manufacturer, model number, and other relevant technical data.
 - b) Manufacturer's description and technical data, such as product specification sheets and installation/maintenance instructions for the items listed below and other relevant items not listed below:
 - i. Central Processing Unit
 - ii. Laptop
 - iii. Power Supply
 - iv. Battery Backup
 - v. Interface Equipment Between CPU and Control Panels
 - vi. Operating System Software
 - vii. Operator Workstation Software
 - viii. Color Graphic Software
 - ix. Third-party Software
 - c) A schematic diagram for all control wiring, communication wiring and power wiring shall be provided. Provide a schematic drawing of the central system installation. Label all cables and ports with computer manufacturers' model numbers, function and data link protocol(s). Show all interface wiring to the control system
 - d) Provide detailed riser diagrams of wiring between central control unit, operator workstation(s), routers, gateways and all control panels

- e) A list of the color graphic screens shall be provided. For each screen, provide a conceptual layout of pictures and data, and show or explain which other screens can be directly accessed
3. Controlled Systems:
- a) A schematic diagram of each controlled system. The schematics shall have all control points/objects labeled and with point/object names shown or listed. The schematics shall graphically show the location of all control elements in the system
 - b) A schematic wiring diagram for each controlled system. Each schematic shall have all elements labeled. Where a control element is the same as that shown on the control system schematic, it shall be labeled with the same name. All terminals shall be labeled
 - c) An instrumentation list for each controlled system. Each element of the controlled system shall be listed in table format. The table shall show element name, type of device, manufacturer, model number, and product data sheet number
 - d) A mounting, wiring, and routing plan view drawing. The drawing shall be done in ¼" scale. The design shall take into account HVAC, electrical and other systems' design and elevation requirements. The drawing shall show the specific location of all concrete pads and bases and any special wall bracing for panels to accommodate this work
 - e) A complete description of the operation of the control system, including sequences of operation. The description shall include and reference a schematic diagram of the controlled system
 - f) A point/object list for each system controller including inputs and outputs (I/O), point/object number, the controlled device associated with the I/O point/object, and the location of the I/O device. Software flag points/objects, alarm points/objects, etc
4. Quantities of items submitted shall be reviewed, but are the responsibility of the Contractor
5. A description of the proposed process along with all report formats and checklists to be used in Part 3: "Control System Demonstration and Acceptance."
6. A BACnet Protocol Implementation Conformance Statement (PICS) for each type of controller and Operator Workstation included in the submittal. PICS to include for each product, as a minimum, a list of BACnet functional groups supported, BACnet services supported, BACnet data link options available and BACnet objects provided

B. Schedules:

- 1. Within one month of contract award, provide a schedule of the work indicating the following:
 - a) Intended sequence of work items
 - b) Start dates of individual work items.
 - c) Duration of individual work items
 - d) Planned delivery dates for major material and equipment, and expected lead times
 - e) Milestones indicating possible restraints on work by other trades or situations.
 - f) Provide monthly written status reports indicating work completed, revisions to expected delivery dates, etc. An updated project schedule shall be included.

- C. Project Record Documents: Upon completion of installation, submit three copies of record (as-built) documents. The documents shall be submitted for approval prior to final completion and

shall include:

1. Project Record Drawings. These shall be as-built versions of the submittal shop drawings. One set of magnetic media including DXF drawing files also shall be provided
2. Testing and Commissioning Reports and Checklists. Completed versions of all reports and checklists, along with all trend logs, used to meet the requirements of Part 3: "Control System Demonstration and Acceptance."
3. Operation and Maintenance (O & M) Manual. This shall include as-built versions of the submittal product data. In addition to the information required for submittals, the O & M manual shall include:
 - a) Names, addresses, and 24-hour telephone numbers of Contractors installing equipment, and the control systems and service representatives of each
 - b) Operators Manual with procedures for operating the control systems, including logging on/off, alarm handling, producing point/object reports, trending data, overriding computer control, and changing setpoints and other variables
 - c) One set of Programming Manuals with a description of the programming language (including syntax), statement descriptions (including algorithms and calculations used), point/object database creation and modification, program creation and modification, and use of the editor
 - d) Engineering, Installation, and Maintenance Manual(s) that explain how to design and install new points/objects, panels, and other hardware; preventive maintenance and calibration procedures; how to debug hardware problems; and how to repair or replace hardware
 - e) A listing and documentation of all custom software created using the programming language, including the setpoints, tuning parameters, and object database. One set of magnetic/optical media containing files of the software and database also shall be provided
 - f) One set of magnetic/optical media containing files of all color graphic screens created for the project
 - g) A list of recommended spare parts with part numbers and suppliers
 - h) Complete original issue documentation, installation, and maintenance information for all third-party hardware provided, including computer equipment and sensors
 - i) Complete original issue diskettes for all software provided, including operating systems, programming language, operator workstation software, and graphics software
 - j) Licenses, guarantee, and warranty documents for all equipment and systems
 - k) Recommended preventive maintenance procedures for all system components, including a schedule of tasks (inspection, cleaning, calibration, etc.), time between tasks, and task descriptions

1.10 WARRANTY

A. Warrant all work as follows:

1. Labor and materials for the control system specified shall be warranted free from defects for a period of 12 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. The Contractor shall respond to the Owner's request

- for warranty service within 24 hours during normal business hours.
2. All work shall have a single warranty date, even when the Owner has received beneficial use due to an early system start-up. If the work specified is split into multiple contracts or a multi-phase contract, then each contract or phase shall have a separate warranty start date and period
 3. At the end of the final start-up, 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 this specification. The date of acceptance shall be the start of warranty.
 4. Operator workstation software, project-specific software, graphic software, database software, and firmware updates which resolve known software deficiencies as identified by the Contractor shall be provided at no charge during the warranty period. Any upgrades or functional enhancements associated with the above mentioned items also can be provided during the warranty period for an additional charge to the Owner by purchasing an in-warranty technical support agreement from the Contractor. Written authorization by the Owner must, however, be granted prior to the installation of any of the above-mentioned items.
 5. Exception: The Contractor shall not be required to warrant reused devices, except for those that have been rebuilt and/or repaired. The Contractor shall warrant all installation labor and materials, however, and shall demonstrate that all reused devices are in operable condition at the time of Engineer's acceptance.

1.11 OWNERSHIP OF PROPRIETARY MATERIAL

- A. All project-developed software and documentation shall become the property of the Owner. These include, but are not limited to:
 1. Project graphic images
 2. Record drawings
 3. Project database
 4. Project-specific application programming code
 5. All documentation

1.12 TRAINING

- A. After substantial completion and prior to final completion of the installation, operating personnel of the Borough of Haines Maintenance shall be instructed on site in the sequence of operation and maintenance of the system hardware and software by the Subcontractor's qualified representative. A minimum 6 hours of training is to be provided. Coordinate with owner to determine the nature of training to be provided.
- B. Subcontractor is to provide minimum of 7 days notice to the Borough of Haines Maintenance Director prior to training and warranty visits.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. All products used in this project installation shall be new, currently under manufacture, and shall be applied in similar installations for a minimum of two years. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner's Representative in writing. Spare parts shall be available for at least five years after completion of this contract.

2.2 COMMUNICATION

- A. All control products provided for this project shall comprise a BACnet internetwork. Communication involving control components (i.e., all types of controllers and Operator Workstations) shall conform to ANSI/ASHRAE Standard 135-2001, BACnet. Operator workstations are to include fixed workstation devices and remote devices such as laptop computers and I-pads.
- B. Each BACnet device shall operate on the BACnet Data Link/Physical layer protocol specified for that device as defined in this section.
- C. The Contractor shall provide all communication media, connectors, repeaters, bridges, hubs, switches, and routers necessary for the internetwork.
- D. All controllers shall have a communication port for connections with the Operator Workstations using the BACnet Data Link/ Physical layer protocol.
- E. A device on the internetwork shall be provided with a 56k-baud modem that will allow for remote Operator Workstation using the BACnet PTP Data Link/ Physical layer protocol. Remote Operator Workstation via this modem shall allow for communication with any and all controllers on this network as described in Paragraph F below.
- F. Communication services over the internetwork shall result in operator interface and value passing that is transparent to the internetwork architecture as follows:
 - 1. Connection of an Operator Workstation device to any one controller on the internetwork will allow the operator to interface with all other controllers as if that interface were directly connected to the other controllers. Data, status information, reports, system software, custom programs, etc., for all controllers shall be available for viewing and editing from any one controller on the internetwork.
 - 2. All database values (e.g., objects, software variables, custom program variables) of any one controller shall be readable by any other controller on the internetwork. This value passing shall be automatically performed by a controller when a reference to an object name not located in that controller is entered into the controller's database. An operator/installer shall not be required to set up any communication services to perform internetwork value passing
- G. The time clocks in all controllers shall be automatically synchronized daily. An operator change to the time clock in any controller shall be automatically broadcast to all controllers on the network.
- H. The network shall have the following minimum capacity for future expansion:
 - 1. Each Building Controller shall have routing capacity for 99 controllers.

2. The Building Controller network shall have capacity for 1000 Building Controllers.
3. The system shall have an overall capacity for 12,500 Building Controller, Advanced Application Controller, and Application Specific Controller input/output objects.

2.3 OPERATOR WORKSTATION

- A. Operator Workstation. Furnish one laptop-based workstations as shown hereunder. Workstation shall be able to access all information in the system. These workstations shall reside on the same Ethernet protocol network as the Building Controllers.
- B. Workstation information access shall use the BACnet protocol. Communication shall use the ISO 8802-3 (Ethernet) Data Link/ Physical layer protocol.
- C. Hardware. Each operator workstation and custom programming workstation shall consist of the following:
 1. Personal Computer: Furnish IBM compatible laptop as specified. The CPU shall be a minimum of an Intel Pentium and operate at a minimum of 1,800 MHz. A minimum of 1 gigabyte of RAM, one DVD readable/writeable drive and a 500GB hard disk with a minimum access time of 12 milliseconds shall be provided. A two-button mouse also will be provided. Furnish all required serial (USB), and network communication ports, and all cables for proper system operation. The laptop shall have a minimum of a 17.5" LED, Anti-glare, backlit monitor (1920 x 1080 resolution) premium panel.
 2. BACnet Interoperability Building Blocks. The workstation shall support the following BIBBs:

Data Sharing	Alarm & Event	Scheduling	Trending	Device & Network Mgmt.
<i>DS-RP-A,B</i>	<i>AE-N-A</i>	<i>SCHED-A</i>	<i>T-VMT-A</i>	<i>DM-DDB-A,B</i>
<i>DS-RPM-A</i>	<i>AE-ACK-A</i>		<i>T-ATR-A</i>	<i>DM-DOB-A,B</i>
<i>DS-WP-A</i>	<i>AE-ASUM-A</i>			<i>DM-DCC-A</i>
<i>DS-WPM-A</i>	<i>AE-ESUM-A</i>			<i>DM-TS-A</i>
				<i>DM-UTC-A</i>
				<i>DM-RD-A</i>
				<i>DM-BR-A</i>
				<i>NM-CE-A</i>

- D. System Software
 1. Operating System. Furnish a concurrent multi-tasking operating system. The operating system also shall support the use of other common software applications that operate under Microsoft Windows. Examples include Microsoft Excel, Microsoft Word, Microsoft Access. Acceptable operating systems are Windows 7 Professional, Windows 8 Pro and Windows Server.
 2. System Graphics. The operator workstation software shall be a graphical user interface (GUI). The system shall allow display of up to 10 dynamic and animated graphic screens at once for comparison and monitoring of system status. Provide a method for the operator to easily move between graphic displays and change the size and location of graphic displays on the screen. The system graphics shall be able to be modified while on-line. An operator with the proper password level shall be able to add, delete, or

