City of Plymouth

Contract Documents

Building Automation Project, City Hall

October 28th, 2020

CONTRACT DOCUMENTS

Building Automation Project, City Hall

PLYMOUTH, MINNESOTA

October 28th, 2020

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ADVERTISEMENT FOR BIDS

Building Automation Project
For Plymouth City Hall
3400 Plymouth Blvd

PLYMOUTH, MINNESOTA

NOTICE IS HEREBY GIVEN that sealed bids will be received by the City of Plymouth until Friday November 13, 2020 at 10:30 am at the Plymouth City Hall, located at 3400 Plymouth Boulevard, Plymouth, MN, at which time they will be publicly opened and read aloud, for the furnishing and installation of building automation at Plymouth City Hall.

Bids shall be on the forms provided for that purpose and according to the Contract Documents dated October 28, 2020.

Contractors desiring a copy of the Bid Forms and Contract Documents may obtain them from the City of Plymouth Web Site at www.plymouthmn.gov/bids.

There will be a one-time only, MANDATORY informational meeting to allow for site inspections on, November 4th, 2020 at 10:00am. This inspection will begin at the main entrance to Plymouth City Hall at 3400 Plymouth Blvd. Plymouth, MN 55447. Bid Forms and Contract Documents may be viewed at the meeting.

Bid Security in the amount of 5% of the bid must accompany each bid in accordance with the Instructions to Bidders.

Bids shall be directed to the Facilities Division, securely sealed and endorsed upon the outside wrapper, "BID FOR BUILDING AUTOMATION PROJECT." Submit bid to City Hal between the hours of 8:00am and 4:00pm.

The City of Plymouth reserves the right to reject any or all bids, to waive irregularities and informalities therein and to award the contract in the best interests of the City.

October 29, 2020

INSTRUCTIONS TO BIDDERS

1. DEFINED TERMS

The term "BIDDER" means one who submits a Bid directly to OWNER, as distinct from a sub bidder, who submits a Bid to a BIDDER. The term "Successful BIDDER" means the lowest, qualified responsible and responsive BIDDER to whom OWNER (on the basis of OWNER'S evaluation as hereinafter provided) makes an award. The term, "Bidding Documents" includes the Advertisement or Invitation to Bid, Instructions to BIDDERS, the Bid Form, and the proposed Contract Documents (including all Addenda issued prior to receipt of Bids).

2. COPIES OF BIDDING DOCUMENTS

2.1 Contractors desiring a copy of the Bid Forms and Contract Documents may obtain them from the City of Plymouth's Engineering Department web site at the following link: www.plymouthmn.gov/bids.

2.2 Complete sets of Bidding Documents must be used in preparing Bids; neither OWNER assumes any responsibility for errors or misinterpretations resulting from the use of incomplete sets of Bidding Documents.

2.3 OWNER in making copies of Bidding Documents available on the above terms does so only for the purpose of obtaining Bids on the Work and does not confer a license or grant for any other use.

3. EXAMINATION OF CONTRACT DOCUMENTS AND SITE

3.1 It is the responsibility of each BIDDER before submitting a Bid, to (a) examine the Contract Documents thoroughly, (b) visit the site to become familiar with local conditions that may affect cost, progress, performance or furnishing of the Work, (c) consider federal, state and local Laws and Regulations that may affect cost, progress, performance or furnishing of the Work, (d) study and carefully correlate BIDDER'S observations with the Contract Documents, and (e) notify OWNER in writing of all conflicts, errors or discrepancies in the Contract Documents.

3.2 **THERE WILL BE A ONE-TIME ONLY MANDATORY INFORMATIONAL MEETING TO ALLOW FOR SITE INSPECTIONS ON: (November 4th, 2020 at 10:00am)** Prospective bidders are requested to meet at Plymouth City Hall main entrance located at 3400 Plymouth Blvd, Plymouth, MN. The site inspections will allow the prospective proposers to become familiar with all conditions that may affect the performance and cost of the contract. Failure on the part of the contractor to familiarize themselves with all conditions shall not constitute a basis for subsequent contract adjustment.

3.3 The submission of a Bid will constitute an incontrovertible representation by BIDDER that BIDDER has complied with every requirement of this Article 3, that without exception the Bid is premised upon performing and furnishing the Work required by the Contract Documents and such means, methods, techniques, sequences or procedures of work as may be indicated in or required by the Contract Documents, and that the Contract Documents are sufficient in scope and detail to indicate and convey understanding of all terms and conditions for performance and furnishing of the Work.

4. INTERPRETATIONS AND ADDENDA

4.1 All questions about the meaning or intent of the Contract Documents are to be made in writing, and directed to OWNER. Interpretations or clarification's considered necessary by OWNER in response to such questions will be issued with an Addenda by email, fax or mailed or to all parties recorded by OWNER as having received the Bidding Documents. Questions received less than two days prior to the date for opening of Bids may not be answered. Only questions answered by formal written Addenda will be binding. Oral and other interpretations or clarifications will be without legal effect.

4.2 Addenda may also be issued to modify the Bidding Documents as deemed advisable by OWNER or ARCHITECT. Questions in regards to the Bidding Documents must be submitted to OWNER or ARCHITECT by **November 6th, 2020 at 4:30pm**. Reponses will be sent to all BIDDERS on **November 10th, 2020 by 12:00pm**

5. Bid Security

5.1 Each Bid must be accompanied by Bid security made payable to Owner in an amount of 5% of the BIDDER'S maximum Bid price and in the form of a certified or bank check or Bid Bond issued by a surety meeting the requirements.

5.2 The Bid security of the Successful BIDDER will be retained until such BIDDER has executed the Agreement and furnished the required contract security, whereupon the Bid security will be returned. If the Successful BIDDER fails to execute and deliver the Agreement and furnish the required contract security within fifteen days after the Notice of Award, OWNER may annul the Notice of Award and the Bid security of the BIDDER will be forfeited. The Bid security of the three lowest BIDDERS may be retained by the OWNER until the Agreement is signed and submitted with the bonds as set forth in Paragraph 2 of the Bid Form. Bid security of other BIDDERS will be returned within seven days after award of the contract.

6. SUBCONTRACTORS, SUPPLIERS AND OTHERS

6.1 No Subcontractors will be allowed without written consent from the City. No CONTRACTOR shall be required to employ any Supplier, other person or organization against whom CONTRACTOR has reasonable objection.

7. BID FORM

7.1 The Bid Form is included with the Bidding Documents; additional copies may be obtained from OWNER.

7.2 All blanks on the Bid Form must be completed in ink or by typewriter.

7.3 Bids by corporations must be executed in the corporate name by the president or a vice-president (or other corporate officer accompanied by evidence of authority to sign) and the corporate seal must be affixed and attested by the secretary or an assistant secretary. The corporate address and state of incorporation must be shown below the signature.

7.4 Bids by partnerships must be executed in the partnership name and signed by a partner, whose title must appear under the signature and the official address of the partnership must be shown below the signature.

7.5 All names must be typed or printed in ink below the signature.

7.6 The Bid shall contain an acknowledgment of receipt of all Addenda (the numbers of which must be filled in on the Bid Form).

7.7 The address and telephone number for communications regarding the Bid must be shown.

7.8 This project's BID FORM contains six sections; Exhibit 1, Exhibit 2, Exhibit 3, Exhibit 4, Exhibit 5, and Exhibit 6. Bids will be evaluated by the OWNER based on any combination of the Exhibits and Alternates.

8. SUBMISSION OF BIDS

Bids shall be submitted at the time and place indicated in the Advertisement or Invitation to Bid and shall be enclosed in an opaque sealed envelope, marked with the Project title (and, if applicable, the designated portion of the Project for which the Bid is submitted) and name and address of the BIDDER and accompanied by the Bid security and other required documents. If the Bid is sent through the mail or other delivery system, the sealed envelope shall be enclosed in a separate envelope with the notation "BID ENCLOSED" on the face of it.

9. MODIFICATION AND WITHDRAWAL OF BIDS

9.1 Bids may be modified or withdrawn by an appropriate document duly executed (in the manner that a Bid must be executed) and delivered to the place where Bids are to be submitted at any time prior to the opening of Bids.

9.2 If, within twenty-four hours after Bids are opened, any BIDDER files a duly signed, written notice with OWNER and promptly thereafter demonstrates to the reasonable satisfaction of OWNER that there was a material and substantial mistake in the preparation of its Bid, that BIDDER may withdraw its Bid and the Bid security will be returned. Thereafter, that BIDDER will be disqualified from further bidding on the Work to be provided under the Contract Documents.

10. OPENING OF BIDS

Bids will be opened and (unless obviously non-responsive) read aloud publicly. An abstract of the amounts of the Bids will be made available to BIDDERS after the opening of Bids.

11. BIDS TO REMAIN SUBJECT TO ACCEPTANCE

All bids will remain subject to acceptance as set forth in Paragraph 2 of the Bid Form, but OWNER may, in its sole discretion, release any Bid and return the Bid security prior to that date.

12. RESPONSIBLE BIDDER EVALUATION

The City will review the qualifications and experience of bidders after bids are opened and before a contract is awarded, to determine if the bidder is "responsible." A "responsible" bidder is a bidder qualified to do the work. This will be determined by assessing the bidder's skill, resources, experience, successful performance of similar contracts (on time and on budget), and all other matters bearing upon the likelihood that the contract will be successfully completed. In all cases where a bidder is unknown or where there are any questions about the qualifications of the bidder, the following information will be required of the apparent low bidder:

You are required to complete and return this questionnaire before the City Council considers awarding you the contract.

12.1 Identify all similar public contracts in which you were the contractor. If you have had more than five such contracts, list only the last five contracts, and as to each contract identified provide the following information:

Contract Description:

Date:

Contact Person at City/County/State:

Were change orders in excess of 5% requested? If yes, explain the circumstances.

Were liquidated damages assessed? If yes, explain the circumstances.

Was the contract completed? If no, explain the circumstances.

12.2 Describe all arbitration claims and any contract litigation in which you have been a party in the last five years.

12.3 Identify all public contracts you have had with the City of Plymouth in the last five years.

12.4 In the last five years has a bonding company ever refused to issue you a performance bond? If yes, explain the circumstances.

12.5 In the last five years have any claims been filed against a performance or payment bond that you have provided a public entity? If yes, explain the circumstances.

12.6 In the last five years, has your firm or any of its owners or employees been fined by a federal or state agency for a contract or workplace matter (such as wage or hour or safety violations), or debarred under Part 29, Title 49 CFR or any other law from submitting bids on public projects? If yes, explain the circumstances.

12.7 In the last five years, has your firm or any of its owners or employees been charged or convicted of a crime involving the awarding, bidding or performance of a government contract? If yes, provide full details.

Contractor Verification of Compliance

The undersigned, being first duly sworn, as a responding contractor on the Project, represents and swears as follows:

Now, and at all times during the duration of the Project, the undersigned complies with each of the minimum criteria in Minn. Stat. § 16C.285, Subd. 3, the Responsible Contractor Statute.

The undersigned understands that a failure to meet or verify compliance with the minimum criteria established for a "responsible contractor" as defined in Minn. Stat. § 16C.285, Subd. 3, renders a bidder ineligible to be awarded a contract or to perform work on the contract.

Upon request, the undersigned will submit copies of the signed verifications of compliance from all subcontractors.

The undersigned understands that a false statement under oath verifying compliance with any of the minimum criteria shall make the undersigned, or its subcontractor that makes the false statement, ineligible to be awarded a contract and may result in termination of a contract awarded to the undersigned or its subcontractor that submits a false statement.

Certified as true and correct this _____ day of _____.

_____
(name)

_____
(name)

Resolution No. 2015-016, January 13, 2015
(Supersedes Resolution No. 2004-024, January 13, 2004)

13. AWARD OF CONTRACT

13.1 OWNER reserves the right to reject any and all Bids, to waive any and all informalities not involving price, time or changes in the Work and to negotiate contract terms with the Successful BIDDER, and the right to disregard all nonconforming, nonresponsive, unbalanced or conditional Bids. Also, OWNER reserves the right to reject the Bid of any BIDDER if OWNER believes that it would not be in the best interest of the Project to make an award to that BIDDER, whether because the Bid is not responsive or the BIDDER is unqualified or of doubtful financial ability or fails to meet any other pertinent standard or criteria established by OWNER. Discrepancies in the multiplication of units of Work and unit prices will be resolved in favor of the unit prices. Discrepancies between the indicated sum of any column of figures and the correct sum thereof will be resolved in favor of the correct sum.