- change dynamic objects on a graphic. Dynamic objects shall include analog and binary values, dynamic text, static text, and animation files. Graphics shall have the ability to show animation by shifting image files based on the status of the object.
3. Custom Graphics. Custom graphic files shall be created with the use of a graphics generation package furnished with the system. The graphics generation package shall be a graphically based system that uses the mouse to create and modify graphics. The graphics generation package also shall provide the capability of capturing or converting graphics from other programs such as Visio or AutoCad
 4. Graphics Library. Furnish a complete library of standard HVAC equipment graphics such as chillers, boilers, air handlers, terminals, fan coils, and unit ventilators. This library also shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers, and ductwork. The library shall be furnished in a file format compatible with the graphics generation package program. Graphics shall be created by drag-and-drop selection of graphic symbols and drag-and-link with BACnet objects with dynamic and interactive display fields.
 5. Multilingual. Software shall be supported in the following languages English, Spanish, French, German, Chinese.
 6. Dynamic Data Exchange (DDE). Software shall support dynamic data sharing with other Windows-based programs for third party add-on functionality e.g. preventative maintenance, tenant billing, etc.
- E. System Applications. Each workstation shall provide operator interface and off-line storage of system information. Provide the following applications at each workstation:
1. System Database Save and Restore. Each workstation shall store on the hard disk a copy of the current database of each Building Controller. This database shall be updated whenever an operator initiates a save command.
 2. Manual Database Save and Restore. A system operator with the proper password clearance shall be able to save the database from any system panel. The operator shall be able to clear a panel database via the network and may initiate a download of a specified database to any panel in the system from the network.
 3. System Configuration. The workstation software shall provide a method of configuring the system. This shall allow for future system changes or additions by users under proper password protection.
 4. On-Line Help. Provide a context-sensitive, on-line help system to assist the operator in operating and editing the system. On- line help shall be available for all applications and shall provide the relevant data for that particular screen. Additional help information shall be available through the use of hypertext.
 5. Security. Each operator shall be required to log on to the system with a user name and password in order to view, edit, add, or delete data. System security shall be selectable for each operator. The system supervisor shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the functions accessible to viewing and/or changing each system application.
 6. System Diagnostics. The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers.
 7. Alarm Processing. Any object in the system shall be configurable to alarm in and out of normal state. The operator shall be able to configure the alarm limits, alarm limit differentials, states, and reactions for each object in the system.
 8. Alarm Messages. Alarm messages shall use the English language descriptor for the

- object in alarm, in such a way that the operator will be able to recognize the source, location, and nature of the alarm without relying upon acronyms or other mnemonics.
9. Alarm Reactions. The operator shall be able to determine (by object) what if any actions are to be taken during an alarm. Actions shall include logging, printing, starting programs, displaying messages, dialing out to remote stations, paging, providing audible annunciation.
 10. Trend Logs. The operator shall be able to define a custom trend log for any data object in the system. This definition shall include change-of-value digital, change-of-value analog, time interval, start time, and stop time. Trend data shall be sampled and stored on the Building Controller panel, and be archivable on the hard disk and be retrievable for use in spreadsheets and standard database programs.
 11. Alarm and Event Log. The operator shall be able to view all system alarms and change of states from any location in the system. Events shall be listed chronologically. An operator with the proper security level may acknowledge and clear alarms.
 12. Object and Property Status and Control. Provide a method for the operator to view, and edit if applicable, the status of any object and property in the system. The status shall be available by menu, on graphics, or through custom programs.
 13. Clock Synchronization. The real-time clocks in all building control panels and workstations shall be using the BACnet Time Synchronization service. The system also shall be able to automatically synchronize all system clocks daily from any operator-designated device in the system. The system shall automatically adjust for daylight savings and standard time, if applicable.
- F. Workstation Applications Editors. Laptop workstation shall support editing of all system applications. Provide editors for each application at the Laptop workstation. The applications shall be downloaded and executed at one or more of the controller panels.
1. Controller. Provide a full-screen editor for each type of application that shall allow the operator to view and change the configuration, name, control parameters, and setpoints for all controllers.
 2. Scheduling. An editor for the scheduling application shall be provided at each workstation. Provide a method of selecting the desired schedule and month. This shall consist of a monthly calendar for each schedule. Exception schedules and holidays shall be shown clearly on the calendar. Provide a method for allowing several related objects to follow a schedule. The start and stop times for each object shall be adjustable from this master schedule.
 3. Custom Application Programming. Provide the tools to create, modify, and debug custom application programming. The operator shall be able to create, edit, and download custom programs at the same time that all other system applications are operating. The system shall be fully operable while custom routines are edited, compiled, and downloaded. The programming language shall have the following features:
 - a) The language shall be English language oriented, be based on the syntax of BASIC, FORTRAN, C, or PASCAL, and allow for free-form programming (i.e., not column-oriented or "fill in the blanks").
 - b) A full-screen character editor/programming environment shall be provided. The editor shall be cursor/mouse-driven and allow the user to insert, add, modify, and delete custom programming code. It also shall incorporate word processing features such as cut/paste and find/replace.

- c) The programming language shall allow independently executing program modules to be developed. Each module shall be able to independently enable and disable other modules.
- d) The editor/programming environment shall have a debugging/simulation capability that allows the user to step through the program and observe any intermediate values and/or results. The debugger also shall provide error messages for syntax and execution errors.
- e) The programming language shall support conditional statements (IF/THEN/ELSE/ELSE-IF) using compound Boolean (AND, OR, and NOT) and/or relations (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.
- f) The programming language shall support floating point arithmetic using the following operators: +, -, /, x, square root, and x-to-the-y-power. The following mathematical functions also shall be provided: natural log, log, trigonometric functions (sine, cosine, etc.), absolute value, and minimum/maximum value from a list of values.
- g) The programming language shall have predefined variables that represent time of day, day of the week, month of the year, and the date. Other predefined variables shall provide elapsed time in seconds, minutes, hours, and days. These elapsed time variables shall be able to be reset by the language so that interval-timing functions can be stopped and started within a program. Values from all of the above variables shall be readable by the language so that they can be used in a program for such purposes as IF/THEN comparisons, calculations, etc.
- h) The language shall be able to read the values of the variables and use them in programming statement logic, comparisons, and calculations.
- i) The programs shall support online changes with the ability to read real time values without exiting the program. Sample programs and syntax help functions shall be resident in the program.

G. Report Management

- 1. The following reporting capability shall be provided at the operator workstation.
- 2. Reporting:
 - a) Internal reports built into operator workstation software
 - b) External reporting via ODBC
- 3. Internal Reports
 - a) User definable query reports (support advanced multiple property, multiple object).
 - b) Reports shall be scheduled for automatic generation by schedule or event.
 - c) Manual execution to printing/file.
 - d) Ability to save report in system report folder.
 - e) Query controller hierarchy.
 - f) Report to multiple destinations
 - i. Email
 - ii. Print
 - iii. File (text, csv, xml)
 - iv. Terminal
- 4. Enterprise Interface
 - a) ODBC driver supporting common SQL statements (select, update, insert, where, order by, group by, etc.)
 - b) Allow integration to Enterprise software

- c) Shall be capable of being used with third party software that supports ODBC connection such as: Microsoft Access, Excel, Crystal Reports, etc.
- d) All queries shall be real time into live controller network.
- e) Shall be able to both read and write using SQL.

H. Web Browser Interface

1. The system shall be capable of supporting an unlimited number of clients using a standard Web browser such as Internet Explorer™ or Netscape Navigator™.
2. The Web browser software shall run on any operating system and system configuration that is supported by the Web browser. Systems that require specific machine requirements in terms of processor speed, memory, etc., in order to allow the Web browser to function with the BAS, shall not be acceptable.
3. The Web browser shall provide the same view of the system, in terms of graphics, schedules, calendars, logs, etc., and provide the same interface methodology as is provided by the Graphical User Interface. Systems that require different views or that require different means of interacting with objects such as schedules, or logs, shall not be permitted.
4. The Web browser client shall support at a minimum, the following functions:
 - a) User log-on identification and password shall be required. If an unauthorized user attempts access, a blank web page shall be displayed. Security using Java authentication and encryption techniques to prevent unauthorized access shall be implemented.
5. Graphical screens developed for the GUI shall be the same screens used for the Web browser client. Any animated graphical objects supported by the GUI shall be supported by the Web browser interface.
6. HTML programming shall not be required to display system graphics or data on a Web page. HTML editing of the Web page shall be allowed if the user desires a specific look or format.
7. Storage of the graphical screens shall be in the Server, without requiring any graphics to be stored on the client machine. Systems that require graphics storage on each client are not acceptable.
8. Real-time values displayed on a Web page shall update automatically without requiring a manual “refresh” of the Web page.
9. User’s shall have administrator-defined access privileges. Depending on the access privileges assigned, the user shall be able to perform the following:
 - a) Modify common application objects, such as schedules, calendars, and set points in a graphical manner.
10. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
11. Commands to start and stop binary objects shall be done by right-clicking the selected object and selecting the appropriate command from the pop-up menu. No entry of text shall be required.
12. The system shall provide the capability to specify a user’s (as determined by the log-on user identification) home page. Provide the ability to limit a specific user to just their defined home page. From the home page, links to other views, or pages in the system shall be possible, if allowed by the system administrator.
13. Graphic screens on the Web Browser client shall support hypertext links to other locations on the Internet or on Intranet sites, by specifying the Uniform Resource Locator

(URL) for the desired link.

2.4 CONTROLLER SOFTWARE

- A. Furnish the following applications software for building and energy management. All software applications shall reside and operate in the system controllers. Editing of applications shall occur at the operator workstation
- B. System Security
 - 1. User access shall be secured using individual security passwords and user names.
 - 2. Passwords shall restrict the user to the objects, applications, and system functions as assigned by the system manager.
 - 3. User Log On/Log Off attempts shall be recorded.
- C. Scheduling. Provide the capability to schedule each object or group of objects in the system. Each schedule shall consist of the following:
 - 1. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop and optimal start. Each schedule may consist of up to 10 events. When a group of objects are scheduled together, provide the capability to adjust the start and stop times for each member.
 - 2. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.
- D. Alarm Reporting. The operator shall be able to determine the action to be taken in the event of an alarm. Alarms shall be routed to the appropriate workstations based on time and other conditions.
- E. Remote Communication. The system shall have the ability to dial out in the event of an alarm using BACnet Point-To-Point at a minimum of 56K baud. Receivers shall be BACnet workstations.
- F. Maintenance Management. The system shall monitor equipment status and generate maintenance messages based upon user-designated run-time, starts, and/or calendar date limits.
- G. Sequencing. Provide application software to properly sequence the start and stop of chillers, boilers, and pumps to minimize energy usage in the facility.
- H. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, setpoint, and PID gains shall be user-selectable.
- I. Staggered Start. This application shall prevent all controlled equipment from simultaneously restarting after a power outage.
- J. Energy Calculations. Provide software to allow instantaneous power (e.g., kW) or flow rates

(e.g., L/s [GPM]) to be accumulated and converted to energy usage data. Provide an algorithm that calculates a sliding-window kW demand value.

- K. Anti-Short Cycling. All binary output objects shall be protected from short cycling. This feature shall allow minimum on-time and off-time to be selected.
- L. On/Off Control with Differential. Provide an algorithm that allows a binary output to be cycled based on a controlled variable and setpoint. The algorithm shall be direct-acting or reverse-acting, and incorporate an adjustable differential.
- M. Run-time Totalization. Provide software to totalize run-times for all binary input objects. A high run-time alarm shall be assigned, if required, by the operator.