13.2 In evaluating Bids, OWNER will consider the qualifications of the BIDDERS, whether or not the Bids comply with the prescribed requirements, and such alternates, unit prices and other data, as may be requested in the Bid Form or prior to the Notice of Award.

13.3 OWNER may consider the qualifications and experience of Subcontractors, Suppliers, and other persons and organizations proposed for those portions of the Work as to which the identity of Subcontractors, Suppliers, and other persons and organizations must be submitted as provided in the Supplementary Conditions. OWNER also may consider the operating costs, maintenance requirements, performance data and guarantees of major items of materials and equipment proposed for incorporation in the Work when such data is required to be submitted prior to the Notice of Award.

13.4 OWNER may conduct such investigations as OWNER deems necessary to assist in the evaluation of any Bid and to establish the responsibility, qualifications and financial ability of BIDDERS, proposed Subcontractors, Suppliers and other persons and organizations to perform and furnish the Work in accordance with the Contract Documents to OWNER'S satisfaction within the prescribed time.

13.5 If the contract is to be awarded, it will be awarded to the lowest BIDDER whose evaluation by OWNER indicates to OWNER that the award will be in the best interests of the Project.

13.6 If the Contract is to be awarded, OWNER will give the Successful BIDDER a Notice of Award within five days after the day of the award.

13.7 OWNER reserves the right to determine the successful BIDDER based on a combination of the Base Bid and Alternate Bid. The OWNER will consider the best interest of the project in making this determination.

14. CONTRACT SECURITY

Performance and Payment Bonds are required. When Successful BIDDER delivers the executed Agreement to OWNER, it must be accompanied by the required performance and payment Bonds

15. SIGNING OF AGREEMENT

When OWNER gives a Notice of Award to the Successful BIDDER, it will be accompanied by the required number of unsigned counterparts of the Agreement with all other written Contract Documents attached. Within fifteen days thereafter CONTRACTOR shall sign and deliver the required number of counterparts of the Agreement and attached documents to OWNER with the required Bonds. Within ten days thereafter OWNER shall deliver one fully signed counterpart to

CONTRACTOR. Each counterpart is to be accompanied by a complete set of the Drawings with appropriate identification.

BID FORM

PROJECT IDENTIFICATION: BUILDING AUTOMATION PROJECT, CITY HALL PLYMOUTH, MINNESOTA

BIDS TO BE OPENED:	**November 13th 2020 at 10:30am**
THIS BID IS SUBMITTED TO:	**CITY OF PLYMOUTH, FACILITIES** **3400 PLYMOUTH BOULEVARD** **PLYMOUTH, MINNESOTA 55447**

BID SUBMITTED BY:_____

1. The undersigned BIDDER proposes and agrees, if this Bid is accepted, to enter into an agreement with OWNER in the form included in the Contract Documents to perform and furnish all Work as specified or indicated in the Contract Documents for the Contract Price and within the Contract Time indicated in this Bid and in accordance with the other terms and conditions of the Contract Documents.

2. BIDDER accepts all of the terms and conditions of the Advertisement for Bids and Instructions to BIDDERS, including without limitation those dealing with the disposition of Bid security. This Bid will remain subject to acceptance for sixty (60) days after the day of Bid opening. BIDDER will sign and submit the Agreement with the Bonds and other documents required by the Bidding Requirements within fifteen days after the date of OWNER'S Notice of Award.

3. In submitting this Bid, BIDDER represents, as more fully set forth in the Agreement, that:

   (a) BIDDER has examined copies of all the Bidding Documents and of the following Addenda (receipt of all which is hereby acknowledged):

Date	Number
_____	_____
_____	_____

   (b) BIDDER has familiarized itself with the nature and extent of the Contract Documents, Work, site, locality, and all local conditions and Laws and Regulations that in any manner may affect cost, progress, performance or furnishing of the Work.

   (c) BIDDER has given OWNER written notice of all conflicts, errors or discrepancies that it has discovered in the Contract Documents and the written resolution thereof by OWNER is acceptable to BIDDER.

   (d) This Bid is genuine and not made in the interest of or on behalf of any undisclosed person, firm or corporation and is not submitted in conformity with any agreement or rules of any group, association, organization or corporation; BIDDER has not directly or indirectly induced or solicited any other BIDDER to submit a false or sham Bid; BIDDER has not solicited or induced any person, firm or corporation to refrain from bidding; and BIDDER has not sought by collusion to obtain for itself any advantage over any other BIDDER or over OWNER

BID FORM

4. BIDDER will complete the Work for the following prices:

Price Schedule

Bid Form

	Individual Cost	Total Project Cost
Project Base Bid	$	
Alternate #1	$	
Alternate #2	$	
Project Total including Alternates		$

5. BIDDER agrees that the Work will be substantially complete and completed and ready for final payment on or before that dates indicated in the Agreement

6. The following documents are attached to and made a condition of this BID:

   A) Required Bid Security in the form of (Bidder's Bond) (Certified Check)

   B) A tabulation of Subcontractors, Suppliers, and other persons and organizations required to be identified in the Bid.

   C) Affidavit of Non-Collusion

7. Communications concerning this Bid shall be addressed to the address of BIDDER indicated below.

8. The terms used in this Bid which are defined in the Contract Document and attached Exhibits 1-6.

SUBMITTED on _____, 2020.

If BIDDER is:

An Individual

By _____ (SEAL)
(Individual's Name)

doing business as _____

_____

Phone No: _____

A Partnership

By _____ (SEAL)
(Firm Name)

_____
(General Partner)

Business Address: _____

_____

Phone No: _____

A Corporation

By _____
(Corporation Name)

_____
(State of Incorporation)

By _____
(Name of Person Authorized to Sign)

_____
(Title)

(Corporate Seal)

Attest _____
(Secretary)

Business Address: _____

_____

Phone No: _____

A Joint Venture

By _____
(Name)

_____
(Address)

_____
(Phone Number)

By _____
(Name)

_____
(Address)

_____
(Phone Number)

(Each joint venture must sign. The manner of signing for each individual, partnership and corporation that is a party to the joint venture should be in the manner indicated above).

STATE OF _____

COUNTY OF _____

AFFIDAVIT OF NON-COLLUSION

I hereby swear (or affirm) under the penalty of perjury:

1) That I am the BIDDER (if the BIDDER is an individual), a partner in the BIDDER (if the BIDDER is a partnership) or an officer or employee of the BIDDER corporation having authority to sign on its behalf (if the BIDDER is a corporation);

2) That the attached Bid or Bids have been arrived at by the BIDDER individually and have been submitted without collusion with, and without any agreement, understanding or planned common course of action with any other vendor of materials, supplies, equipment or services described in the invitation to Bid designed to limit individual bidding or competition;

3) That the contents of the Bid or Bids have not been communicated by the BIDDER or its employees or agents to any person not an employee or agent of the BIDDER or its surety on any bond furnished with the Bid or Bids, and will not be communicated to any such person, prior to any official opening of the Bid or Bids; and

4) That I have fully informed myself regarding the accuracy of the statements made in this affidavit.

Subscribed and sworn to before me _____
(Bidder)

this _____ day of _____, 2020 _____
(Firm making Bid or Bids)

_____ _____

OFFICIAL TITLE: _____

Building Automation PROJECT CONTRACT AGREEMENT

AGREEMENT made this ___ day of _____2020, by and between the **CITY OF PLYMOUTH,** a Minnesota municipal corporation ("City") and _____("Contractor").

IN CONSIDERATION OF THEIR MUTUAL COVENANTS THE PARTIES AGREE AS FOLLOWS:

1. CONTRACT DOCUMENTS. The Contract consists of the following documents. In the event of conflict among the documents the conflict shall be resolved by the order in which they are listed with the document listed first having the first priority and the document listed last having the last priority: 1) this Project Agreement, 2) Contract Documents including Summary of Work & Supplementary Conditions, and 3) Contractor's bid.

2. SCOPE OF SERVICES. The City retains Contractor to furnish the services set forth on the attached Exhibits 1 – 6. The Contractor agrees to perform the services and act as installer to building automation system for the City at assigned location. Contractor shall provide all personnel, supervision, services, material, tools, equipment and supplies. The work shall be performed in accordance of this services agreement, Contractor has the proper and necessary qualification, experience and abilities to provide agreed upon services in Exhibit 1.

3. COMPENSATION. Contractor shall be paid by the City in accordance with the Contractor's bid. Contractor shall submit monthly invoices and the City shall pay the invoices within thirty-five (35) days of receipt. The fees shall not be adjusted if the estimated hours to perform a task or any other estimate or assumption are exceeded.

4. COMPLETION DATE. Contractor shall complete work within negotiated timeline established between City and Contractor.

5. COMPLIANCE WITH LAWS AND REGULATIONS. In providing services hereunder, Contractor shall abide by all statutes, ordinances, rules and regulations pertaining to the provisions of services to be provided.

6. STANDARD OF CARE. Contractor will provide and install all needed equipment to outlined specification a good and workmanlike manner consistent with industry standards. City shall not be responsible for discovering deficiencies in the Contractor's services.

7. INDEMNIFICATION. The Contractor shall indemnify and hold harmless the City, its officers, agents, and employees, of and from any and all claims, demands, actions, causes of action, including costs and attorney's fees, arising out of or by reason of the execution or performance of the work or services provided for herein and further agrees to defend at its sole cost and expense any action or proceeding commenced for the purpose of asserting any claim of whatsoever character arising hereunder.

8. INSURANCE. Contractor shall secure and maintain such insurance as will protect Contractor from claims under the Worker's Compensation Acts, automobile liability, and from claims for bodily injury, death, or property damage which may arise from the performance of services under this Agreement. Such insurance shall be written for amounts not less than:

Commercial General Liability	$1,000,000 each occurrence/aggregate
Automobile Liability	$1,000,000 combined single limit
Workers' Compensation	Statutory requirement

	$500,000 Bodily Injury by Disease per employee $500,000 Bodily Injury by Disease aggregate $500,000 Bodily Injury by Accident
Excess/Umbrella Liability	$2,000,000 each occurrence/aggregate

The City shall be named as an additional insured on the general liability and umbrella policies.

Before commencing work the Contractor shall provide the City with a certificate of insurance evidencing the required insurance coverage in a form acceptable to City.

9. INDEPENDENT CONTRACTOR. The City hereby retains the Contractor as an independent contractor upon the terms and conditions set forth in this Agreement. The Contractor is not an employee of the City and is free to contract with other entities as provided herein. Contractor shall be responsible for selecting the means and methods of performing the work. Contractor shall furnish any and all supplies, equipment, and incidentals necessary for Contractor's performance under this Agreement. City and Contractor agree that Contractor shall not at any time or in any manner represent that Contractor or any of Contractor's agents or employees are in any manner agents or employees of the City. Contractor shall be exclusively responsible under this Agreement for Contractor's own FICA payments, workers compensation payments, unemployment compensation payments, withholding amounts, and/or self-employment taxes if any such payments, amounts, or taxes are required to be paid by law or regulation.

10. SUBCONTRACTORS. Contractor shall not enter into subcontracts for services provided under this Agreement without the express written consent of the City. Contractor shall comply with Minnesota Statute § 471.425. Contractor must pay subcontractor for all undisputed services provided by subcontractor within ten days of Contractor's receipt of payment from City. Contractor must pay interest of 1.5 percent per month or any part of a month to subcontractor on any undisputed amount not paid on time to subcontractor. The minimum monthly interest penalty payment for an unpaid balance of $100 or more is $10.

11. ASSIGNMENT. Neither party shall assign this Agreement, or any interest arising herein, without the written consent of the other party.

12. WAIVER. Any waiver by either party of a breach of any provisions of this Agreement shall not affect, in any respect, the validity of the remainder of this Agreement.

13. ENTIRE AGREEMENT. The entire agreement of the parties is contained herein. This Agreement supersedes all oral agreements and negotiations between the parties relating to the subject matter hereof as well as any previous agreements presently in effect between the parties relating to the subject matter hereof. Any alterations, amendments, deletions, or waivers of the provisions of this Agreement shall be valid only when expressed in writing and duly signed by the parties, unless otherwise provided herein.

14. CONTROLLING LAW. This Agreement shall be governed by and construed in accordance with the laws of the State of Minnesota. All proceedings relate to this Agreement shall be venued in Hennepin County, Minnesota.

15. RECORDS. The Contractor shall maintain complete and accurate records of time and expense involved in the performance of services.