2.5 BUILDING CONTROLLERS

- A. General. Provide an adequate number of Building Controllers to achieve the performance specified in the Part 1 Article on "System Performance." Each of these panels shall meet the following requirements.
 - 1. The Energy Management and Control System shall be comprised of one or more independent, standalone, microprocessor-based Building Controllers to manage the global strategies described in the System Software section.
 - 2. The Building Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - 3. Data shall be shared between networked Building Controllers.
 - 4. The operating system of the Building Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
 - 5. Controllers that perform scheduling shall have a real-time clock.
 - 6. The Building Controller shall communicate with other BACnet objects on the internetwork using the Read (Execute and Initiate) and Write (Execute and Initiate) Property services as defined in Clauses 15.5 and 15.8, respectively, of ASHRAE Standard 135-2001.
 - 7. BACnet Functional Groups. The Building Controller shall support the following BACnet functional groups: Clock, Event Initiation, COV Event Response, Files, Device Communication and Time Master.
- B. Communication
 - 1. Each Building Controller shall support BACnet™ over Ethernet and BACnet™ over IP. The Building Controller shall be connected to the BACnet network using the ISO 8802-3 (Ethernet) Data Link/ Physical layer protocol.
 - 2. Each Building Controller with a communications card shall perform BACnet routing if connected to a network of Custom Application and Application Specific Controllers.
 - 3. The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol P-T-P for connection to a hand-held workstation/ and/or modem.
 - 4. The Building Controller secondary communication network shall support BACnet MS/TP.
- C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.

1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 0°C to 40°C [32°F to 100°F] and 10 to 90% RH.
 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 0°C to 50°C [32°F to 120°F].
- D. Building Controllers shall be fully peer to peer.
- E. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field- removable, modular terminal strips — or to a termination card connected by a ribbon cable.
- F. Memory. The Building Controller shall have as a minimum standard SRAM of 256 KB, standard DRAM of 1MB and standard non-volatile 1 MB of flash memory in lieu of EPROM. Memory shall be user extendible through RAM chip sockets and SIMMs for future memory expansion.
- G. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. The Building Controller shall maintain all database information including BIOS and programming information in the event of a power loss for at least 72 hours. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 1 m [3 ft].
- H. Inputs/Outputs.
1. Inputs. Controller input/output board shall support dry contact, 0-5 VDC and 0-10 VDC-voltage, 4-20 mA- current and thermistor-resistive signal types on an individual basis for connecting any status or sensing device. Analog resolution shall be 10-bit A to D.
 2. Outputs. Controller input/output board shall support built in HOA modules configured with manual-auto-off override switch. Output supported shall be 0-10 VDC. All HOA's shall be supervised.
 3. Diagnostics. Controller input/output board shall have red LEDs providing input status indication.
 4. Building Controller shall have the capability to create, delete and support the following BACnet Objects:
 - a) ANALOG INPUT, ANALOG OUTPUT AND ANALOG VALUE: These objects shall have the following writeable properties: Object Name; Object Value; Description; COV Increment; Out of Service and Units. In addition, these objects shall support the properties: Device type; Reliability; Min./Max. Values; Update Interval and Resolution.
 - b) BINARY INPUT, BINARY OUTPUT AND BINARY VALUE: These objects shall have the following writeable properties: Object Name; Object Value; Description; Polarity; Default Value; Min On/Off and Out of Service. In addition, these objects shall support the properties: Device Type; Reliability; Active/Inactive Texts; Update Interval; Resolution; Change-of-State Time; Count Times and Time Reset.
 - c) CALENDAR: This object shall have the following writeable properties: Object Name; Object Value; Description; and Date List.
 - d) DEVICE: This object shall have the following writeable properties: Object Name; Description; Location; and UTC Offset.

- e) **EVENT ENROLMENT:** This object shall have the following writeable properties: Object Name; Object Value; Description; Out-of-Service; Event & Notify Types; Parameters; Property Ref; Enable; and Notification Class.
- f) **FILE:** This object shall have the following writeable properties: Object Name; Description; File Type; and File Access.
- g) **LOOP (PID):** This object shall have the following writeable properties: Object Name; Object Value; Description; Polarity; Output and Input Refs.; Input Value & Units; Setpoint Value; PID Values; Bias; Write Priority and COV Increment. In addition, this object shall support the properties: Reliability; Update Interval; Proportional Constant & Units; Derivative Constant & Units.
- h) **NOTIFICATION CLASS:** This object shall have the following writeable properties: Object Name; Object Value; Description; Priority and Ack Required.
- i) **PROGRAM:** This object shall have the following writeable properties: Object Name; Object Value and Description. In addition, this object shall support the property Reliability.
- j) **SCHEDULE:** This object shall have the following writeable properties: Object Name; Object Value and Description; Effective period; Schedule; Exception; Controlled Properties and Write Properties.
- k) **TREND LOG:** This object shall have the following writeable properties: Object Name; Description; Log Enable; Start/stop Times; Log Device Object Property; Log Interval; Stop When Full; Buffer Size; and Record Count.

2.6 **ADVANCED APPLICATION CONTROLLERS**

- A. **General.** Provide an adequate number of Programmable Application Controllers to achieve the performance specified in the Part 1 Article on “System Performance.” Each of these panels shall meet the following requirements.
 - 1. The Advanced Application Controller shall have sufficient memory to support its operating system, database, and programming requirements.
 - 2. Advanced Application Controllers shall be fully peer to peer.
 - 3. The operating system of the Controller shall manage the input and output communication signals to allow distributed controllers to share real and virtual object information, and allow central monitoring and alarms.
 - 4. All equipment that requires scheduling shall be scheduled in that equipments controller.
 - 5. Both firmware and controller database shall be loadable over the network.
 - 6. Advanced Application Controllers shall support the following BACnet Interoperability Building Blocks (BIBBs):

Data Sharing	Alarm & Event	Scheduling	Trending	Device & Network Mgmt.
<i>DS-RP-B</i>	<i>AE-N-B</i>	<i>SCHED-B</i>		<i>DM-DDB-B</i>
<i>DS-RPM-B</i>	<i>AE-ACK-B</i>			<i>DM-DOB-B</i>
<i>DS-WP-B</i>	<i>AE-ASUM-B</i>			<i>DM-DCC-B</i>
<i>DS-WPM-B</i>				<i>DM-TS-B</i>
				<i>DM-UTC-B</i>
				<i>DM-RD-B</i>

- B. **Communication.**

1. Each Advanced Application Controller shall reside on a BACnet network using the MS/TP or Ethernet Data Link/ Physical layer protocol.
 2. The controller shall provide a service communication port using BACnet Data Link/ Physical layer protocol for connection to portable operators' workstation and allow access to the entire network.
- C. Environment. Controller hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at 32°F to 100°F.
 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 120°F.
- D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips — or to a termination card connected by a ribbon cable.
- E. Memory. The Advanced Application Controller shall be non-volatile FLASH memory.
- F. Immunity to power and noise. Controller shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios up to 5 W at 3 ft.

2.7 APPLICATION SPECIFIC CONTROLLERS

- A. General. Application Specific Controllers (ASCs) are microprocessor-based DDC controllers which through hardware or firmware design are able to control a wide variety of equipment. They are fully user-programmable, and are not restricted to any one type of equipment.
1. Each ASC shall be capable of standalone operation and shall continue to provide control functions without being connected to the network
 2. Each ASC will contain sufficient I/O capacity to control the target system.
 3. Both firmware and controller database shall be loadable over the network
 4. Application Specific Controllers shall be fully peer to peer
 5. ASC's shall come with an integrated housing to allow for easy mounting and protection of the circuit board. Only wiring terminals shall be exposed.
 6. Application Specific Controllers shall support the following BACnet Interoperability Building Blocks (BIBBs):

Data Sharing	Alarm & Event	Scheduling	Trending	Device & Network Mgmt.
DS-RP-B				DM-DDB-B
DS-WP-B				DM-DOB-B
				DM-DCC-B

- B. Communication
1. The controller shall reside on a BACnet network using the MS/TP Data Link/ Physical layer protocol.
 2. Each controller shall have a BACnet Data Link/ Physical layer compatible connection for

- a laptop computer or a portable operator's tool. This connection shall be extended to a space temperature sensor port where shown and allow access to the entire network.
3. Each controller shall have a secondary sub network for communicating sensors or I/O expansion modules
- C. Environment. The hardware shall be suitable for the anticipated ambient conditions.
1. Controllers used outdoors and/or in wet ambient conditions shall be mounted within waterproof enclosures, and shall be rated for operation at -40°F to 150°F and/or suitably installed in a heated or fan cooled enclosure
 2. Controllers used in conditioned space shall be mounted in dust-proof enclosures, and shall be rated for operation at 32°F to 120°F.
- D. Serviceability. Provide diagnostic LEDs for power, communication, and processor. All wiring connections shall be made to field-removable, modular terminal strips.
- E. Memory. The Application Specific Controller shall use non-volatile memory and maintain all BIOS and programming information in the event of a power loss.
- F. Immunity to power and noise. ASC shall be able to operate at 90% to 110% of nominal voltage rating and shall perform an orderly shutdown below 80%. Operation shall be protected against electrical noise of 5-120 Hz and from keyed radios up to 5 W at 1 m [3 ft].
- G. Transformer. Power supply for the ASC must be rated at minimum of 125% of ASC power consumption, and shall be fused or current limiting type.
- H. Input/Output. ASC shall support as a minimum, directly connected, a combination of analog outputs and binary outputs and universal software selectable analog or digital inputs. ASC inputs shall support 0-5 VDC-voltage, 4-20mA-current, thermistor-resistance and dry contacts. ASC outputs shall support 0-10 VDC-voltage, digital triac rated at 0.5 amps at 24 VAC
- I. System Object Capacity. The system size shall be expandable to at least twice the number of input/output objects required for this project. Additional controllers (along with associated devices and wiring) shall be all that is necessary to achieve this capacity requirement. The Operator Workstations installed for this project shall not require any hardware additions or software revisions in order to expand the system.

2.8 AUXILIARY CONTROL DEVICES

- A. Motorized control dampers, unless otherwise specified elsewhere, shall be furnished by the controls contractor.
- B. Electric damper/valve actuators.
1. The actuator shall have electronic overload or digital rotation sensing circuitry to prevent damage to the actuator throughout the rotation of the actuator.
 2. Where shown, for power-failure/safety applications, an internal mechanical, spring-return mechanism shall be built into the actuator housing.
 3. All non-spring-return actuators shall have an external manual gear release to allow manual positioning of the damper when the actuator is not powered. Spring-return

actuators with more than 7 N·m [60 in-lb] torque capacity shall have a manual crank for this purpose.

C. Control valves.

1. Control valves shall be two-way or three-way type for two-position or modulating service as shown.
2. Close-off (differential) Pressure Rating: Valve actuator and trim shall be furnished to provide the following minimum close-off pressure ratings:
 - a) Water Valves:
 - i. Two-way: 150% of total system (pump) head.
3. Water Valves:
 - a) Body and trim style and materials shall be per manufacturer's recommendations for design conditions and service shown, with equal percentage ports for modulating service.

D. Binary Temperature Devices

1. Low-limit thermostats. Low-limit thermostats shall be vapor pressure type with an element 20 ft minimum length. Element shall respond to the lowest temperature sensed by any 1 ft section. The low-limit thermostat shall be manual reset only and be supplied as DPST.

E. Temperature sensors.

1. Temperature sensors shall be thermistors.
2. Space sensors shall be equipped with the following:
 - a) Programmable buttons for setpoint adjustment and override
 - b) 3-value, 96-segment LCD display
3. Provide matched temperature sensors for differential temperature measurement.

F. Pressure transducers

1. Transducer shall have linear output signal. Zero and span shall be field-adjustable.
2. Transducer sensing elements shall withstand continuous operating conditions of positive or negative pressure 50% greater than calibrated span without damage
3. Water pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Transducer shall be complete with 1 - 5vdc or 4 to 20 mA output, required mounting brackets, and block and bleed valves.
4. Water differential pressure transducer shall have stainless steel diaphragm construction, proof pressure of 150 psi minimum. Over-range limit (differential pressure) and maximum static pressure shall be 300 psi. Transducer shall be complete with 1 – 5vdc or 4 to 20 mA output, required mounting brackets, and five-valve manifold.

G. Pressure-Electric (PE) Switches

1. Shall be metal or neoprene diaphragm actuated, operating pressure rated 0–175 kPa [0–

- 25 psig], with calibrated scale setpoint range of 14–125 kPa [2–18 psig] minimum, UL listed
2. Provide one- or two-stage switch action SPDT, DPST, or DPDT, as required by application.
 3. Shall be open type (panel-mounted) or enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified
 4. Shall have a permanent indicating gauge on each pneumatic signal line to PE switches.

H. Local control panels

1. All indoor control cabinets shall be fully enclosed NEMA 1 construction with hinged door, key-lock latch, removable sub-panels. A single key shall be common to all field panels and sub-panels
2. Interconnections between internal and face-mounted devices pre-wired with color-coded stranded conductors neatly installed in plastic troughs and/or tie-wrapped. Terminals for field connections shall be UL Listed for 600 volt service, individually identified per control/interlock drawings, with adequate clearance for field wiring. Control terminations for field connection shall be individually identified per control drawings
3. Provide 120v receptacle at each local panel location.

2.9 WIRING AND RACEWAYS

- A. General: Provide copper wiring, plenum cable, and raceways as specified in the applicable sections of Division 16.
- B. All insulated wire to be copper conductors, UL labeled for 90C minimum service.

2.10 EQUIPMENT - GENERAL

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

2.11 CONTROL PANELS

- A. Unitized cabinet type for each system under automatic control with relays and controls mounted in cabinet and temperature indicators, pressure gages, pilot lights, push buttons and switches flush on cabinet panel face.
- B. NEMA 250, general purpose utility enclosures with enameled finished face panel.
- C. Provide common keying for all panels.

2.12 WIRING

- A. Includes all control wiring to complete the system and provide control arrangements specified

or shown on the drawings. Power or interlock wiring shall be run in separate conduits from sensor and communications wiring.

1. Low-voltage Control Wiring (12-24v): Protected in exposed locations including, but not limited to, mechanical rooms and storage rooms. Plenum rated cable installed in ceiling plenums above accessible ceilings only. Motor disconnect switch shall also disconnect control circuit. Indicating lights wired from the motor terminals or from the last controlling device to the motor to show actual operation. All low voltage control wiring 18 AWG minimum.
 2. 110-volt and larger Control Wiring: 12 AWG minimum if directly operating a motor, and 14 AWG minimum if controlling relays and holding coils.
- B. Control Power: Control Power will be provided hereunder for new panel locations. Provide the electrical connection between all automatic control equipment and starter and the electrical panels.

2.13 FIRE STOP SYSTEMS

- A. Manufacturers
1. Hilti
 2. Dow Corning
 3. Fyre Putty
- B. General purpose Vibration Resistant Fire Stopping Sealant: Silicone based, non-slumping premixed sealant with intumescent properties, vibration and moisture resistant, rated for 3 hours per ASTM E814 and UL 1479.
- C. Fire rated Stuffing: Non-combustible mineral wool insulation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. The project plans shall be thoroughly examined for control device and equipment locations. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started
- B. The Contractor shall inspect the site to verify that equipment may be installed as shown. Any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started
- C. The Contractor shall examine the drawings and specifications for other parts of the work. If head room or space conditions appear inadequate or if any discrepancies occur between the plans and the Contractor's work, and the plans and the work of others the Contractor shall report these discrepancies to the Engineer and shall obtain written instructions for any changes necessary to accommodate the Contractor's work with the work of others. Any changes in the work covered by this specification made necessary by the failure or neglect of the Contractor to

report such discrepancies shall be made by and at the expense of this Contractor.

- D. Verify conditions before starting work.
- E. Verify that systems are ready to receive work.
- F. Sequence work to ensure installation of components is complementary to installation of similar components in other systems.
- G. Coordinate installation of system components with installation of mechanical systems equipment such as air handling units and air terminal units.

3.2 PROTECTION

- A. The Contractor shall protect all work and material from damage by its work or employees, and shall be liable for all damage thus caused.
- B. The Contractor shall be responsible for its work and equipment until finally inspected, tested, and accepted. The Contractor shall protect any material that is not immediately installed. The Contractor shall close all open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.3 COORDINATION

- A. Site
 - 1. Where the mechanical work will be installed in close proximity to, or will interfere with work of other trades, the Contractor shall assist in working out space conditions to make a satisfactory adjustment. If the Contractor installs its work before coordinating with other trades, so as to cause any interference with work of other trades, the Contractor shall make the necessary changes in its work to correct the condition without extra charge
 - 2. Coordinate and schedule work with all other work in the same area, or with work which is dependent upon other work, to facilitate mutual progress.
- B. Submittals. Refer to the "Submittals" Article in Part 1 of this specification for requirements.
- C. Test and Balance
 - 1. The Contractor shall furnish all tools necessary to interface to the control system for test and balance purposes.
 - 2. The Contractor shall provide training in the use of these tools. This training will be planned for a minimum of 4 hours.
 - 3. In addition, the Contractor shall provide a qualified technician to assist in the test and balance process, until the first 20 terminal units are balanced.
 - 4. The tools used during the test and balance process will be returned at the completion of the testing and balancing.
- D. Life Safety

1. Duct smoke detectors required for air handler shutdown are existing.
- E. Coordination with controls specified in other sections or divisions. Other sections and/or divisions of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. These controls shall be integrated into the system and coordinated by the Contractor as follows:
1. All communication media and equipment shall be provided as specified in Part 2: "Communication" of this specification.
 2. Each supplier of controls product is responsible for the configuration, programming, start-up, and testing of that product to meet the sequences of operation described in this section.
 3. The Contractor shall coordinate and resolve any incompatibility issues that arise between the control products provided under this Section and those provided under other sections or divisions of this specification.
- F. Coordinate this WORK with the WORK of other trades, and make arrangements for the complete and proper accomplishment of all related WORK. Coordinate required control interlocks with HVAC manufacturers or local representatives as necessary.
- G. Mechanical Subcontractor Responsibilities: Installs automatic valves and separable wells that are supplied by the Temperature Control Subcontractor.

3.4 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring/raceway parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
- B. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
- C. Install all equipment in readily accessible locations as defined by Chapter 1, Article 100, Part A of the National Electrical Code (NEC).
- D. All wiring shall be verified for its integrity to ensure continuity and freedom from shorts and grounds.
- E. All equipment, installation, and wiring shall comply with acceptable industry specifications and standards for performance, reliability, and compatibility and be executed in strict adherence to local codes and standard practices.
- F. Install wiring in a neat and orderly manner generally running piping and wiring along building lines.
- G. Seal conduit penetrations at rated walls with fire-stopping installed in accordance with fire-stopping manufacturers UL listed installation requirements.
- H. Wire all electrical controls and switches furnished under this section of the Specifications.
- I. Support and conceal wiring in finished areas.

3.5 FIELD QUALITY CONTROL

- A. All work, materials, and equipment shall comply with the rules and regulations of applicable local, state, and federal codes and ordinances as identified in Part 1 of this specification.
- B. Contractor shall continually monitor the field installation for code compliance and quality of workmanship.
- C. Contractor shall have work inspected by local and/or state/provincial authorities having jurisdiction over the work.

3.6 ACTUATORS

- A. Mount and link control damper actuators per manufacturer's instructions.
 - 1. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, and then tighten the linkage.
 - 2. Check operation of damper/actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 - 3. Provide all mounting hardware and linkages for actuator installation.
- B. Electric/Electronic
 - 1. Dampers: Actuators shall be direct-mounted on damper shaft or jackshaft unless shown as a linkage installation. For low-leakage dampers with seals, the actuator shall be mounted with a minimum 5° available for tightening the damper seals. Actuators shall be mounted following manufacturer's recommendations.
 - 2. Valves: Actuators shall be connected to valves with adapters approved by the actuator manufacturer. Actuators and adapters shall be mounted following the actuator manufacturer's recommendations.

3.7 IDENTIFICATION OF HARDWARE AND WIRING

- A. All wiring and cabling, including that within factory-fabricated panels, shall be labeled at each end within 2" of termination with the DDC address or termination number.
- B. Permanently label or code each point/object of field terminal strips to show the instrument or item served.
- C. Identify control panels with minimum ½" letters on laminated plastic nameplates.
- D. Identify all other control components with permanent labels. All plug-in components shall be labeled such that removal of the component does not remove the label.
- E. Identify room sensors relating to terminal box or valves with nameplates.

3.8 CONTROLLERS

- A. Provide a separate controller for each AHU or other HVAC system.
- B. Building Controllers and Advanced Application Controllers shall be selected to provide a minimum of 15% spare I/O point/object capacity for each point/object type found at each location. If input /objects are not universal, 15% of each type is required. If outputs are not universal, 15% of each type is required. A minimum of one spare is required for each type of point/object used.
 - 1. Future use of spare capacity shall require providing the field device, field wiring, point/object database definition, and custom software. No additional controller boards or point/object modules shall be required to implement use of these spare points.

3.9 PROGRAMMING

- A. Provide sufficient internal memory for the specified sequences of operation and trend logging. There shall be a minimum of 25% of available memory free for future use.
- B. Point/object Naming: System point/object names shall be modular in design, allowing easy operator interface without the use of a written point/object index. Use the following naming convention:
 - 1. AAABBBCCDDDEEE where:
 - 2. AAA is used to designate the location of the point/object within the building such as mechanical room, wing, or level, or the building itself in a multi-building environment.
 - 3. BBB is used to designate the mechanical system with which the point/object is associated (e.g., A01, HTG, CLG, LTG).
 - 4. CCC represents the equipment or material referenced (e.g., SAF for supply air fan , EXF for exhaust fan, RAF for return air fan).
 - 5. D or DD or DDD may be used for clarification or for identification if more than one of CCC exists (e.g., SAF10, EXF121).
 - 6. EE represents the action or state of the equipment or medium (e.g., T for temperature, RH for humidity, CO for control, S for status, D for damper control, I for current).
- C. Software Programming
 - 1. Provide programming for the system and adhere to the sequences of operation provided. The Contractor also shall provide all other system programming necessary for the operation of the system, but not specified in this document. Imbed into the control program sufficient comment statements to clearly describe each section of the program. The comment statements shall reflect the language used in the sequences of operation. Use the appropriate technique based on the following programming types:
 - a) Text-based:
 - i. must provide actions for all possible situations
 - ii. must be modular and structured
 - iii. must be commented
 - b) Graphic-based
 - i. must provide actions for all possible situations
 - ii. must be documented
 - c) Parameter-based

- i. must provide actions for all possible situations
- ii. must be documented

D. Operator Interface

1. Standard Graphics. Provide graphics for all mechanical systems and floor plans of the building. This includes each chilled water system, hot water system, chiller, boiler, air handler, and all terminal equipment. Point/object information on the graphic displays shall dynamically update. Show on each graphic all input and output points/objects for the system. Also show relevant calculated points/objects such as setpoints
2. Show terminal equipment information on a “graphic” summary table. Provide dynamic information for each point/object show
3. The Contractor shall provide all the labor necessary to install, initialize, start up, and troubleshoot all Operator Workstation software and their functions as described in this section. This includes any operating system software, the Operator Workstation database, and any third-party software installation and integration required for successful operation of the operator interface

3.10 CONTROL SYSTEM CHECKOUT AND TESTING

- A. Start-up Testing: All testing listed in this article shall be performed by the Contractor and shall make up part of the necessary verification of an operating control system. This testing shall be completed before the Owner’s Representative is notified of the system demonstration.
1. The Contractor shall furnish all labor and test apparatus required to calibrate and prepare for service of all instruments, controls, and accessory equipment furnished under this specification.
 2. Verify that all control wiring is properly connected and free of all shorts and ground faults. Verify that terminations are tight.
 3. Enable the control systems and verify calibration of all input devices individually. Perform calibration procedures per manufacturers’ recommendations.
 4. Verify that all binary output devices (relays, solenoid valves, two-position actuators and control valves, magnetic starters, etc.) operate properly and that the normal positions are correct.
 5. Verify that all analog output devices (I/Ps, actuators, etc.) are functional, that start and span are correct, and that direction and normal positions are correct. The Contractor shall check all control valves and automatic dampers to ensure proper action and closure. The Contractor shall make any necessary adjustments to valve stem and damper blade travel
 6. Verify that the system operation adheres to the Sequences of Operation. Simulate and observe all modes of operation by overriding and varying inputs and schedules. Tune all DDC loops and optimum Start/Stop routines.
 7. Alarms and Interlocks.
 - a) Check each alarm separately by including an appropriate signal at a value that will trip the alarm
 - b) Interlocks shall be tripped using field contacts to check the logic, as well as to ensure that the fail-safe condition for all actuators is in the proper direction.
 - c) Interlock actions shall be tested by simulating alarm conditions to check the initiating value of the variable and interlock action