16. MINNESOTA GOVERNMENT DATA PRACTICES ACT. Contractor must comply with the Minnesota Government Data Practices Act, Minnesota Statutes Chapter 13, as it applies to (1) all data provided by the City pursuant to this Agreement, and (2) all data, created, collected, received, stored, used, maintained, or disseminated by the Contractor pursuant to this Agreement. Contractor is subject to all the provisions of

the Minnesota Government Data Practices Act, including but not limited to the civil remedies of Minnesota Statutes Section 13.08, as if it were a government entity. In the event Contractor receives a request to release data, Contractor must immediately notify City. City will give Contractor instructions concerning the release of the data to the requesting party before the data is released. Contractor agrees to defend, indemnify, and hold City, its officials, officers, agents, employees, and volunteers harmless from any claims resulting from Contractor's officers', agents', city's, partners', employees', volunteers', assignees' or subcontractors' unlawful disclosure and/or use of protected data. The terms of this paragraph shall survive the cancellation or termination of this Agreement.

17. NONDISCRIMINATION. In the hiring of employees to perform work under this Agreement, the Contractor shall not discriminate against any person by reason of any characteristic or classification protected by state or federal law.

18. SAVINGS CLAUSE. If a court finds any portion of this Agreement to be contrary to law, invalid, or unenforceable, the remainder of the Agreement will remain in full force and effect.

BY:_____ Signature:_____
Name, Title

Dated:_____, 2020

Business Name and Address:_____

CITY OF PLYMOUTH

BY: _____ BY: _____
Jeff Wosje, Mayor Its_____

Dated: _____, 2020.

BY: _____
David Callister, City Manager

Dated: _____, 2020.

EXHIBIT 1

Plymouth City Hall
BAS System Update

Project Manual

Issued for Bid
October 20, 2020

HGA

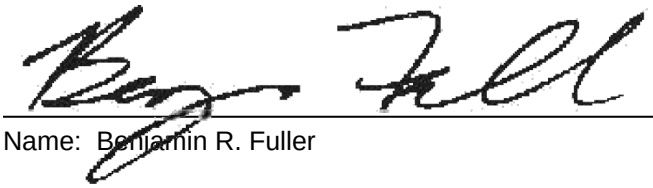
Hammel, Green and Abrahamson, Inc.
420 North Fifth Street, Suite 100
Minneapolis, Minnesota 55401-1180
612.758.4000 | HGA.COM

Project No. 3948-004-00

SECTION 000105
CERTIFICATIONS PAGE

MECHANICAL

I hereby certify that the plans and specifications for Mechanical Work were prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the State of Minnesota.



Name: Benjamin R. Fuller

Registration No. 47953

END OF DOCUMENT

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SECTION 010000
GENERAL REQUIREMENTS

1.1 PROJECT SUMMARY

A. Plymouth City Hall currently uses a combination of a pneumatic control system and a Tridium Niagara BAS system for the control and actuation of various City Hall HVAC system components.

B. The Work of Project is defined by the Contract Documents and includes, but is not limited to, the following:

1. Demolition of existing pneumatic controls, including devices, air tubing, air compressors, sensors, supports, and other existing equipment as required.
2. Provide new DDC terminal unit controllers, valve and damper actuators, and DDC thermostats served by a new Niagara BAS control system.
3. Transfer all existing City Hall equipment control points and functionality from the existing Niagara BAS system to the new BAS platform.

C. Cutting and Patching Work By Owner: Coordinate the Work of this Contract with work performed concurrently by Owner. Cooperate fully with Owner, so work may be carried out smoothly, without interfering with or delaying Work. Owner will perform the following construction operations at Project site.

1. Cutting: Cutting and selective demolition of in-place construction to provide for installation of other components or performance of other construction, and subsequently patch as required to restore surfaces to their original condition.
2. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during installation or cutting and patching operations, by methods and with materials so as not to void existing warranties.
3. Protection: Protect in-place construction during cutting and patching to prevent damage. Provide protection from adverse weather conditions for portions of Project that might be exposed during cutting and patching operations.
4. Patching: Patch construction by filling, repairing, refinishing, closing up, and similar operations following performance of other Work. Patch with durable seams that are as invisible as practicable, as judged by Architect. Provide materials and comply with installation requirements specified in other Sections, where applicable.
5. Restoration of Finishes: Restore exposed finishes of patched areas and extend finish restoration into retained adjoining construction in a manner that will eliminate evidence of patching and refinishing.
6. Progress Cleaning: Clean areas and spaces where cutting and patching are performed.

1.2 ALTERNATES

A. Carefully examine Contract Documents and determine extent of Work of each Alternate. Submit price for each Alternate listed on Bid Form.

B. Add Alternate No.1: Provide duct temperature sensor downstream of each terminal unit.

C. Add Alternate No.2: Control unit heaters from Building Automation System.

1.3 REQUESTS FOR INFORMATION (RFI'S)

A. General: Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI in the form specified.

1. Architect will review each RFI, determine action required, and respond. Allow [**seven**] working days for Architect's response for each RFI.

1.4 WORK RESTRICTIONS

A. It is essential that full Owner's services and functions are maintained throughout construction period, with minimum disturbance and disruption to operations.
   1. Contractor, subcontractors and workers shall be aware of these requirements and objectives.
   2. Conduct work and develop detailed schedule to meet these requirements and objectives.
   3. Maintain access to existing walkways, corridors, and other adjacent occupied or used facilities. Do not close or obstruct walkways, corridors, or other occupied or used facilities without written permission from Owner and approval of authorities having jurisdiction.
   4. Notify the Owner not less than 72 hours in advance of activities that will affect Owner's operations.

B. Keep Owner advised of intended operations and schedule and be guided by other constraints or timing of work that may develop during construction, as instructed by Owner.

1.5 SUBMITTAL PROCEDURES

A. Electronic Submittals: Prepare and submit submittals as specified in individual Specification Sections; submit with completed Submittal Transmittal Form.

B. Contractor’s Review: Prior to submitting to Architect, review each submittal for clarity, coordination with other Work and compliance with the Contract Documents; note corrections, clarifications and field dimensions and insert Contractor’s approval stamp.

C. Architect's Review: Architect will review each submittal, annotate to indicate required corrections or revisions, insert action stamp and mark stamp appropriately to indicate action, as follows:
   1. APPROVED: Submittal has no exceptions noted.
   2. CONDITIONALLY APPROVED: Submittal has exceptions noted, but resubmission is not required.
   3. NOT APPROVED: Submittal is incomplete and/or need corrections. Complete and/or correct and resubmit until final acceptance is obtained.
   4. RECEIVED: Submittal is for information only.
   5. NOT REVIEWED: Submittal was not required and has not been reviewed.
   6. Architect will advise Contractor when a submittal being processed must be delayed for coordination. Architect reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.

D. Review and Processing Time: Allow at least 10 working days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required.
   1. Include additional time for making corrections or revisions to submittals noted by Architect and for handling and reviewing submittals required by those corrections.
   2. Allow extra review time for large groups of related submittals transmitted at one time, and for submittals requiring sequential review by multiple parties such as Architect’s consultants or Owner.
   3. Resubmittal Review: Allow 10 working days for review of resubmittal.

E. Final Submittals: Distribute final submittals to manufacturers, subcontractors, suppliers, fabricators, installers, authorities having jurisdiction, and others as necessary for coordination and performance of construction activities. Provide copies to Owner if Owner requests copies during construction.

1.6 QUALITY REQUIREMENTS

A. Comply with applicable codes, regulations, ordinances and requirements of authorities having jurisdiction, including accessibility guidelines where applicable. Submit copies of inspection reports, notices and similar documents to Architect.

1.7 PRODUCT REQUIREMENTS & SUBSTITUTION PROCEDURES

A. Submit requests for substitution in writing to Architect at least ten days prior to bid date and hour. Requests received after this time will not be considered. Substitution Request Form provided upon request.

B. Architect and Owner reserve the right to accept or reject proposed products. Should a proposed product be unable to meet requirements to satisfaction of Architect, product shall not be used.

1.8 EXECUTION

A. Existing Conditions: The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.

1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.

B. Installation:

1. Inspect substrates and report unsatisfactory conditions in writing.
2. Do not proceed until unsatisfactory conditions have been corrected.
3. Take field measurements prior to fabrication where practical. Form to required shapes and sizes with true edges, lines and angles. Provide inserts and templates as needed for work of other trades.
4. Install materials in exact accordance with manufacturer's instructions and approved submittals.
5. Install materials in proper relation with adjacent construction and with proper appearance.
6. Restore units damaged during installation. Replace units which cannot be restored at no additional expense to the Owner.

1.9 CLOSEOUT PROCEDURES

A. Closeout: Plan an efficient, orderly and coordinated completion process including organizing, scheduling and coordinating the Work of contractor's own forces and Work of subcontractors. Establish firm commitments for on-time completion.

1. Prepare punchlist for remaining work for review by the Architect.
2. Complete punchlist items promptly at no additional expense to the Owner.
3. Test equipment and systems to demonstrate each system and piece of equipment is installed and operating properly.
4. Submit operating manuals, maintenance manuals, and warranty information.
5. Obtain and submit copy of occupancy permits.
6. Provide final cleaning and touch-up.
7. Restore portions of building, site improvements, and other items damaged by construction operations to the satisfaction of the Architect at no additional expense to the Owner.

B. After Substantial Completion expedite completion of remaining work in an organized, efficient manner that maintains quality standards. Scheduled work in advance with Owner.

1. Perform Work in occupied spaces when space is not in use, such as after hours in administrative areas, unless otherwise approved by Owner.
2. Perform Work in occupied areas in a manner and at such time as will not significantly interfere with, hamper or inconvenience Owner's program or functions.

C. Closeout Submittals: Provide operating instruction data and maintenance manuals to the Owner, including Manufacturer’s cleaning and maintenance instructions, and copies of warranties.

1.10 OPERATION & MAINTENANCE MANUALS

A. Electronic PDF File Format: Submit manuals in the form of a multiple file composite electronic PDF file for each manual type required.

B. Paper Copy: Submit two manuals in the form of hard copy, bound and labeled volumes.
   1. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.

C. Organize each manual into a separate section for each product, equipment, system and subsystem. Organize into sets of manageable size. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
   1. System, subsystem, and equipment descriptions.
   2. Performance and design criteria
   3. Operating standards, procedures and logs.
   4. Wiring, piping, and control diagrams.
   5. License requirements including inspection and renewal dates.
   6. Other operation data required in individual Specifications Sections.

D. Source Information: Engage a manufacturer's service representative to assemble and prepare information for each system, subsystem, and piece of equipment not part of a system. List each product, system, subsystem, and piece of equipment included in manual, identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent.

E. Maintenance Documentation: For Manufacturer's standard maintenance procedures, including: test and inspection instructions, troubleshooting guide; aligning, adjusting, and checking instructions; maintenance and service schedules. Drawings, diagrams, and instructions required for maintenance, including disassembly and component removal, replacement, and assembly. Identification and nomenclature of parts and components.

F. Diagrams: Prepare drawings supplementing manufacturers' printed data to illustrate the relationship of component parts of equipment and systems and to illustrate control sequence and flow diagrams. Coordinate these drawings with information contained in record Drawings to ensure correct illustration of completed installation.

G. Emergency Procedures: Assemble a complete set of emergency information indicating procedures for use by emergency personnel and by Owner's operating personnel for types of emergencies procedures as follows:
   1. Instructions on stopping.
   2. Shutdown instructions for each type of emergency.
   3. Operating instructions for conditions outside normal operating limits.
   4. Required sequences for electric or electronic systems.
   5. Special operating instructions and procedures.

H. Warranties and Bonds: Include copies of warranties and bonds and lists of circumstances and conditions that would affect validity of warranties or bonds.
   1. Include procedures to follow and required notifications for warranty claims.

1.11 DEMONSTRATION & TRAINING

A. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participant is expected to master. For each module, include instruction for the following as applicable to the system, equipment, or component:
   1. Basis of System Design, Operational Requirements, and Criteria: Include the following:
      a. System, subsystem, and equipment descriptions.
      b. Performance and design criteria if Contractor is delegated design responsibility.
      c. Operating standards.
      d. Regulatory requirements.
      e. Equipment function.

f. Operating characteristics.
g. Limiting conditions.
h. Performance curves.