3.11 CONTROL SYSTEM DEMONSTRATION AND ACCEPTANCE

A. Demonstration

1. 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 Contractor has completed the installation, started up the system, and performed its own tests.
2. The tests described in this section are to be performed in addition to the tests that the Contractor performs as a necessary part of the installation, startup, and debugging process and as specified in the "Control System Checkout and Testing" Article in Part 3 of this specification. The Owner and their representatives will be present to observe and review these tests. The Owner and their representatives shall be notified at least 10 days in advance of the start of the testing procedures.
3. The demonstration process shall follow that approved in Part 1: "Submittals." The approved checklists and forms shall be completed for all systems as part of the demonstration.
4. The Contractor shall provide at least two persons equipped with two-way communication, and shall demonstrate actual field operation of each control 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/object and system. Any test equipment required to prove the proper operation shall be provided by and operated by the Contractor.
5. As each control input and output is checked, a log shall be completed showing the date, technician's initials, and any corrective action taken or needed.
6. Demonstrate compliance with Part 1: "System Performance".
7. Demonstrate compliance with Sequences of Operation through all modes of operation.
8. Demonstrate complete operation of Operator Workstation.
9. Additionally, the following items shall be demonstrated:
 - a) DDC Loop Response. The 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 setpoint, which represents a change of actuator position of at least 25% of its full range. The sampling rate of the trend shall be from 10 seconds to 3 minutes, depending on the speed of the loop. The trend data shall show for each sample the setpoint, actuator position, and controlled variable values. Any loop that yields unreasonably under-damped or over-damped control shall require further tuning by the Contractor.
 - b) Demand limiting. The Contractor shall supply a trend data output showing the action of the demand-limiting algorithm. The data shall document the action on a minute-by-minute basis over at least a 30-minute period. Included in the trend shall be building kW, demand limiting setpoint, and the status of shed-able equipment outputs.
 - c) Optimum Start/Stop. The Contractor shall supply a trend data output showing the capability of the algorithm. The hour-by-hour trends shall include the output status of all optimally started and stopped equipment, as well as temperature sensor inputs of affected areas.
 - d) Operational logs for each system that indicate all setpoints, operating points, valve positions, mode, and equipment status shall be submitted to the Architect/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.

- e) Any tests that fail to demonstrate the operation of the system shall be repeated at a later date. The Contractor shall be responsible for any necessary repairs or revisions to the hardware or software to successfully complete all tests.

B. Acceptance

1. 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 Completion. Any tests that cannot be performed due to circumstances beyond the control of the Contractor may be exempt from the Completion requirements if stated as such in writing by the Engineer. Such tests shall then be performed as part of the warranty.
2. The system shall not be accepted until all forms and checklists completed as part of the demonstration are submitted and approved as required in Part 1: "Submittals."

3.12 WIRING AND RACEWAYS

A. General:

1. Provide wiring, conduits and raceway complying with the National Electrical Code, Division 16, State and Local Codes and Ordinances.
2. Existing control conduit and junction boxes may be used by the Contractor unless they must be removed due to new Work modifications. All unused or abandoned conduit, junction boxes, wiring, and control equipment no longer needed shall be removed. Where devices are being removed from existing equipment or ductwork, affected existing equipment or ductwork shall be patched in a clean and airtight manner approved by the Engineer. All wiring shall be new.
3. Unenclosed low voltage wiring shall be plenum rated cabling type and shall be acceptable for installation only in concealed, accessible areas such as above suspended ceilings. All other wiring/cabling shall be installed in conduit.
4. Cutting and patching will be required for vertical drops to sensors and control devices. Existing thermostats are typically at 60-inches AFF. All new thermostats/sensors shall be installed at 48-inch height.
5. Use EMT, metal duct, IMC, rigid conduit, surface metal raceways, or totally enclosed metal through with flexible metal tubing as required by Division 16. Paint all exposed conduit in occupied areas two coats of enamel paint selected by ARCHITECT.
6. Provide wire with copper stranded conductors. Provide color or number coded jackets.
7. Provide 20 gauge minimum foil-shielded cable rated 100 VDC at 80 C. for input/output wiring.
8. Provide communications network wiring meeting the gauge, impedance, capacitance, resistance and shielding requirements specified by the manufacturer of the connected devices.
9. Install wiring in a neat an orderly manner generally running piping and wiring along building lines.
10. Seal conduit penetrations at rated walls with fire-stopping installed in accordance with fire-stopping manufacturers UL listed installation requirements.
11. Wire all electrical controls and switches furnished under this section of the

Specifications.

12. Support and conceal wiring in finished areas.

3.13 TESTING AND ADJUSTING

- A. Upon completion of the control installation, start up the system, perform necessary testing, and adjust the system to ensure proper operation.
- B. Coordinate the final adjustments and “fine tuning” of control functions and devices so the mechanical systems and the control systems operate and respond as an integrated comfortable and energy efficient component of this facility.

3.14 CLEANING

- A. The Contractor shall clean up all debris resulting from its activities daily. The Contractor shall remove all cartons, containers, crates, etc., under its control as soon as their contents have been removed. Waste shall be collected and placed in a designated location.
- B. At the completion of work in any area, the Contractor shall clean all of its work, equipment, etc., keeping it free from dust, dirt, and debris, etc.
- C. At the completion of work, all equipment furnished under this section shall be checked for paint damage, and any factory-finished paint that has been damaged shall be repaired to match the adjacent areas. Any cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.15 TRAINING

- A. General
 1. Provide a minimum of one onsite training class 6 hours in length during the construction period for personnel designated by the owner.
 2. Provide two additional training sessions at 6 and 12 months following building’s turnover. Each session shall be 4 hrs in length and must be coordinated with the building Owner.
- B. Train the designated staff of Owner’s Representative and Owner to enable Day-to-day Operators to:
 1. Proficiently operate the system.
 2. Understand control system architecture and configuration.
 3. Understand DDC system components.
 4. Understand system operation, including DDC system control and optimizing routines (algorithms).
 5. Operate the workstation and peripherals.
 6. Log on and off the system.
 7. Access graphics, point/object reports, and logs.
 8. Adjust and change system setpoints, time schedules, and holiday schedules.

9. Recognize malfunctions of the system by observation of the printed copy and graphical visual signals.
 10. Understand system drawings, and Operation and Maintenance manual.
 11. Understand the job layout and location of control components.
 12. Access data from DDC controllers and ASC.
 13. Operate portable operator's terminals.
- C. Train the designated staff of Owner's Representative and Owner to enable Advanced Operators to:
1. Make and change graphics on the workstation
 2. Create, delete, and modify alarms, including annunciation and routing of these
 3. Create, delete, and modify point/object trend logs, and graph or print these
 4. Create, delete, and modify reports
 5. Add, remove, and modify system's physical points/objects
 6. Create, modify, and delete programming
 7. Add panels when required
 8. Add Operator Workstation stations
 9. Create, delete, and modify system displays — both graphical and otherwise
 10. Perform DDC system field checkout procedures
 11. Perform DDC controller unit operation and maintenance procedures
 12. Perform workstation and peripheral operation and maintenance procedures
 13. Perform DDC system diagnostic procedures
 14. Configure hardware including PC boards, switches, communication, and I/O points/objects
 15. Maintain, calibrate, troubleshoot, diagnose, and repair hardware
 16. Adjust, calibrate, and replace system components
- D. Train the designated staff of Owner's Representative and Owner to enable System Managers/Administrators to:
1. Maintain software and prepare backups
 2. Interface with job-specific, third-party operator software
 3. Add new users and understand password security procedures

3.16 WARRANTY ACCESS

- A. The Owner shall grant to the Contractor, reasonable access to the BAS system during the warranty period. The owner shall provide, at no cost to the Subcontractor, a dedicated voice grade telephone extension for remote telecommunications during this period.

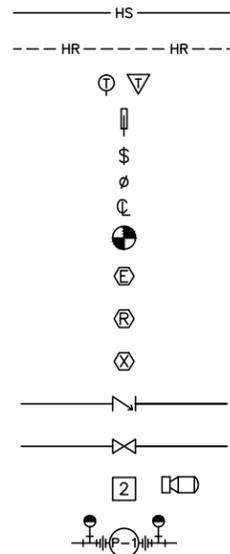
3.17 SEQUENCE OF OPERATIONS

- A. See Sheet M103 for Sequence of Operations.

END OF SECTION



SYMBOLS



HEATING SUPPLY
 HEATING RETURN
 THERMOSTAT OR THERMOSTATIC SENSOR - IMMERSION, ROOM
 THERMOMETER
 CONTROL SWITCH
 DIAMETER OR PHASE
 CENTER LINE
 POINT OF REMOVAL AND CONNECTION
 EXISTING
 RELOCATE
 REMOVE
 SPRING CHECK VALVE
 ISOLATION VALVE
 CONSTRUCTION NOTE
 PUMP WITH TEST PORTS

AHU AIR HANDLING UNIT
 AFF ABOVE FINISHED FLOOR
 AS AIR SEPARATOR
 AV AUTOMATIC VALVE
 B BUTTERFLY DAMPER
 BAS BUILDING AUTOMATION SYSTEM
 C COMMON
 CFM CUBIC FEET PER MINUTE
 CU COPPER
 DDC DIRECT DIGITAL CONTROL
 DG DOOR GRILLE
 DI DUCTILE IRON
 EA EXHAUST AIR
 EAD EXHAUST AIR DAMPER
 EAT ENTERING AIR TEMPERATURE
 EF EXHAUST FAN
 EG EXHAUST GRILLE
 ESP EXTERNAL STATIC PRESSURE
 FLD FIRE RATED DAMPER/FUSIBLE LINK DAMPER
 FPM FEET PER MINUTE
 GPH GALLONS PER HOUR
 GPM GALLONS PER MINUTE
 HC HEATING COIL
 HX HEAT EXCHANGER
 INV. EL. INVERT ELEVATION
 IPS IRON PIPE SIZE
 LAT LEAVING AIR TEMPERATURE
 LL LOW LIMIT
 LV LOUVER
 LWCO LOW WATER CUTOFF

LWT LEAVING WATER TEMPERATURE
 MA MIXED AIR
 MAD MIXED AIR DAMPER
 MAT MIXED AIR TEMPERATURE
 MB MANUAL MULTIBLADE DAMPER
 MBH 1,000 BTU PER HOUR
 NC NORMALLY CLOSED
 NIC NOT IN CONTRACT
 NIM NOT IN MECHANICAL
 NF NON FREEZE
 NO NORMALLY OPEN
 OAD OUTSIDE AIR DAMPER
 OC ON CENTER
 OSA OUTSIDE AIR
 P PUMP
 PSI POUNDS PER SQUARE INCH
 RA RETURN AIR
 RAD RECIRCULATING AIR DAMPER
 RF RETURN FAN
 RG RETURN GRILLE
 RLD RELIEF AIR DAMPER
 SA SUPPLY AIR
 SAT SUPPLY AIR THERMOSTAT
 SF SUPPLY FAN
 SG SUPPLY GRILLE
 TSP TOTAL STATIC PRESSURE
 TYP TYPICAL
 V VOLTAGE
 VAR VARIABLE FREQUENCY/SPEED

GENERAL NOTES:

- SCOPE OF WORK: INTENT OF WORK IS TO UPGRADE THE CONTROLS IN THE BUILDING TO DDC TYPE WITH A GRAPHIC USER INTERFACE, WEB/ETHERNET CONNECTION, AND LAPTOP HOST COMPUTER. PROVIDE CONTROL COMPONENTS, CONTROL PANELS, CONTROL WIRING, AND APPURTENANCES FOR A FULLY OPERATIONAL AND INTEGRATED DDC CONTROL PACKAGE. REMOVE EXISTING TEKMAR, HONEYWELL, SIEBE, AND OTHER ELECTRONIC CONTROLS SYSTEM ENTIRELY EXCEPT RADIANT ZONE THERMOSTATS MAY BE INCORPORATED INTO DDC CONTROLS OTHERWISE PROVIDE NEW. DDC CONTROLS COMPONENTS ARE NEW AND PROVIDED HEREUNDER UNLESS OTHERWISE NOTED.
- INFORMATION SHOWN HEREUNDER IS COMPILED FROM ORIGINAL CONSTRUCTION DRAWINGS AND REPORTED AS-BUILTS. DRAWINGS ARE FOR REFERENCE AND VIEW OF OVERALL SYSTEMS. VERIFY ALL EXISTING CONDITIONS ON SITE. REPORT ANY DEFICIENCIES TO PROJECT MANAGER.

MECHANICAL DRAWING INDEX

SHEET	TITLE
M001	SYMBOLS & SCHEDULES
M101	FLOOR PLAN
M102	MECHANICAL ROOM PLAN
M103	CONTROL DIAGRAMS

EXISTING PUMP SCHEDULE

EQUIPMENT	FUNCTION	GPM	HEAD, FT	DESIGN MANUFACTURER AND MODEL	MINIMUM HORSEPOWER ELECTRICAL CHARACTERISTICS	FEATURES
EP-1	RADIANT HEATING PRIMARY	30	15	TACO 1611	1/2 HP, 115V, SINGLE-PHASE	INLINE PUMP.
EP-2	RADIANT HEATING ZONES 1,2,4,5,6	8.7	25	TACO 0013	1/8 HP, 115V, SINGLE-PHASE	UNITIZED PUMP.
EP-3	RADIANT HEATING ZONES 3,7,8,9	8.0	25	TACO 0013	1/8 HP, 115V, SINGLE-PHASE	UNITIZED PUMP.
EP-4	RADIANT HEATING ZONES 10,11	13.3	25	TACO 0013	1/8 HP, 115V, SINGLE-PHASE	UNITIZED PUMP.
EP-5	AHU HEATING COIL	8.0	24	TACO 0011	1/8 HP, 115V, SINGLE-PHASE	UNITIZED PUMP.

EXISTING AIR HANDLING EQUIPMENT SCHEDULE

EQUIPMENT	LOCATION	MANUFACTURER, MODEL, SERIAL #	CFM	Δ P, INCHES OF WATER	MIN. HP	VOLTS / PHASE
AHU-1	ATTIC FAN ROOM	PACE, PACH-410, 02-83090-01	6,290	2.25" TSP	5.0	230V / 1φ
EF-1	ATTIC FAN ROOM	COOL, 135 CPS-CW-TH	780	0.75" TSP	1/2	120V / 1φ

EXISTING AUTOMATIC DAMPER SCHEDULE

DAMPER	FUNCTION	SIZE (INCHES)	OPERATION	LOCATION
OAD*	AHU OSA	24x30	MODULATING, NC	FAN ROOM 201
RAD*	AHU RECIRCULATING	24x30	MODULATING, NO	FAN ROOM 201
EAD*	EF EXHAUST	6x20	POSITIVE, NC	READING 113
RLD*	BUILDING RELIEF	42x20	MODULATING, NC	READING 113

*PROVIDE NEW ACTUATORS FOR ALL AUTOMATIC DAMPERS.

EXISTING FLOWSETTER AND AUTOMATIC VALVE SCHEDULE

NUMBER	UNIT SERVED	LOCATION	DESIGN GPM	SETTER SIZE (INCHES)	VALVE TYPE	VALVE OPERATION	NORMAL POSITION
1*	RADIANT MIXING	BOILER ROOM	30	2	FOUR-WAY	MODULATING	OPEN
2*	AHU HEATING COIL	AHU ATTIC	8.0	1-1/4	THREE-WAY	MODULATING	OPEN

*PROVIDE NEW ACTUATORS FOR AUTOMATIC VALVES.

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SHEET TITLE:
 SYMBOLS & SCHEDULES

SCALE: AS SHOWN
 DATE: MARCH 2014
 DRAWN: LH/KB
 DESIGNED: LH
 CHECKED: DM

SHEET NO.

M001

JOB NO. M-490

TEL: 907 780-6151
 FAX: 907 780-6182
 P O BOX 21081
 JUNEAU, ALASKA 99802



SHEET NOTES:

1. INTENT OF WORK IS TO REMOVE CONTROL COMPONENTS AND REPLACE WITH DDC TYPE. REUSE AS MUCH OF THE EXISTING CONTROL PANEL BOXES AND CONDUIT RUNS AS POSSIBLE.

CONSTRUCTION NOTES:

1. REPLACE OSA TEMPERATURE SENSOR WITH DDC TYPE.
2. REPLACE RELIEF AIR AND EXHAUST AIR DAMPER ACTUATORS. NOT ALL DUCTWORK IS SHOWN. COORDINATE WITH EXISTING CONDITIONS.
3. PROVIDE NEW RADIANT ZONE THERMOSTATS, IF UNABLE TO RETAIN EXISTING ZONE THERMOSTATS AND INCORPORATE INTO DDC SYSTEM. VERIFY THERMOSTATS WILL FUNCTION WITH DDC SYSTEM. REPORT ANY DEFICIENCIES TO PROJECT MANAGER.
4. REPLACE ALL RADIANT ZONE AUTOMATIC VALVES AT EACH MANIFOLD, REVISE EXISTING WIRING IF POSSIBLE, OTHERWISE INSTALL NEW.
5. INSTALL DDC SPACE PRESSURE SENSOR, ROUTE WIRING THROUGH FAN ROOM.

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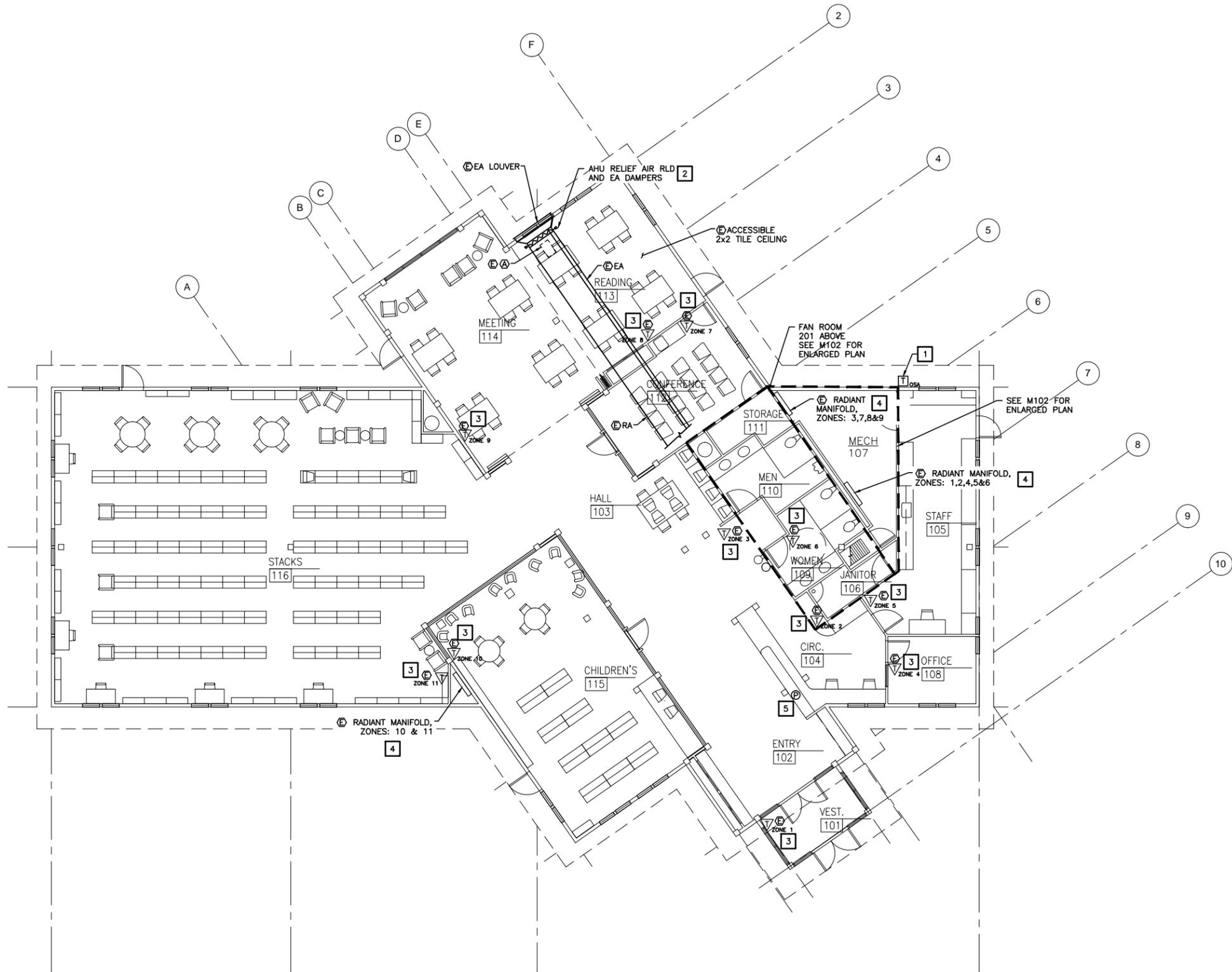
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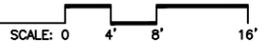
SHEET TITLE:
FLOOR PLAN

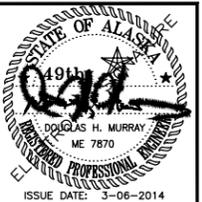
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SHEET NO.
M101
JOB NO. M-490