2. Documentation: Review the following items in detail:
   a. Emergency manuals.
   b. Operations manuals.
   c. Maintenance manuals.
   d. Project record documents.
   e. Identification systems.
   f. Warranties and bonds.
   g. Maintenance service agreements and similar continuing commitments.
3. Emergencies: Include the following, as applicable:
   a. Instructions on meaning of warnings, trouble indications, and error messages.
   b. Instructions on stopping.
   c. Shutdown instructions for each type of emergency.
   d. Operating instructions for conditions outside of normal operating limits.
   e. Sequences for electric or electronic systems.
   f. Special operating instructions and procedures.
4. Operations: Include the following, as applicable:
   a. Startup procedures.
   b. Equipment or system break-in procedures.
   c. Routine and normal operating instructions.
   d. Regulation and control procedures.
   e. Control sequences.
   f. Safety procedures.
   g. Instructions on stopping.
   h. Normal shutdown instructions.
   i. Operating procedures for emergencies.
   j. Operating procedures for system, subsystem, or equipment failure.
   k. Seasonal and weekend operating instructions.
   l. Required sequences for electric or electronic systems.
   m. Special operating instructions and procedures.
5. Adjustments: Include the following:
   a. Alignments.
   b. Checking adjustments.
   c. Noise and vibration adjustments.
   d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
   a. Diagnostic instructions.
   b. Test and inspection procedures.
7. Maintenance: Include the following:
   a. Inspection procedures.
   b. Types of cleaning agents to be used and methods of cleaning.
   c. List of cleaning agents and methods of cleaning detrimental to product.
   d. Procedures for routine cleaning
   e. Procedures for preventive maintenance.
   f. Procedures for routine maintenance.
   g. Instruction on use of special tools.
8. Repairs: Include the following:
   a. Diagnosis instructions.
   b. Repair instructions.
   c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
   d. Instructions for identifying parts and components.
   e. Review of spare parts needed for operation and maintenance.

B. Engage qualified instructors to instruct Owner's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.

   1. Owner will furnish Contractor with names and positions of participants.

C. Scheduling: Provide instruction at mutually agreed on times. For equipment that requires seasonal operation, provide similar instruction at start of each season.

   1. Schedule training with Owner**,** with at least ten business days' advance notice.

D. Training Location and Reference Material: Conduct training on-site in the completed and fully operational facility using the actual equipment in-place. Conduct training using final operation and maintenance data submittals.

END OF SECTION

SECTION 013310
SUBMITTAL TRANSMITTAL FORM

To: Hammel Green and Abrahamson, Inc.
Attn: Submittals Coordinator
420 North Fifth Street, Suite 100
Minneapolis, Minnesota 55401
submittals@hga.com

From: _____
_____
_____
Contact: _____
Email: _____
Phone: _____

Owner: City of Plymouth
Project: City Hall BAS Controls Replacement

Submittal Date: _____
Previous Date: _____

HGA No.: 3948-004-00

PRODUCT DATA ☐ Partial ☐ Complete ☐ Preliminary ☐ Final

Specification Section, Article, Paragraph: _____

Description: _____

_____

Product/Model: _____

Manufacturer: _____

Supplier: _____

Subcontract: _____

SHOP DRAWINGS ☐ Partial ☐ Complete ☐ Preliminary ☐ Final

Specification Section, Article, Paragraph: _____

Description: _____

_____

Product/Model: _____

Manufacturer: _____

Supplier: _____

Subcontract: _____

SAMPLES ☐ Partial ☐ Complete ☐ Preliminary ☐ Final

Specification Section, Article, Paragraph: _____

Description: _____

_____

Product/Model: _____

Manufacturer: _____

Supplier: _____

Subcontract: _____

SUBMITTED BY

Name: _____ Company: _____

Signature: _____ Date: _____

SECTION 230900
BUILDING AUTOMATION SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This specification for a Building Automation System (BAS) as detailed herein shall be strictly enforced.

1. Provide a Building Automation System (BAS) incorporating ASHRAE Standard 135-2016 BACnet certified technology devices using standard BACnet profiles communicating over a Local Area Network (LAN) consisting of BACnet Testing Laboratories (BTL) certified BACnet devices communicating over a BACnet/IP network at the plant and field controller level, Niagara 4 based network managers at the network level, and Master-Slave Token Passing (MS/TP) at the instrumentation level.
2. BACnet/IP network shall be a subnet of the Owner's IT network. Coordinate network interfaces with the Owner's IT department prior to installation.
3. The Niagara 4 based network managers shall bridge the BACnet/IP field communications network to the Owner's Local and/or Wide Area Network, as designated by the Owner, and shall communicate seamlessly with the other Niagara 4 based devices on the Owner's BAS network. The BAS shall consist of Direct Digital Control (DDC) controllers, Building Controllers (BC), network switches, network management tools, programming tools, web browser based Graphical User Interface, sensors, relays, valves, actuators, and other equipment as may be necessary to provide for a complete and operational control system for the HVAC and other building related systems as described within these specifications.
4. Provide three (3) year software licensing for 100 Niagara devices. This quantity is intended to supply enough licenses for the City Hall and future City of Plymouth buildings that will be added to the BAS.
5. The City's electrician will provide 120V outlets and connections where required. Coordinate requirements with the City.
6. The City will provide the Virtual Machine (VM) server for hosting the Niagara application and database servers. Coordinate database requirements with City IT.
7. Coordinate and document standards for Niagara configuration and graphics requirements to enable third party Niagara-certified integrators to perform work on the system. Turn over a library of standard graphics elements to the City.
8. Coordinate system downtime and cutover with the City. Create a strategy to minimize system downtime and submit proposed strategy with shop drawing submittal.
9. The documentation contained in this section and other Contract Documents pertaining to HVAC Controls is schematic in nature. The Contractor shall provide hardware and software necessary to implement the functions shown and as implied by the Contract Documents.
10. System configuration and monitoring shall be performed via a PC-type computer or mobile and a web interface.

B. BAS Network Architecture

1. The network between controllers shall be based on BACnet communications. BACnet/IP is the preferred communications protocol for connecting controllers to the BAS network. A sub-network using the BACnet MS/TP protocol, with a minimum of 76.8kb speed, shall connect the local, stand-alone controllers with Ethernet-level controller/routers. BACnet/MSTP may be used to connect controllers to instrumentation devices unless otherwise noted. The use of BACnet/MSTP or any protocol other than BACnet/IP for BAS network communications must be pre-approved by the Engineer. The Contractor shall ensure that all network architecture elements adhere to the requirements for network wiring length, number of devices per segment, wire type, and other physical networking requirements for the protocol selected.

2. Alarm Management - A hierarchical topology is required to assure reasonable system response times and to manage the flow and sharing of data without unduly burdening the customer's internal Intranet network. Systems employing a "flat" single tiered architecture shall not be acceptable.
3. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 5 seconds for network connected user interfaces.
4. Maximum acceptable response time from any alarm occurrence (at the point of origin) to the point of annunciation shall not exceed 60 seconds for remote connected user interfaces.

1.3 DEFINITIONS

A. AI: Analog Input.

B. AO: Analog Output.

C. API (Advanced Programming Interface): A set of routines, protocols, and tools for building software applications that specifies how software components should interact.

D. Application Specific Controller (ASC): A controller that controls specific pieces of complex or custom equipment, such as a cooling tower or rooftop unit, that includes preprogrammed routines prepared by the manufacturer. The user may select the appropriate sequence from a menu. The ASC is typically dedicated to the piece of equipment it controls.

E. BACnet: ASHRAE 135-2016 standard communications protocol for building automation and control networks.

F. BACnet/IP: A collection of one or more IP subnetworks (IP domains) that are assigned a single BACnet network number.

G. BACnet/MSTP (Master-Slave/Token-Passing): A data link protocol that is unique to BACnet that is commonly used as a field bus. EIA-485 used as the physical layer.

H. BACnet XD: ASHRAE addendum 135-2012ba adds device descriptions based on BACnet XD using CSML as the language, and adds extended semantic information to objects and to relations in structures of objects

I. BTL: BACnet Testing Lab

J. Building Controller: A general purpose term used to describe a variety of controller types, depending on the environment, protocol, vendor, or integrator terms.

K. Configurable Controller: A flexible controller that can have a variety of uses and can be configured through selectable controls options. A configurable controller lacks the fully programmable features available in a programmable controller.

L. DDC: Direct Digital Control

M. DI: Discrete Input.

N. DO: Discrete Output

O. Field Terminal Controller:

P. Haystack: The industry standard administered by the Project Haystack organization that is used to define a library of semantic tags for defining machine-readable contextual data about physical equipment and attributes.

Q. Gateway: A device that provides routing of communication signals and enables translation of communication protocols between devices or networks that use different protocols to communicate.

R. GUI: Graphical User Interface.

S. I/O (or IO): Physical Input/Output connections or points that provide analog or digital interface to sensors, actuators, or other physical hardware.

T. JACE: Java Application Control Engine.

U. License Holder: The Owner shall be considered the license holder for all software used, for all custom system programming applications, scripts, and files, and for all work performed under this section.

V. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

W. LonMark®: LonMark International, a global non-profit membership created to advance the efficiency and effective integration of multi-vendor controls systems using LonTalk as an automation protocol. LonMark creates and guidelines for development of products that connect and provide interoperability between manufacturers. A LonMark certified product are stamped and indicate that the product has successfully passed testing by LonMark International.

X. LonTalk®: Automation protocol developed by the Echelon Corporation. See ANSI standard 709.1.

Y. Modbus: a serial communication protocol for transmitting information over serial lines between electronic devices.

Z. NC: Normally closed position of switch after control signal is removed or normally closed position of manually operated valves or dampers.

AA. NO: Normally open position of switch after control signal is removed; or the open position of a controlled valve or damper after the control signal is removed; or the usual position of a manually operated valve.

BB. OPC: An industrial connectivity standard based on client/server technology that enables the transfer of automation data between automation hardware and software.

CC. Programmable Controller: A flexible controller that can have a variety of uses and can be fully programmed by a qualified individual.

DD. Router: A device that provides routing of communication signals but does not translate from one communication protocol to another.

EE. REST API: A Representational State Transfer Advanced Programming Interface that relies on a stateless, client-server, cacheable communications protocol, typically using the HTTP protocol, used for designing networked applications.

FF. SI: System Integrator; the contractor responsible for the overall installation, coordination and integration of the building control systems identified in this section.

GG. Supervisory Controller: A device that performs a higher level function or set of functions for a system, subsystem, or set of equipment and provides for communication between the field level controllers and the Owner's wide and/or local area IT network.

HH. TCP/IP: Transmission Control Protocol/Internet Protocol. The standard for transmitting data over networks, typically made up of many different protocols.

1.4 OPEN SYSTEMS DESIGN

A. The Building Automaton System shall be such that products from different manufacturers and/or suppliers are able to be integrated into a single unified system in order to provide flexibility for expansion, maintenance, and service of the system. The BAS provided shall maintain open interoperability in the following areas.

1. System Architecture - The intent of this specification is to provide a peer-to-peer networked, stand-alone, distributed control system utilizing Open protocols in one open, interoperable system. The supplied computer software shall employ object-oriented technology (OOT) for representation of all data and control devices within the system. Physical connection of any BACnet control equipment, such as chillers, shall be via IP or Ethernet only when IP is not an available option.
2. Communications - Provide a networked, stand-alone, distributed control system with the capability to integrate ANSI/ASHRAE Standard 135 BACnet, LonWorks technology, Modbus, OPC, and other open communication protocols in a single open, interoperable system. Where existing systems using proprietary protocols exist, a gateway or driver shall be incorporated to provide for interoperability.