1 FLOOR PLAN





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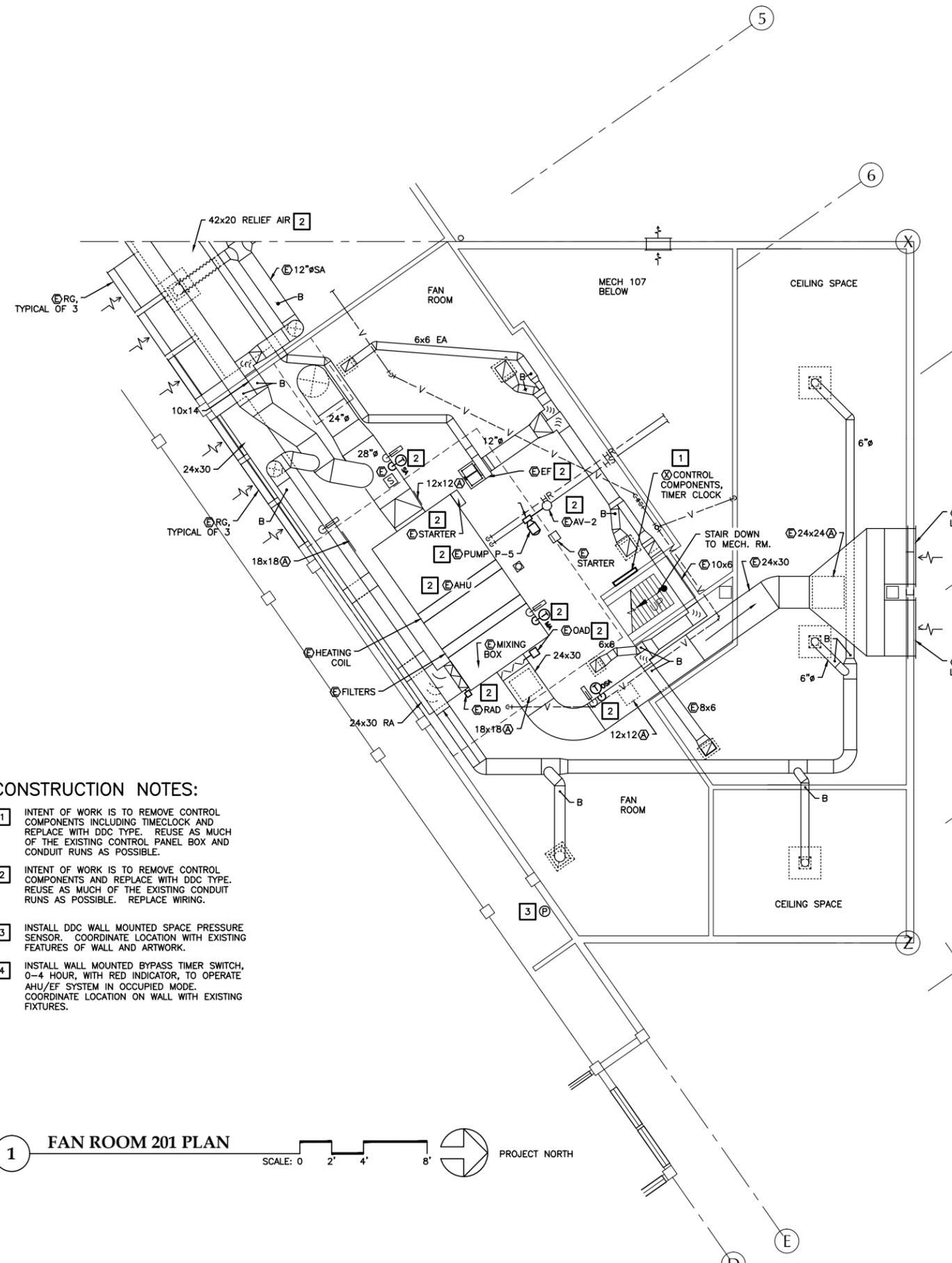
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SHEET TITLE:
 MECHANICAL
 ROOM PLAN

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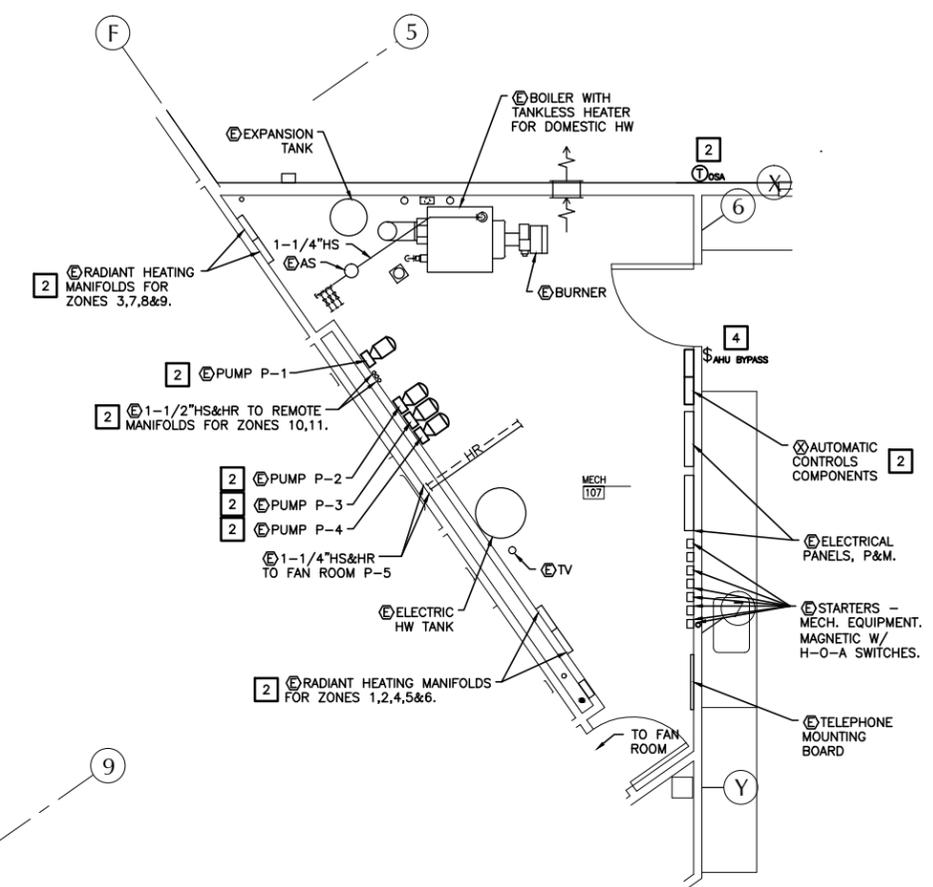
SHEET NO.
M102
 JOB NO. M-490



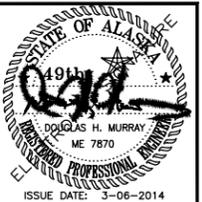
CONSTRUCTION NOTES:

- 1 INTENT OF WORK IS TO REMOVE CONTROL COMPONENTS INCLUDING TIMECLOCK AND REPLACE WITH DDC TYPE. REUSE AS MUCH OF THE EXISTING CONTROL PANEL BOX AND CONDUIT RUNS AS POSSIBLE.
- 2 INTENT OF WORK IS TO REMOVE CONTROL COMPONENTS AND REPLACE WITH DDC TYPE. REUSE AS MUCH OF THE EXISTING CONDUIT RUNS AS POSSIBLE. REPLACE WIRING.
- 3 INSTALL DDC WALL MOUNTED SPACE PRESSURE SENSOR. COORDINATE LOCATION WITH EXISTING FEATURES OF WALL AND ARTWORK.
- 4 INSTALL WALL MOUNTED BYPASS TIMER SWITCH, 0-4 HOUR, WITH RED INDICATOR, TO OPERATE AHU/EF SYSTEM IN OCCUPIED MODE. COORDINATE LOCATION ON WALL WITH EXISTING FIXTURES.

1 FAN ROOM 201 PLAN
 SCALE: 0 2' 4' 8' PROJECT NORTH



2 MECH. 107 PLAN
 SCALE: 0 2' 4' 8' PROJECT NORTH



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SHEET TITLE:
 CONTROL DIAGRAMS

SCALE: AS SHOWN
 DATE: MARCH 2014
 DRAWN: LH/KB
 DESIGNED: LH
 CHECKED: DM

SHEET NO.
M103
 JOB NO. M-490

LEGEND

CONTROLLER	AI ANALOG INPUT
CURRENT SENSOR	AO ANALOG OUTPUT
VALVE ACTUATOR	AHU AIR HANDLING UNIT
DAMPER ACTUATOR	DI DIGITAL INPUT
THERMOSTAT OR THERMOSTATIC SENSOR	DO DIGITAL OUTPUT
PUMP	DP DIFFERENTIAL PRESSURE
MOTOR	EAD EXHAUST AIR DAMPER
AIR DIRECTION	EF EXHAUST FAN
SWITCH	MA MIXED AIR
THERMOMETER	NC NORMALLY CLOSED
GAGE	NO NORMALLY OPEN
SMOKE SENSOR WITH AUXILIARY CONTACT	OAD OUTSIDE AIR DAMPER
	OSA OUTSIDE AIR
	P PUMP
	RAD RETURN AIR DAMPER
	RLD RELIEF AIR DAMPER
	SA SUPPLY AIR

SHEET NOTES:

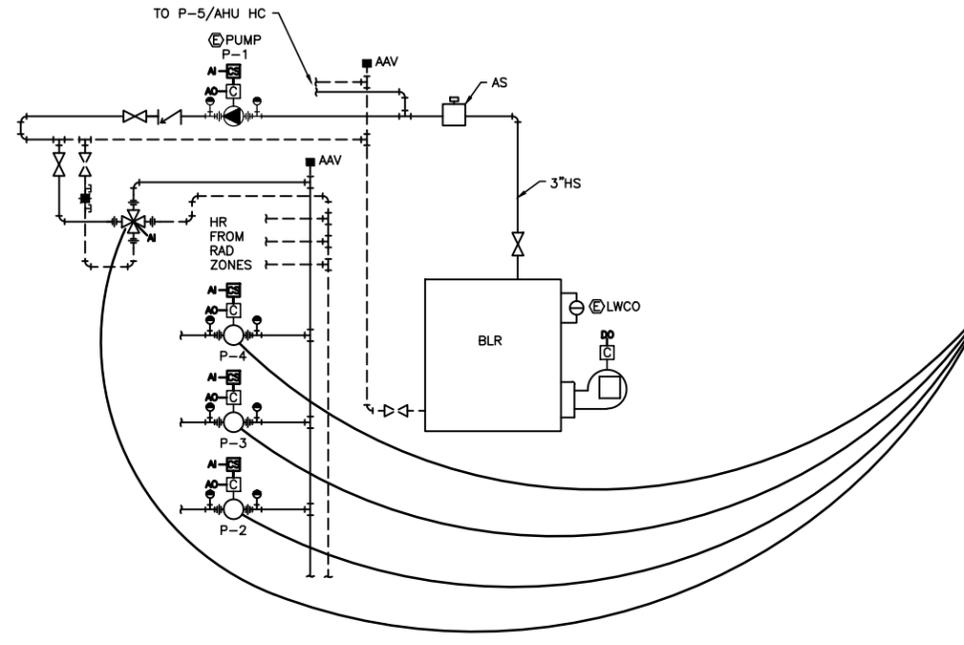
- THE DIAGRAMS AND POINTS SHOWN HERE ARE SCHEMATIC ONLY.
- REUSE THE FOLLOWING EXISTING COMPONENTS, OTHERWISE PROVIDE NEW.
 - A. ROOM THERMOSTATS: EXISTING ARE TEKMAR, MODEL RTU 055.
 - B. RADIANT ZONE VALVES: EXISTING ARE UPONOR.
 - C. RADIANT 4-WAY MIXING VALVE. EXISTING IS TEKMAR MODEL 017 WITH WIRSBO 24 VOLT ACTUATOR.
- ALL CONTACTORS AND STARTERS ARE EXISTING; GE MANUFACTURER.

SCOPE OF WORK:

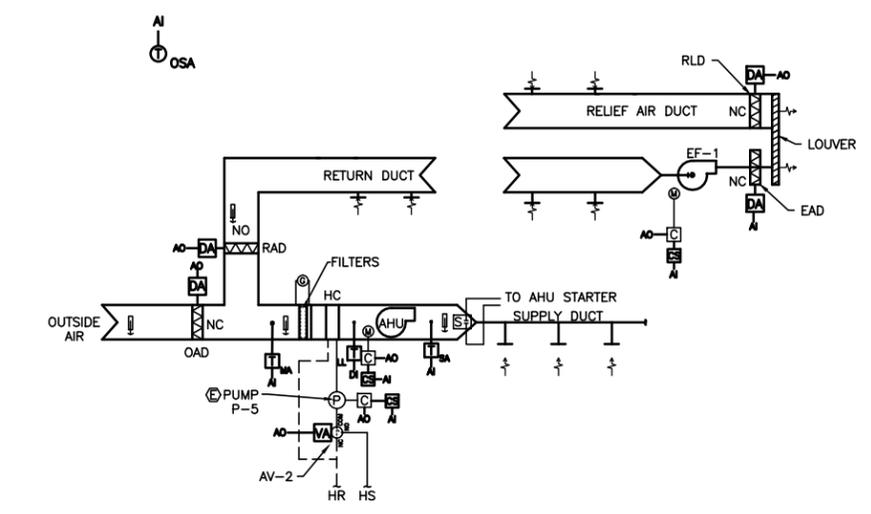
- REPLACE ALL CONTROL POINTS WITH DDC COMPATIBLE COMPONENTS SEE EXISTING SEQUENCE OF OPERATION ON THIS SHEET. PROVIDE MICROZONE AND CONTROL PANELS AS REQUIRED FOR A COMPLETE AND INTEGRATED DDC SYSTEM. PROVIDE COMPUTER BASED USER INTERFACE WITH GRAPHIC PACKAGE. PROVIDE SCHEDULING AND TRENDING OFF MECHANICAL SYSTEMS. PROVIDE CRITICAL CONTROL COMPONENTS WITH BATTERY BACK UP AND AUTOMATIC RESET.
- INTENT IS TO REUSE EXISTING THERMOSTATS, RADIANT ZONE VALVES, AND EXISTING RUNS AS MUCH AS POSSIBLE. IF CONDUIT CONTROL ITEMS ARE NOT COMPATIBLE WITH DDC SYSTEM REPORT TO PROJECT MANAGER.