3. Network Management - Network management tools shall be based upon the Niagara 4 Framework technology as developed by the Tridium Corporation. All tools and hardware provided shall comply with the current release of the Niagara Framework platform. All control devices furnished with this Section shall be programmable directly from a Niagara 4-based non-licensed toolset upon completion of this project. The use of configurable or programmable controllers that require additional software tools for post-installation maintenance shall not be acceptable.
    a. All toolkits and ".jar" files are to become the property of the Owner and are to be left on site for third party contractors.
    b. Any control vendor that shall provide additional BMS server software shall be unacceptable. Only systems that utilize the Niagara 4 Framework shall satisfy the requirements of this section.
4. System Continuity - Changes made at the server shall be automatically recorded and downloaded to the appropriate Controller. Changes made at the Controllers shall be automatically uploaded to the workstation, ensuring system continuity. System configuration, programming, editing, and graphics generation shall be performed on-line.
5. User Access - The supplied system shall incorporate the ability to access all data using HTML5 (Hypertext Markup Language, Version 5) enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. An Open Database Connectivity (ODBC) or Structured Query Language (SQL) compliant server database is required for all system database parameter storage. This data shall reside on the Operating System Server located in the Facilities Office on the LAN. Systems requiring proprietary database and user interface programs shall not be acceptable.
6. Databases - All controller program graphics and network databases shall be provided in a Niagara 4 Framework format. The database shall be stored on a server grade PC. A separate CD containing the database shall be provided upon final acceptance of the project, and an updated database shall be provided on a CD at the end of the warranty period.
7. Graphics - The BAS server shall host all graphic files for the control system. Graphics shall be designed using HTML5-based technologies.
8. Data Tagging – BACnet objects shall be tagged with machine-readable metadata that can be used by applications to contextualize the associated data. Project Haystack library shall be used for tagging points, and system programming shall be based on tagged points. Any proprietary data tagging nomenclature must be approved by the Engineer prior to installation.
9. Building Controllers (BC) – Provide for global functionality such as alarms, trends, schedules and normalization of data; shall conform to the current release of the Niagara Framework. No BC shall be provided with less than 512 MB of RAM. The number of BACnet and/or LonWorks nodes (controllers) attached to any Niagara based network manager shall not exceed the following limits:

COMBINED MEMORY	MAXIMUM NUMBER OF NODES
128 MB SDRAM/64 MB SERIAL FLASH	25
256 MB DDR RAM/128 MB SERIAL FLASH	50
1 GB DDR2 RAM/1 GB SERIAL FLASH	125

   Regardless of the maximum number of nodes indicated above, it is the responsibility of the systems integrator/building controls contractor to ensure that the BC has adequate resources for the number of nodes (controllers) attached to it.
10. Direct Digital Controllers (DDC) - All DDC devices shall be certified to the current BACnet BTL standards appropriate to their application, provided an appropriate BTL Certification standard exist. All points within a controller including hard I/O and software based points shall be available for viewing, management, and manipulation through the Niagara Framework tools.
11. Product Access – All products provided shall be available for sale directly to the Owner or to the Owner from a designated agent from multiple sources without restrictions on territory. A list of at least 3 purchasing sources shall be provided as part of the BAS submittals.

12. Software Tools - All software tools needed for full functional use, including programming of BC, field level controllers, network management, network expansion, and graphical user interface development of the BAS described within these specifications, shall be provided to the Owner or his designated agent, allowing the Owner access to support the system by themselves or by a third party. Any licensing required by the manufacturer now and into the future, including changes to the licensee of the software tools, and the addition of hardware corresponding to the licenses, shall be provided to allow for a complete and operational system for both normal day to day operation and servicing of the system. Any such changes to the designated license holders shall be made by the manufacturer upon written request by the Owner or his agent. Any cost associated with the license changes shall be identified within the BAS submittals.
13. Programming Tools - Provide freely available Niagara 4 Wizards to facilitate the programming and configuration of all of the DDC devices that are provided for the HVAC control. Wizards shall be provided free of charge and be compatible with the current published versions of the network management tool that is provided as part of this project. The Niagara 4 Wizard software shall be available for public access from the System Integrator's and/or manufacturer's web site. These Wizard programming tools shall be compatible with at least 3 other brands of the Niagara Framework network management tools. The SI shall demonstrate as part of their prequalification as to how they intend to comply with these requirements.
14. Software License Agreement - The Owner shall sign a copy of the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights as it relates to disclosure of trade secrets contained within said software. The Owner shall be the named license holder of all software associated with any and all incremental work on the project(s). In addition, the Owner shall receive Ownership of all job specific configuration documentation, data files, and application-level software developed for the project. This shall include all custom, job specific software code, databases and documentation for all configuration and programming that is generated for a given project and/or configured for use with the BC, BAS Server(s), and any related LAN / WAN / Intranet and Internet connected routers and devices. Any and all required IDs and passwords for access to any component or software program shall be provided to the Owner.
15. The System Integrator shall provide as part of the submittals a copy of the Niagara Compatibility Statement (NiCS) verifying that all aspect of the Niagara Framework as provided maintain an Open System Design. The System as provided shall confirm with the following:

Property	Value
STATION COMPATIBILITY IN	All
STATION COMPATIBILITY OUT	All
TOOL COMPATIBILITY IN	All
TOOL COMPATIBILITY OUT	All

1.5 QUALITY ASSURANCE

A. General - The HVAC Control System shall be furnished, engineered, and installed by a licensed Controls System Integrator (SI). All work provided under this section shall be provided by direct employees of the SI or under the direct supervision of the SI personnel.

B. System Integrator Qualifications:

1. The SI must be regularly engaged in the service and installation of BACnet, and Niagara 4 based systems as specified herein, The SI shall have a minimum of five (5) years of experience in the sales, installation, engineering, programming servicing and commissioning of the Niagara platform and the field controller as proposed.
2. The system integrator must be an authorized factory representative, in good standing, of the manufacturer of the proposed hardware and software components. Provide a letter dated within the last 6 months, from the manufacturer certifying that the System Integrator is an authorized factory trained representative.

3. The SI shall have an office within 60 miles of the Building site that is staffed with a minimum of two (2) engineers and five (5) technicians who have successfully completed the factory authorized training of the proposed manufacturer's hardware and software components and have successfully completed a Niagara 4 certification course. SI must provide proof of required training. The SI capabilities shall include engineering and design of control systems, programming, electrical installation of control systems, troubling shooting and service.
4. The SI shall submit a list of no less than three (3) similar projects, which have similar Building Automation Systems as specified herein installed by the SI. These projects must be on-line and functional such that the Owner's/User's representative can observe the system in full operation.

C. Hardware and Software Component Manufacturer Qualifications
   1. The manufacturer of the hardware and software components must be primarily engaged in the manufacture of BACnet based systems as specified herein, and must have been so for a minimum of three (3) years.
   2. The manufacturer of the hardware and software components as well as its subsidiaries must be a member in good standing of the BACnet International, and the BACnet Manufacturers Association.
   3. The manufacturer of the hardware and software components shall have a technical support group accessible via a toll free number that is staffed with qualified personnel, capable of providing instruction and technical support service for networked control systems.

D. Electrical Components, devices, and accessories shall be listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

E. Comply with ASHRAE 135 for DDC system components.

F. All BACnet components shall be BTL listed.

G. Startup Personnel Qualifications: Factory trained personnel who are experienced with the installation and startup of automatic control systems installations similar to those required for this Project.

H. Codes and Standards: Equipment, materials, and labor; provided as work of this section shall comply with federal, state, and local standards, codes, and ordinances.

1.6 SEQUENCE OF OPERATION

A. See drawings for Sequence of Operation.

1.7 SUBMITTALS

A. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

B. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated; and indicate where it will be applied.
   1. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
   2. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.
   3. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Floor plans indicating anticipated locations for; control panels, temperature sensors, thermostats, humidity sensors, and humidistats.

2. Anticipated elevations of locations for; temperature sensors, thermostats, humidity sensors, and humidistats with all wall mounted devices shown.
3. Bill of materials of equipment indicating quantity, manufacturer, and model number.
4. Schematic system flow diagrams showing fans, pumps, heat pumps, coils, dampers, valves, and control devices. Each shall have a schedule of components including all analog and binary input and outputs with spares shown.
5. Details of control panel faces, including controls, instruments, and labeling.
6. Wiring Diagrams: Power, signal, and control wiring.
7. Written description of sequence of operation.
8. Schedule of dampers including size, leakage, and flow characteristics.
9. Schedule of valves including flow characteristics.
10. DDC System Hardware:
    a. Wiring diagrams for control units with termination numbers.
    b. Schematic diagrams and floor plans for field sensors and control hardware.
    c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control unit locations.
11. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
12. Controlled Systems:
    a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
    b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
    c. Written description of sequence of operation including schematic diagram.
    d. Points list.
13. JACEs: Identify any Java Application Control Engines provided under the contract. Submit the specifications for each type of JACE. Indicate that each JACE has an open license. Open license requirement is applicable to all controllers on the project.

D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

E. Dashboard graphics:
    1. “Cartoon” storyboard outlining hierarchy and configuration of each dashboard.
    2. Proposed graphic standards (colors, page design, logos, etc.)
    3. Color printed images of representative screens.

F. Samples for Selection: For each color required, of each type of thermostat or space temperature sensor with factory-applied color finishes.

G. Submittals after Construction
    1. The following is a list of post construction submittals that shall be updated to reflect any changes during construction and re-submitted as “As-Built”. As-Built drawings will each be stamped “As-Built” and have the as-built date on them. The As-Built drawings will contain at a minimum:
        a. System architecture drawing.
        b. Detailed drawings for each piece of controlled and monitored equipment
            1) Layout drawing for each control panel.
            2) Wiring diagram for each control panel.
            3) Wiring diagram for individual components.
            4) Point lists
            5) Room Schedules
            6) Sequence of operation
            7) Hardware with part number information
            8) System flow diagram for each controlled system.
        c. Detailed routing of all communication trunk wires within the building, locations of all network and integration devices, front-end workstations, UPS and exterior network/LAN connections.
        d. Binding map.
    2. Operation and Maintenance Manuals:
        a. The controls contractor will provide an electronic (PDF) copy.

b. Arrange the manuals according to specification section numbers used in the Project Manual; include a table of contents that identifies the responsible installing contractor, contact person, and telephone number with area code and thumb tab index sheets.
c. Provide pocket folders for folded sheet information.
d. Maintenance and Operating Manual will include the following type of information:
1) One copy of the executed Certificate(s) of Substantial Completion. This document will be used to communicate to all necessary Owner personnel the starting date of the one-year Warranty period.
2) Signed record copy of bonds, guarantees, and warranties required by the Contract Documents.
3) Manufacturer's required preventative maintenance inspections, testing, service, lubrication, maintenance instructions, and schedules.
4) Parts lists and local service organization.
5) As-built wiring and piping diagrams.
6) System architecture diagram for components within the building annotated with specific location information.
7) As-built drawing for each control panel.
8) As-built wiring design diagram for each control panel.
9) As-built wiring design diagram for all components.
10) Installation design details for each I/O device.
11) As-built system flow diagram for each system.
12) Sequence of control for each system.
13) Room schedules.
14) Binding map for the building.
15) Product data sheet for each component.
16) Installation data sheet for each component.
17) Other information required by the Specifications.
e. Instruct Owner personnel in the use of Maintenance and Operating Manuals.

3. Software and Programming
a. Submit a copy of all software installed on the servers and workstations.
b. Submit all licensing information for all software installed on the servers and workstations.
c. Submit a copy of all software used to execute the project even if the software was not installed on the servers and workstations.
d. Submit all licensing information for all of the software used to execute the project.
e. Software revisions will be as installed at the time of the system acceptance.
f. All toolkits and ".jar" files are to become the property of the Owner and are to be left on site for third party contractors. Provide summary and transmittal of all programming files.

4. Controllers
a. Submit all licensing information for all JACEs and controllers installed on the project.
b. Provide a complete list of all controller passwords.

5. Firmware Files
a. Submit a copy of all firmware files that were downloaded to or pre-installed on any devices installed as part of this project.
b. This does not apply to firmware that is permanently burned on a chip at the factory and can only be replaced by replacing the chip.
c. Submit a copy of all application files that were created during the execution of the project.
d. Submit a copy of all graphic page files created during the execution of the project.
e. Submit a copy of all secondary graphic files such as bitmaps, jpegs, etc. that were used in the creation of the graphic pages.

6. Dashboard graphics:
a. Submit printed color copy of all screens for each dashboard. For screens with multiple options/configurations, provide representative images.

H. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

I. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
2. Program Software: Provide USB drive, complete with data files.
3. Device address list.

4. Printout of software application and graphic screens.
5. Software license required by and installed for DDC workstations and control systems.

J. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

K. Field quality control test reports.

L. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Interconnection wiring diagrams with identified and numbered system components and devices.
3. Keyboard illustrations and step-by-step procedures indexed for each operator function.
4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
5. Calibration records and list of set points.

M. Provide necessary non-disclosure and license agreements for required software. Owner will receive software licenses, the original copies of software loaded into the system, and back-ups of system databases and programs on USB drive. Original software and documentation will be delivered to facility management. During construction the contractor will maintain CD copies of data files, application programs, and system software.

N. Two copies of software and hardware needed to configure control devices will be provided to the Owner at the completion of the project. This includes software tools, cabling, disks, USB drives, etc. needed to program, configure, and maintain building and unit level DDC devices and networking hardware provided as part of the project.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to equipment manufacturer.

B. System Software: Update to latest version of software at Project completion.

1.9 WARRANTY

A. Components, system software, parts and assemblies will be guaranteed against defects in materials and workmanship for one year from the acceptance date.

B. Labor, equipment, material, and software required to troubleshoot, repair, reprogram, or replace system components will be provided, at no charge to the Owner during the two year warranty period.

C. Corrective software modifications made during warranty period will be updated on all user documentation and on user and manufacturer archived software disks/ USB drives. Provide the Owner with a new USB drive whenever software changes are required.

D. Install current version DDC system and configuration software fix packs and patches at no cost to the Owner during the warranty period.

E. Install current version DDC system and configuration software version upgrades released during the warranty period at no cost to the Owner.

F. The installer will be capable of doing any repairs with factory trained technicians operating out of a local service office, and furnish the Owner with a local telephone number and email address where a factory-trained technician may be reached at all times.

G. The factory-trained technician will arrive at the job-site ready to service the system within four hours upon receiving a request for repairs and will perform the work without interruption (unless authorized by the owner) until the system is back in proper reliable operating condition.

H. The installer will keep a permanent maintenance record at the local service office of all repairs performed and all service calls responded to during the warranty period (including labor and material used); copy of record will be presented to Owner's representative at completion of each service call.

I. Permanent maintenance records will include all dial-up-type service calls made via the dial-up communications feature.

J. Ball Valves, Ball Valve Actuators and Electronic Valve Actuators for Butterfly Valves shall be covered by a 4 year product warranty from the date of substantial project completion. Industrial-type Electronic Valve Actuators and Butterfly Valves shall be covered by a 36 month product warranty from date of substantial project completion.

K. All labor to replace failed Valves and Actuators shall be provided during the first 12 months of the warranty starting from the date of project completion.

L. System components and local service will be available for a total of seven years.

M. The warranty shall extend to material that is supplied and installed by the Contractor. Material supplied but not installed by the Contractor shall be covered per the above to the extent of the product only. Installation labor shall be the responsibility of the trade contractor performing the installation.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements provide products from the following manufacturers:
   1. Honeywell
   2. Johnson Controls Facility Explorer
   3. LynxSpring
   4. Niagara/Tridium/Vykon
   5. Distech Controls
   6. KMC Conquest
   7. Other prior-approved open-architecture system manufacturer

2.2 NETWORKS

A. All Niagara 4 based network managers supplied under this section shall bridge the BACnet, LonWorks, and/or ModBus field buses to the Owner’s Local Area Network (LAN) and/or Wide Area Network (WAN) as designated by the Owner. The network managers shall communicate at no less than 100 Megabits/sec over the Ethernet network and shall support TCP/IP, UDP, FTP, BACnet over IP, HTTP/HTTPS, REST API, MQTT, and SOAP/XML for maximum flexibility as it relates to the integration of building data with enterprise information systems. The system shall provide support for multiple network managers, Building Controllers (BC), user workstations and, if specified, a local server. The WAN and/or LAN will be provided by others. The SI shall coordinate with the General Contractor for the access to the WAN and/or LAN.
   1. Network minimum physical and media access requirements:
      a. Ethernet; IEEE standard 802.3.
      b. Cable; 100 Base-T, UTP-8 wire
      c. Category 6 Minimum throughput; 1 Gbps

B. Network - Field Level Controllers – The communication network between the field level controllers shall be BACnet/IP. All wiring shall be provided in accordance with the standards for the appropriate protocol. The number of devices on any one network shall not exceed 80% of capacity.

C. Java Application Control Engines (JACE): JACEs may be used as Supervisory Controllers to communicate with other control panels and operator workstation. Provide JACE as needed to achieve and maintain BAS LAN performance. Each JACE shall have an Open license. JACE’s shall meet the minimum specifications:
   1. 1000 MHz Microprocessor

2. 1 GB RAM
3. Removable micro-SD card with minimum 4GB flash total storage with minimum 2GB available for user-configurable storage.
4. Battery backup (8-hour minimum back up), UPS is acceptable where battery backup it not available.
5. Real-time clock
6. Networking:
   a. Ethernet: Minimum (2) ports 10/100 mbps with RJ45 connectors
   b. IEEE 802.11a/b/g/n Wi-Fi with configurable radio (off, WAP, or Client) with support for WPAPSK/WPA2PSK
7. Serial Ports (Minimum):
   a. (2) RS-485
   b. (1) USB ports
8. Capability expanding I/O ports through compatible expansion modules
9. Operating Temperature: -4°F to 140°F
10. Operating Relative Humidity: 5% to 95%, non-condensing

D. Network Management Devices – These various devices will service multiple functions on the network depending on network design, communication medium and needed task. These functions can include: management of traffic on the network, reconfiguring and strengthening of signals, the conversion of protocols, normalizing of data, global management of alarms, trends and schedules, control logic, protocol conversion and web page hosting for use as a Graphical User Interface.
   1. Building Controller (BC) – This Niagara Framework based device shall provide the interface between the LAN or WAN and the field control devices, and provide global supervisory control functions over the control devices connected to the BC. It shall be provided with these features:
      a. Web page hosting.
      b. Extended memory.
      c. Network management tools resident within the BC (optional).
      d. Appropriate hardware and driver(s) associated with the protocol it manages.
      e. Din rail mounted power supply.
      f. Network level controllers shall support Project Haystack tagging.
      g. Controllers shall be both readable and writable.
   2. Provide multiple Building Controllers as necessary. In order to maintain peak performance of the network, limit the maximum consumed resources to 80 percent as indicated by the resource meter resident in the network management tools.
   3. Alarm Management:
      a. Provide for the creation of a minimum of eight of alarm classes for the purpose of routing types and or classes of alarms, i.e.: security, HVAC, Fire, etc. Manage alarms as defined in the points list.
      b. Provide timed (schedule) routing of alarms by class, object, group, or node.
      c. Provide alarm generation from binary object “runtime” and /or event counts for equipment maintenance. The user shall be able to reset runtime or event count values with appropriate password control. Control equipment and network failures shall be treated as alarms and annunciated.
      d. Alarms shall be annunciated in any of the following manners as defined by the user:
         1) Screen message text.
         2) Email of the complete alarm message to multiple recipients. Provide the ability to route and email alarms based on:
            (a) Day of week.
            (b) Time of day.
            (c) Recipient.
         3) Pagers via paging services that initiate a page on receipt of email message.
         4) Graphic with flashing alarm object(s).
      e. The following shall be recorded by the BC for each alarm (at a minimum):
         1) Time and date.
         2) Location (building, floor, zone, office number, etc.)
         3) Equipment (air handler #, access way, etc.)
      f. Acknowledge time, date, and user who issued acknowledgement.
      g. Number of occurrences since last acknowledgement.

h. Alarm actions may be initiated by user defined programmable objects created for that purpose.
i. Defined users shall be given proper access to acknowledge any alarm, or specific types or classes of alarms defined by the user.
j. A log of all alarms shall be maintained by the BC and/or a server (if configured in the system) and shall be available for review by the user.
k. Provide a “query” feature to allow review of specific alarms by user defined parameters.
l. A separate log for system alerts (controller failures, network failures, etc.) shall be provided and available for review by the user.

4. An Error Log to record invalid property changes or commands shall be provided and available for review by the user.
5. Data Collection and Storage - The BC shall collect data for any property of any object and store this data as defined in the points list.
6. The data collection shall be performed by log objects, resident in the BC that shall have, at a minimum, the following configurable properties:
   a. Designating the log as interval or deviation.
7. For interval logs, the object shall be configured for time of day, day of week and the sample collection interval.
8. For deviation logs, the object shall be configured for the deviation of a variable to a fixed value. This value, when reached, will initiate logging of the object.
9. For all logs, provide the ability to set the maximum number of data stores for the log and to set whether the log will stop collecting when full, or rollover the data on a first-in, first-out basis.
10. Each log shall have the ability to have its data cleared on a time-based event or by a user-defined event or action.
11. Audit Log - Provide and maintain an Audit Log that tracks all activities performed on the BC. Provide the ability to specify a buffer size for the log and the ability to archive log based on time or when the log has reached its user-defined buffer size. Provide the ability to archive the log locally (to the BC), to another BC on the network, or to a server. For each log entry, provide the following data:
    a. Time and date.
    b. User ID.
12. Change or activity: i.e., Change setpoint, add or delete objects, commands, etc.

E. LON to LON and LON to BACnet Routers and Repeaters – A router or repeater may be used on a LON segment between controllers and a BC as a means to manage traffic and reconfigure and strengthen a transmission signal. Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing LonWorks. A repeater or signal booster may only be used to increase ths signal strength of the communictions. Under no circumstances may it be used in the place of a router.

F. BACnet Routers and Repeaters - A router or repeater may be used on a BACnet segment between controllers and a BC as a means to manage traffic and reconfigure and strengthen a transmission signal. Routers shall be fully programmable and permit a systems integrator to define message traffic, destination, and other network management functions utilizing BACnet. A repeater or signal booster may only be used to increase ths signal strength of the communictions. Under no circumstances may it be used in the place of a router.

1. Hardware Requirements:
   a. Provides Routing Between:
      1) BACnet/IP and BACnet/MSTP
      2) BACnet Ethernet and BACnet/MSTP
      3) BACnet/IP and BACnet Ethernet
      4) BACnet/IP and BACnet Ethernet and BACnetMSTP
      5) Two BACnet/IP networks
   b. Communications
      1) 10/100 Mbps Ethernet with auto-negotiation and Auto-MDIX
      2) MS/TP baud rates range from 9.6-76.8 kbps
      3) Jumper-selectable MS/TP bias and termination
   c. IP Network Support
      1) Web server for commissioning and troubleshooting
      2) Communication diagnostic web page

3) BACnet/IP Broadcast Management Device (BBMD)
4) Foreign Device Registration (FDR)

d. Installation
1) 24 VAC/VDC (± 10%), 47-63 Hz input voltage
2) Din-rail mounted

e. Manufacturer:
1) Contemporary Controls
2) KMC Controls
3) Sierra Monitor FieldServer
4) Pre-approved equivalent

2. Provide network gateway to translate between BACnet/IP to MS/TP protocol.

G. Server Functions–The Owner's IT department shall provide an enterprise grade rack mounted server located in the main server room. Provide Niagara Framework Network management tools and server software, unlimited connectivity version. The server shall support all BCs connected to the customer's network whether local or remote. It shall be possible to provide access to all BC via a single connection to the server. In this configuration, each BC can be accessed from a remote Graphical User Interface (GUI) or from a standard Web Browser Interface (WBI) by connecting to the server. The server shall provide the following functions, at a minimum:

1. Global Data Access: The server shall provide complete access to distributed data defined anywhere in the system.
2. Distributed Control: The server shall provide the ability to execute global control strategies based on control and data objects in any BC in the network, local or remote.
3. The server shall include a master clock service for its subsystems and provide time synchronization for all BCs.
4. The server shall provide scheduling for all Network Area Controllers and their underlying field control devices.
5. The server shall provide demand limiting that operates across all BCs. The server must be capable of multiple demand programs for sites with multiple meters and or multiple sources of energy. Each demand program shall be capable of supporting separate demand shed lists for effective demand control.
6. Provide for browser based graphical home screen with links to each connected BC. See graphic section for additional details.
7. The server shall provide central alarm management for all BC supported by the server. Alarm management shall include:
   a. Routing of alarms to display, printer, email and text message.
   b. View and acknowledge alarms.
   c. Query alarm logs based on user-defined parameters.
8. The server shall provide central management of log data for all BCs supported by the server. Log data shall include process logs, runtime and event counter logs, audit logs and error logs. Log data management shall include:
   a. Viewing and printing log data.
   b. Exporting log data to other software applications.
   c. Query log data based on user-defined parameters.

2.3 BUILDING AUTOMATION SYSTEM CONTROLLERS

A. All controllers shall be designed for easy installation and servicing including removable enclosures, removable terminals, and factory applied labels for all I/O. All internal points within the Programmable Controllers shall be fully supported by the Graphical User Interface (GUI), allowing the user to easily modify them and monitor them. All of the internal programming points (e.g. variables, constants, PID's, timers, inputs and outputs) shall be exposed to the network on dedicated network variable outputs. All controllers programs and schedules shall contain non-volatile flash memory. Upon a loss of power all controllers shall perform a self-restart.

B. All devices that control and/or monitor equipment shall support BACnet intrinsic reporting.

C. Programmable Controllers – a controller designed for more complex sequences of operations such as built up AHU, central plant operations, electrical monitoring, and control and management for chillers, boilers and generators. The Programmable Controllers are to allow for the flexibility of custom control programming to meet the needed sequences of operation.