SEQUENCE OF OPERATIONS

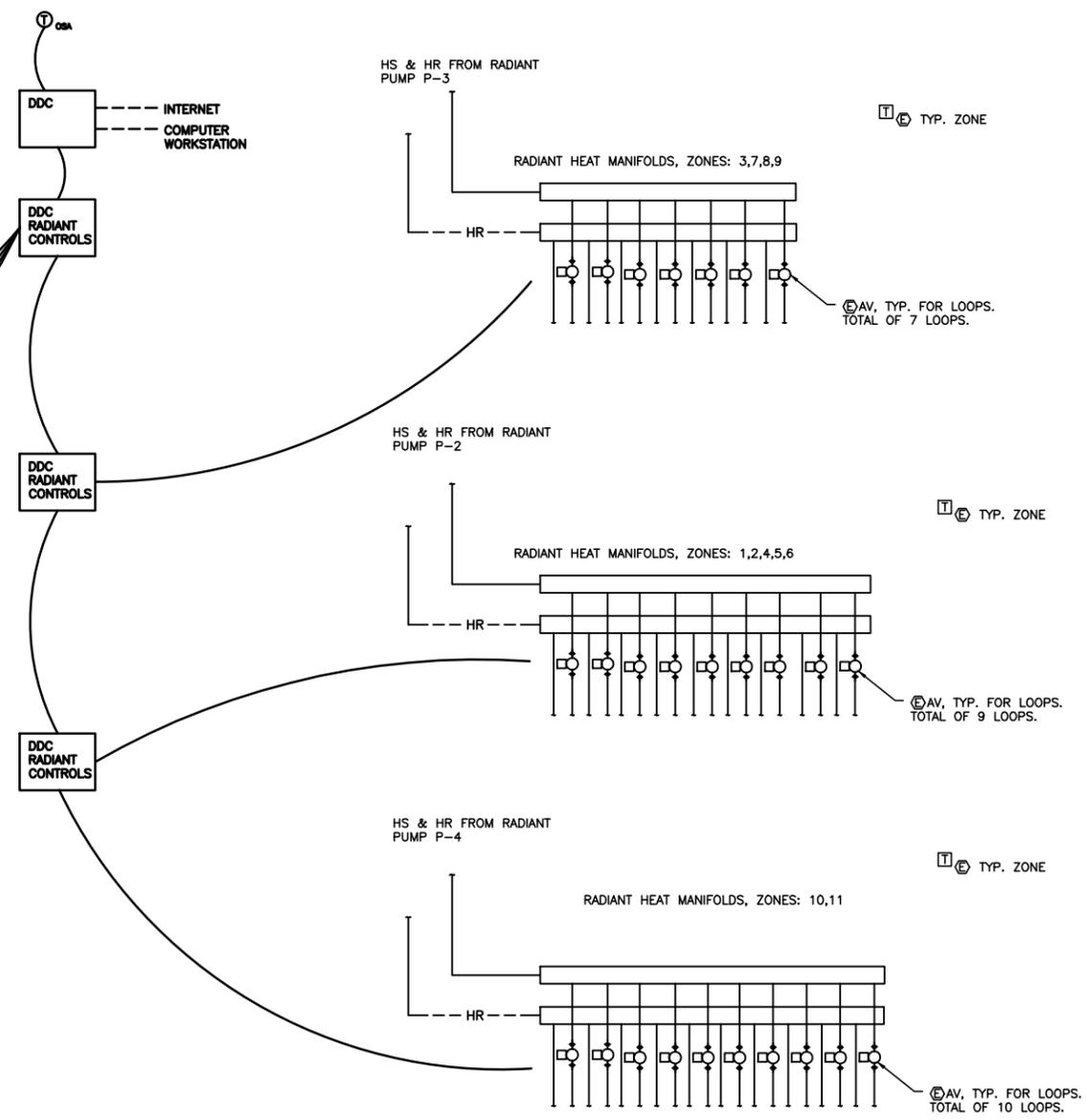
- AIR HANDLING UNIT (AHU):
 - SWITCHES: MAGNETIC STARTER WITH HAND-OFF-AUTO SWITCH, LOCATED ON THE MOUNTING BOARD IN MECHANICAL 107. IN THE AUTO POSITION, THE AHU OPERATES AND THE CONTROL SEQUENCE IS ENABLED DURING THE OCCUPIED SCHEDULE OF THE PROGRAM CLOCK. IN THE HAND POSITION, THE FAN OPERATES IN OCCUPIED MODE.
 - MIXED AIR TEMPERATURE: AVERAGING BULB DUCT THERMOSTAT TO POSITION THE OAD AND RAD DAMPERS, TO PROVIDE ADJUSTABLE 60F MIXED AIR. DURING LOW LIMIT CONDITION, DAMPERS SHALL POSITION TO NORMAL POSITIONS. NORMAL POSITIONS: OAD NORMALLY CLOSED, RAD NORMALLY OPEN, RLD NORMALLY CLOSED, EAD NORMALLY CLOSED.
 - SUPPLY AIR TEMPERATURE: DUCT THERMOSTAT SHALL CONTROL SUPPLY AIR TO MODULATE THE AUTOMATIC VALVE ON THE HEATING COIL TO PROVIDE 70F SUPPLY AIR TEMPERATURE AT AN OUTSIDE TEMPERATURE OF 30F AND BELOW, AND MODULATED TO PROVIDE 65F SUPPLY AIR TEMPERATURE AT AN OUTSIDE TEMPERATURE OF 60F AND ABOVE.
 - RELIEF DAMPER CONTROL: RLD TO MODULATE TO MAINTAIN POSITIVE SPACE PRESSURE AT SENSOR LOCATION, ADJUSTABLE, INITIALLY SET AT 0.05 INCHES. ADJUST IN THE FIELD AT FINAL COMPLETION.
 - LOW OSA TEMPERATURE: BELOW 35°F OSA POSITION AHU HC AV-2 TO MINIMUM 25% OPEN TO HEATING DURING UNOCCUPIED SCHEDULE.
 - LOW LIMIT CONTROL: AVERAGING BULB THERMOSTAT TO STOP THE FAN BELOW 40F ADJUSTABLE, AFTER AN ADJUSTABLE TIME DELAY OF 45 SECONDS IN EITHER HAND OR AUTO POSITION OF STARTER. DURING A LOW LIMIT CONDITION, AV-2 POSITIONED TO FULL HEATING, AUTOMATIC DAMPER TO ADJUST TO NORMAL POSITIONS, AND PUMP P-5 OPERATES.
 - BYPASS SWITCH: SWITCH WITH LARGE RED INDICATING LIGHT SHALL COMMAND THE AHU TO BYPASS THE PROGRAM CLOCK AND OPERATE THE AHU AND CONTROLS IN THE OCCUPIED CYCLE. INSTALLED WHERE SHOWN WITH INDICATING SIGN.
 - SMOKE SENSORS: UPON ACTIVATION OF SENSOR, THE SMOKE SENSOR SHALL STOP THE AHU. EXISTING HARDWIRE - VERIFY.
- PRIMARY CIRCULATION PUMP P-1: MAGNETIC STARTER WITH HAND-OFF-AUTO SWITCH, LOCATED ON THE MOUNTING BOARD IN MECHANICAL 107. IN THE AUTO POSITION, THE PUMP OPERATES WHENEVER THE OSA TEMPERATURE IS BELOW 50°F WHENEVER ANY OTHER PUMP IS OPERATING. IN THE HAND POSITION, THE PUMP OPERATES IN OCCUPIED MODE.
- RADIANT PUMPS (P-2,P-3,P-4): MAGNETIC STARTER WITH HAND-OFF-AUTO SWITCH, LOCATED ON THE MOUNTING BOARD IN MECHANICAL 107. IN THE AUTO POSITION, THE PUMP OPERATES WHEN RADIANT FLOOR HEATING ZONE THERMOSTATS CALLS FOR HEATING. IN THE HAND POSITION, THE PUMP OPERATES IN OCCUPIED MODE. PROVIDE NIGHT HEATING ZONE SETBACK CONTROL FOR PUMPS, P-2, P-3, & P-4.
- PUMP P-5: MAGNETIC STARTER WITH HAND-OFF-AUTO SWITCH, LOCATED ON THE MOUNTING BOARD IN MECHANICAL 107. IN THE AUTO POSITION, THE PUMP OPERATES WHEN AHU IS OPERATING AND AUTOMATIC VALVE IS OPEN. PUMP ALSO OPERATES DURING ITS LOW LIMIT ALARM. IN THE HAND POSITION, THE PUMP OPERATES IN OCCUPIED MODE.
- BOILER LOW TEMP CONTROL: IMMERSION THERMOSTATIC SENSOR IN HEATING RETURN TO SHUT OFF RADIANT PUMPS P-2, P-3, AND P-4 WHEN SENSING ADJUSTABLE 135°F AND BELOW.
- EXHAUST FAN EF-1: MAGNETIC STARTER WITH HAND-OFF-AUTO SWITCH, LOCATED ON THE MOUNTING BOARD IN MECHANICAL ROOM 107. IN THE AUTO POSITION, THE FAN OPERATES WHEN AHU OPERATES AT COMMAND OF THE PROGRAM TIME CLOCK OCCUPIED SCHEDULE. IN THE HAND POSITION, THE FAN OPERATES. EAD OPENS WHENEVER EF-1 OPERATES, IN HAND OR AUTO MODES.
- RADIANT SYSTEM CONTROLS: MICROPROCESSOR CONTROL PROPORTIONAL INTEGRAL TYPE WITH 120 VOLT POWER SUPPLY AND 24 VOLT TRANSFORMERS. CONTROLLER IS TO CONTROL OPERATION OF RADIANT HEATING WATER PUMPS (P-2, P-3, AND P-4) AND CONTROL 4-WAY MIXING VALVE TO MAINTAIN WATER TEMPERATURE REQUIRED TO ZONES AND ROOM THERMOSTAT SET POINTS. CONTROLLER TO ANTICIPATE RADIANT HEATING WATER TEMPERATURE REQUIREMENTS BASED ON OUTSIDE AIR TEMPERATURES. CONTROLLER TO SHUT DOWN THE HEATING PUMPS IF OUTSIDE AIR TEMPERATURE IS ABOVE SET POINT OF 70°F ADJUSTABLE AND ALSO SHUT DOWN INDIVIDUAL ZONE PUMPS IF ALL OF THOSE RESPECTIVE ZONES' AUTOMATIC VALVES ARE CLOSED TO HEATING. CONTROLLER IS TO BE INTEGRAL WITH THE DDC SYSTEM AND HAVE ADJUSTABLE SET POINTS. ALL CONTROL POINTS TO BE MONITORED, DISPLAYED ON CONTROL GRAPHICS PROGRAM FOR DDC SYSTEM.
- RADIANT ZONE CONTROLS: ZONE THERMOSTAT TO OPEN ALL RESPECTIVE AV'S AND OPERATE RESPECTIVE PUMP BELOW ADJUSTABLE SET POINT. ZONE AV'S TO CLOSE AND PUMP TO SHUT OFF ABOVE SETPOINT.



CONTROL SCHEMATIC FOR BOILER AND RADIANT PUMPS
 NO SCALE



CONTROL SCHEMATIC FOR AHU AND EF
 NO SCALE



CONTROL SCHEMATIC FOR RADIANT MANIFOLDS
 NO SCALE