1. Performance – Each Programmable Controller shall have a minimum of 64K of Non-volatile Flash memory for control applications and 128K non-volatile flash memory for storage with a 8 bit processor. The Programmable Controller shall have a minimum ambient operating temperature range of -0°C to 70°C or 32°F to 158°F.
2. Inputs – Analog inputs shall have the following minimum level of performance: 16-bit A to D resolution; allow monitoring of platinum 100 ohms, platinum 1000 ohm, nickel 1000 ohms, thermistor 10K type II, thermistor 10K type III, voltage input 0-10VDC, current input 4-20mA, digital input, pulsed input minimum 2 Hz.
3. Outputs – Outputs shall be either software configurable to be either analog or digital or dedicated digital only - Analog outputs shall be selectable as voltage of 0-10 VDC (linear) or 4-20mA or Digital outputs shall be 0-12 VDC (off/on), floating or PWM. Outputs shall have an adjustable range of 2 seconds to 15 minutes. Output Resolution shall be a minimum 8 bits digital / analog converter. All individual outputs and power supply shall be protected by an auto reset fuse. There shall be an LED status indicator on each of the outputs.
4. Programmable Controller Features:
    a. Provide an onboard network communication jack.
    b. Programmable Controllers shall be read/write compatible with third party software and must be Haystack compatible. No read/write restrictions shall be placed on the third party software.
    c. The Programmable Controller shall be provided with a diagnostic indicator lights for power and network communication of transmit and receive along with a light indication position for each output.
    d. Hand/Off/Auto Switches – For all controllers applied to a AHU, fan, chiller, pump, cooling Tower or boiler, provide for the manual override and adjustment of all Analog and Digital outputs through a three position switch giving the selection of Hand, Off and Auto (HOA). A HOA shall be provided for each separate digital and analog output from the controller and be an integral part of the controller. HOA switches external from the controller shall not be accepted. For the Analog outputs the Hand position of the switch shall provide for the adjustment of the output signal through a linear scaled potentiometer. The position of the HOA shall be monitored and an alarm shall be delivered to the Graphical User Interface should the switch be in an Off or Hand position. An indicating LED shall be provided on the controller for each HOA indicating position of the switch. For all Analog outputs, the indicating LED shall provide a linear indication of the position of the Potentiometer through a variation in the intensity of the indicator LED and be provided as a numerical value that can be viewed at the Graphical User Interface.
    e. Enclosures – Provide for a plastic enclosure with a separate back plate with terminals such that the electronic portion of the controller can be easily removed for ease of installation and servicing.
        1) Cable Management: Provide cable management within enclosures, including but not limited to:
            (a) Finger Duct
            (b) Brush Duct
            (c) Channeled Raceway
            (d) Terminal Strips
            (e) Velcro Cable Ties

D. Special Purpose Configurable Controllers (SPCC) – A controller designed with unique functions and featues particular to a specific type of mechanical equipment or applications that may be less common and or standarizied in its use and application.
    1. SPCC – Thermostat (SPCCT) – A self-contained controller with a built-in user interface that is intended for installation in the occupied space of the building. The SPCCT shall have the following features:
        a. The SPCCT shall be a microprocessor based controller with all of its control logic, sensors, inputs and outputs, network communication and user interface provided within a manufacture provided enclosure specific to the application. The enclosure shall be aesthetically appealing with a modern design that will fit in with the architecture of the building. A sample of the SPCCT shall be provided as part of the submittal process.
        b. The SPCCT shall be programmed through the user interface contained within the controller and through the LNS plug-in.

c. The User interface display shall be provided with 3 levels of password protection: Level 1 – Lockout with view only and time adjustment; Level 2 - schedule override and mode settings; Level 3 – full access to all parameters. The display shall be back lighted for easy viewing.
d. The SPCCT shall utilize a PI (proportional and integral) control algorithm. Upon power failure, all programmed schedules and parameters must be retained in non-volatile flash memory. Progressive temperature recovery shall be a standard feature. Two configurable digital/binary inputs will be available as well as two remote temperature sensor inputs for outdoor air and remote room/return air monitoring. Built-in frost protection, which can be disabled, will energize the heating as soon as the ambient temperature falls below 45°F (5°C). An auxiliary digital/binary output, which can be configured for normally open or normally closed operation, will also be available.

E. Air terminal controller
1. Existing air terminal units (also known as VAV boxes) shall be retrofitted with a controller that provides direct digital control for room temperature control in variable air volume systems. The controller will operate independently, stand-alone or networked to perform HVAC control, monitoring and energy management functions without relying on a higher level processor. The controller will include a pressure differential transducer and electronic controller.
2. Control algorithms will be preprogrammed; the operator's terminal may be used to adjust air volume set points and other parameters. The controller will be designed for operation and modification without vendor assistance.
3. The controller will interface with the following external devices:
   a. Averaging air velocity sensor.
   b. Floating control valve and damper actuators.
   c. Temperature sensors.
   d. Portable operators terminal.
   e. Building Automation System.
   f. Digital input devices (alarm contacts).
   g. Digital output devices.
4. Controller requirements:
   a. Power requirements:
      1) Operating Range: 18 to 28 Vac.
      2) Power Consumption: 3.5 VA (Nominal) to 5.0 VA (Peak) at 24 Vac.
   b. Analog Inputs:
      1) One room temperature sensor.
      2) One velocity sensor.
      3) One set point.
      4) One auxiliary temperature sensor.
   c. Digital Inputs: Two dry contacts.
   d. Outputs: Six DO 24 Vac. optically isolated solid state switches @ 0.5 amps.
   e. Controlled temperature accuracy: plus or minus 1.5 deg F.
   f. Communications
      1) Remote: LAN Truck
      2) Local: Portable Operators Terminal.
   g. Ambient Conditions:
      1) Operating Temperature: 32 deg F to 122 deg F.
      2) Humidity Range: 10 to 95 percent.
5. Differential Pressure Transducer: The averaging air velocity sensor (provided by the VAV terminal unit manufacturer) sends an average air velocity measurement of the duct air velocity to the controller. If an existing VAV box is not equipped with an air velocity sensor, provide a VAV box manufacturer's approved air velocity sensor. The air velocity sensor connects to the differential pressure transducer and measures the average differential pressure. The air terminal controller converts this value to actual airflow in CFM. The controller will report CFM and set points.
6. Differential Pressure Transducer Requirements:
   a. Temperature range: 48 deg F to 112 deg F.
   b. Measurement Range: 0 to 4000 fpm.
   c. Measurement Resolution: Plus or minus 4 fpm.

d. Measurement Accuracy.
   1) 300 to 4000 fpm: Plus or minus 5 percent of actual reading.
   2) 200 to 300 fpm: +12 percent to -15 percent of actual reading.
e. Repeatability: Plus or minus 8 fpm.

7. Control Panel Enclosure: Provide a control panel enclosure with access panel sealed from airflow and mounted on side of unit.

2.4 BAS SOFTWARE TOOLS

A. The Graphical User Interface (GUI) shall employ browser-like functionality for ease of navigation. It shall include a tree view (similar to Windows Explorer or a “hamburger” menu) for quick viewing of, and access to, the hierarchical structure of the database. In addition, menu-pull downs, and toolbars shall employ buttons, commands and navigation to permit the operator to perform tasks with a minimum knowledge of the HVAC Control System and basic computing skills. These shall include, but are not limited to, forward/backward buttons, home button, and a context sensitive locator line (similar to a URL line), that displays the location and the selected object identification.

B. Provide a visual graphical representation of each piece of mechanical equipment and/or mechanical system that duplicates the represented system, where applicable. Graphics shall include at a minimum the value of each input, each output, each setpoint, alarms and graphical representation of trend logs. The graphic shall provide for the ability to command each point, including both timed and permanent overrides. In addition, provide for all information represented in the graphics in an associated graphical table with links to the equipment graphics and commandable points. All graphics shall commiserate with latest industries standards and practices. Sample graphics shall be provide as part of the submittals for approval by Owner.

C. Real-Time Displays. The GUI, shall at a minimum, support the following graphical features and functions:

1. Graphic screens shall be developed using any drawing package capable of generating or assembling objects from a GIF, or JPG file format. Use of proprietary graphic file formats shall not be acceptable. In addition to, or in lieu of a graphic background, the GUI shall support the use of scanned pictures.
2. Graphic screens shall have the capability to contain objects for text, real-time values, animation, color spectrum objects, logs, graphs, HTML or XML document links, schedule objects, hyperlinks to other URL’s, and links to other graphic screens.
3. Modifying common application objects, such as schedules, calendars, and set points shall be accomplished in a graphical manner.
   a. Schedule times will be adjusted using a graphical slider, without requiring any keyboard entry from the operator.
   b. Holidays shall be set by using a graphical calendar, without requiring any keyboard entry from the operator.
4. 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.

D. System Configuration: At a minimum, the GUI shall permit the operator to perform the following tasks, with proper password access:

1. Create, delete or modify control strategies.
2. Add/delete objects to the system.
3. Tune control loops through the adjustment of control loop parameters.
4. Enable or disable control strategies.
5. Generate hard copy records or control strategies on a printer.
6. Select points to be alarm-able and define the alarm state.
7. Select points to be trended over a period of time and initiate the recording of values automatically.

E. The web browser GUI shall provide a completely interactive user interface and shall provide a HTML5 experience that supports the following features as a minimum:

1. Trending.
2. Scheduling.
3. Electrical demand limiting.

4. Duty Cycling.
5. Downloading Memory to field devices.
6. Real time 'live' Graphic Programs.
7. Tree Navigation.
8. Parameter change of properties.
9. Set point adjustments.
10. Alarm / event information.
11. Configuration of operators.
12. Execution of global commands.
13. Add, delete, and modify graphics and displayed data.

F. On-Line Help: Provide a context sensitive, on-line help system to assist the operator in operation and editing of 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. All system documentation and help files shall be in HTML format.

G. Security: Each operator shall be required to log on to that 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 administrator shall have the ability to set passwords and security levels for all other operators. Each operator password shall be able to restrict the operators' access for viewing and/or changing each system application, full screen editor, and object. Each operator shall automatically be logged off of the system if no keyboard or mouse activity is detected. This auto log-off time shall be set per operator password. All system security data shall be stored in an encrypted format.

H. System Diagnostics: The system shall automatically monitor the operation of all workstations, printers, modems, network connections, building management panels, and controllers. The failure of any device shall be annunciated to the operator.
   1. Alarm Console The system will be provided with a dedicated alarm window or console. This window will notify the operator of an alarm condition, and allow the operator to view details of the alarm and acknowledge the alarm. The use of the Alarm Console can be enabled or disabled by the system administrator.
   2. When the Alarm Console is enabled, a separate alarm notification window will supersede all other windows on the desktop and shall not be capable of being minimized or closed by the operator. This window will notify the operator of new alarms and un-acknowledged alarms. Alarm notification windows or banners that can be minimized or closed by the operator shall not be acceptable.

2.5 USER INTERFACES

A. Web Browser Clients: Provide for a series of browser accessible graphical screens that are resident on the BC and Server that represent the systems controllers and managed by that BC and its associated controllers. The Web browser client shall support at a minimum, the following functions:
   1. The BAS Contractor shall provide system software based on server/thin-client architecture, designed around the open standards of web technology. The BAS server shall communicate using Ethernet and TCP. Server shall be accessed using a web browser over Owner intranet and remotely over the Internet.
   2. The intent of the thin-client architecture is to provide the operator(s) complete access to the BAS system via a web browser. The thin-client web browser Graphical User Interface (GUI) shall be browser and operating system agnostic, meaning it will support HTML5 enabled browsers without requiring proprietary operator interface and configuration programs or browser plug-ins. Microsoft, Firefox, and Chrome browsers (current released versions), and Windows as well as non-Window operating systems.
   3. Thin Client - Web Browser Based: The GUI shall be thin client or browser based and shall meet the following criteria:
      a. Web Browser's for PC's: Only the current released browser (Explorer/Firefox/Chrome) will be required as the GUI and a valid connection to the server network. No installation of any custom software shall be required on the operator's GUI workstation/client. Connection shall be over an intranet or the Internet.

b. Secure Socket Layers: Communication between the Web Browser GUI and BAS server shall offer encryption using 128-bit encryption technology within Secure Socket Layers (SSL). Communication protocol shall be Hyper-Text Transfer Protocol (HTTP).

4. Web Browser Navigation: The Thin Client web browser GUI shall provide a comprehensive user interface. Using a collection of web pages, it shall be constructed to "feel" like a single application, and provide a complete and intuitive mouse/menu driven operator interface. It shall be possible to navigate through the system using a web browser to accomplish requirements of this specification. The Web Browser GUI shall (as a minimum) provide for navigation, and for display of animated graphics, schedules, alarms/events, live graphic programs, active graphic set point controls, configuration menus for operator access, reports and reporting actions for events.
5. Login: On launching the web browser and selecting the appropriate domain name or IP address, the operator shall be presented with a login page that will require a login name and strong password. Navigation in the system shall be dependent on the operator's role-based application control privileges.
6. Navigation: Navigation through the GUI shall be accomplished by clicking on the appropriate level of a navigation tree (consisting of an expandable and collapsible tree control like Microsoft's Explorer program) and/or by selecting dynamic links to other system graphics. Both the navigation tree and action pane shall be displayed simultaneously, enabling the operator to select a specific system or equipment and view the corresponding graphic. The navigation tree shall as a minimum provide the following views: Geographic, Network, Groups and Configuration.
    a. Geographic View shall display a logical geographic hierarchy of the system including: cities, sites, buildings, building systems, floors, equipment and objects.
    b. Groups View shall display Scheduled Groups and custom reports.
    c. Configuration View shall display all the configuration categories (Operators, Schedule, Event, Reporting and Roles).
7. Action Pane: The Action Pane shall provide several functional views for each subsystem specified. A functional view shall be accessed by clicking on the corresponding button:
    a. Graphics: Using graphical format suitable for display in a web browser, graphics shall include aerial building/campus views, color building floor-plans, equipment drawings, active graphic set point controls, web content and other valid HTML elements. The data on each graphic page shall automatically refresh.
    b. Dashboards: User customizable data using drag and drop HTML5 elements. Shall include Web Charts, Gauges, and other custom developed widgets for web browser. User shall have ability to save custom dashboards.
    c. Search: User shall have multiple options for searching data based upon Tags. Associated equipment, real time data, Properties, and Trends shall be available in result.
    d. Properties: Shall include graphic controls and text for the following: Locking or overriding objects, demand strategies, and any other valid data required for setup. Changes made to the properties pages shall require the operator to depress an 'accept/cancel' button.
    e. Schedules: Shall be used to create, modify/edit and view schedules based on the systems hierarchy (using the navigation tree).
    f. Alarms: Shall be used to view alarm information geographically (using the navigation tree), acknowledge alarms, sort alarms by category, actions and verify reporting actions.
    g. Charting: Shall be used to display associated trend and historical data, modify colors, date range, axis and scaling. User shall have ability to create HTML charts through web browser without utilizing chart builder. User shall be able to drag and drop single or multiple data points, including schedules, and apply status colors for analysis.
    h. Logic - Live Graphic Programs: Shall be used to display' live' graphic programs of the control algorithm, (micro block programming) for the mechanical/electrical system selected in the navigation tree.
    i. Other actions such as Print, Help, Command, and Logout shall be available via a drop-down window.
8. Color Graphics: The Web Browser GUI shall make extensive use of color in the graphic pane to communicate information related to set points and comfort. Animated .gifs or .jpg, vector scalable, active set point graphic controls shall be used to enhance usability. Graphics tools used to create Web Browser graphics shall be non-proprietary and conform to the following basic criteria:

a. Display Size: The GUI workstation software shall graphically display in a minimum of 1080p 24 bit True Color.
b. General Graphic: General area maps shall show locations of controlled buildings in relation to local landmarks.
c. Color Floor Plans: Floor plan graphics shall show heating and cooling zones throughout the buildings in a range of colors, as selected by Owner. Provide a visual display of temperature relative to their respective set points. The colors shall be updated dynamically as a zone's actual comfort condition changes.
d. Mechanical Components: Mechanical system graphics shall show the type of mechanical system components serving any zone through the use of a pictorial representation of components. Selected I/O points being controlled or monitored for each piece of equipment shall be displayed with the appropriate engineering units. Animation shall be used for rotation or moving mechanical components to enhance usability.
e. Minimum System Color Graphics: Color graphics shall be selected and displayed via a web browser for the following:
    1) Each piece of equipment monitored or controlled including each terminal unit.
    2) Each building.
    3) Each floor and zone controlled.

9. Hierarchical Schedules: Utilizing the Navigation Tree displayed in the web browser GUI, an operator (with proper access credentials) shall be able to define a Normal, Holiday or Override schedule for an individual piece of equipment or room, or choose to apply a hierarchical schedule to the entire system, site or floor area. For example, Independence Day ' Holiday' for every level in the system would be created by clicking at the top of the geographic hierarchy defined in the Navigation Tree. No further operator intervention would be required and every control module in the system with would be automatically downloaded with the ' Independence Day' Holiday. All schedules that affect the system/area/equipment highlighted in the Navigation Tree shall be shown in a summary schedule table and graph.
    a. Schedules: Schedules shall comply with the BACnet standards, (Schedule Object, Calendar Object, Weekly Schedule property and Exception Schedule property) and shall allow events to be scheduled based on:
        1) Types of schedule shall be Normal, Holiday or Override.
        2) A specific date.
        3) A range of dates.
        4) Any combination of Month of Year (1-12, any), Week of Month (1-5, last, any), Day of Week (M-Sun, Any).
        5) Wildcard (example, allow combinations like second Tuesday of every month).
    b. Schedule Categories: The system shall allow operators to define and edit scheduling categories (different types of "things" to be scheduled; for example, lighting, HVAC occupancy, etc.). The categories shall include: name, description, icon (to display in the hierarchy tree when icon option is selected) and type of value to be scheduled.
    c. Schedule Groups: In addition to hierarchical scheduling, operators shall be able to define functional Schedule Groups, comprised of an arbitrary group of areas/rooms/equipment scattered throughout the facility and site. For example, the operator shall be able to define an ' individual tenant' group - who may occupy different areas within a building or buildings. Schedules applied to the ' tenant group' shall automatically be downloaded to control modules affecting spaces occupied by the ' tenant group'.
    d. Intelligent Scheduling: The control system shall be intelligent enough to automatically turn on any supporting equipment needed to control the environment in an occupied space. If the operator schedules an individual room in a VAV system for occupancy, for example, the control logic shall automatically turn on the VAV air handling unit, chiller, boiler and/or any other equipment required to maintain the specified comfort and environmental conditions within the room.
    e. Partial Day Exceptions: Schedule events shall be able to accommodate a time range specified by the operator (ex: board meeting from 6 pm to 9 pm overrides Normal schedule for conference room).
    f. Schedule Summary Graph: The schedule summary graph shall clearly show Normal versus Holiday versus Override Schedules and the net operating schedule that results from all contributing schedules. Note: In case of priority conflict between schedules at the different geographic hierarchy, the schedule for the more detailed geographic level shall apply.

10. Alarms: Alarms associated with a specific system, area, or equipment selected in the Navigation Tree, shall be displayed in the Action Pane by selecting an ' Alarms' view. Alarms, and reporting actions shall have the following capabilities:
    a. Alarms View: Each Alarm shall display an Alarms Category (using a different icon for each alarm category), date/time of occurrence, current status, alarm report and a bold URL link to the associated graphic for the selected system, area or equipment. The URL link shall indicate the system location, address and other pertinent information. An operator shall easily be able to sort events, edit event templates and categories, acknowledge or force a return to normal in the Events View as specified in this section.
    b. Alarm Categories: The operator shall be able to create, edit or delete alarm categories such as HVAC, Maintenance, Fire, or Generator. An icon shall be associated with each alarm category, enabling the operator to easily sort through multiple events displayed.
    c. Alarm Templates: Alarm template shall define different types of alarms and their associated properties. As a minimum, properties shall include a reference name, verbose description, severity of alarm, acknowledgement requirements, and high/low limit and out of range information.
    d. Alarm Areas: Alarm Areas enable an operator to assign specific Alarm Categories to specific Alarm Reporting Actions. For example, it shall be possible for an operator to assign all HVAC Maintenance Alarm on the 1st floor of a building to email the technician responsible for maintenance. The Navigation Tree shall be used to setup Alarm Areas in the Graphic Pane.
    e. Alarm Time/Date Stamp: All events shall be generated at the DDC control module level and comprise the Time/Date Stamp using the standalone control module time and date.
    f. Alarm Configuration: Operators shall be able to define the type of Alarm generated per object. A ' network' view of the Navigation Tree shall expose all objects and their respective Alarm Configuration. Configuration shall include assignment of Alarm, type of Acknowledgement and notification for return to normal or fault status.
    g. Alarm Summary Counter: The view of Alarm in the Graphic Pane shall provide a numeric counter, indicating how many Alarms are active (in alarm), require acknowledgement and total number of Alarms in the BAS Server database.
    h. Alarm Auto-Deletion: Alarms that are acknowledged and closed shall be auto-deleted from the database and archived to a text file after an operator defined period.
    i. Alarm Reporting Actions: Alarm Reporting Actions specified shall be automatically launched (under certain conditions) after an Alarm is received by the BAS server software. Operators shall be able to easily define these Reporting Actions using the Navigation Tree and Graphic Pane through the web browser GUI. Reporting Actions shall be as follows:
        1) Print: Alarm information shall be printed to the BAS server's PC or a networked printer.
        2) Email: Email shall be sent via any POP3-compatible e-mail server (most Internet Service Providers use POP3). Email messages may be copied to several email accounts. Note: Email reporting action shall also be used to support alphanumeric paging services, where email servers support pagers.
        3) File Write: The ASCII File write reporting action shall enable the operator to append operator defined alarm information to any alarm through a text file. The alarm information that is written to the file shall be completely definable by the operator. The operator may enter text or attach other data point information (such as AHU discharge temperature and fan condition upon a high room temperature alarm).
        4) Write Property: The write property reporting action updates a property value in a hardware module.
        5) SNMP: The Simple Network Management Protocol (SNMP) reporting action sends an SNMP trap to a network in response to receiving an alarm.
        6) Run External Program: The Run External Program reporting action launches specified program in response to an event.
11. Trends: As system is engineered, all points shall be enabled to trend. Trends shall both be displayed and user configurable through the Web Browser GUI. Trends shall comprise analog, digital or calculated points simultaneously. A trend log's properties shall be editable using the Navigation Tree and Graphic Pane.

a. Viewing Trends: The operator shall have the ability to view trends by using the Navigation Tree and selecting a Trends button in the Graphic Pane. The system shall allow y- and x-axis maximum ranges to be specified and shall be able to simultaneously graphically display multiple trends per graph.
b. Local Trends: Trend data shall be collected locally by Multi-Equipment/Single Equipment general-purpose controllers, and periodically uploaded to the BAS server if historical trending is enabled for the object. Trend data, including run time hours and start time date shall be retained in non-volatile module memory. Systems that rely on a gateway/router to run trends are NOT acceptable.
c. Resolution. Sample intervals shall be as small as one second. Each trended point will have the ability to be trended at a different trend interval. When multiple points are selected for displays that have different trend intervals, the system will automatically scale the axis.
d. Dynamic Update. Trends shall be able to dynamically update at operator-defined intervals.
e. Zoom/Pan. It shall be possible to zoom-in on a particular section of a trend for more detailed examination and ' pan through' historical data by simply scrolling the mouse.
f. Numeric Value Display. It shall be possible to pick any sample on a trend and have the numerical value displayed.
g. Copy/Paste. The operator shall have the ability to pan through a historical trend and copy the data viewed to the clipboard using standard keystrokes (i.e. CTRL+C, CTRL+V).

12. Security Access: Systems that are accessed from the web browser GUI to BAS server shall require a Login Name and Strong Password. Access to different areas of the BAS system shall be defined in terms of Role-Based Access Control privileges as specified:
    a. Roles: Roles shall reflect the actual roles of different types of operators. Each role shall comprise a set of ' easily understood English language' privileges. Roles shall be defined in terms of View, Edit and Function Privileges.
        1) View Privileges shall comprise: Navigation, Network, and Configuration Trees, Operators, Roles and Privileges, Alarm/Event Template and Reporting Action.
        2) Edit Privileges shall comprise: Set point, Tuning and Logic, Manual Override, and Point Assignment Parameters.
        3) Function Privileges shall comprise: Alarm/Event Acknowledgement, Control Module Memory Download, Upload, Schedules, Schedule Groups, Manual Commands, Print and Alarm/Event Maintenance.
    b. Geographic Assignment of Roles: Roles shall be geographically assigned using a similar expandable/collapsible navigation tree. For example, it shall be possible to assign two HVAC Technicians with similar competencies (and the same operator defined HVAC Role) to different areas of the system.

2.6 PERIPHERAL DEVICES

A. Description: Vibration and corrosion resistant; for wall, slab, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:
    1. Manufacturers:
        a. BEC Controls Corporation.
        b. Ebtron, Incorporated
        c. Heat-Timer Corporation.
        d. I.T.M. Instruments Incorporated
        e. Kele Incorporated
        f. MAMAC Systems, Incorporated
        g. Precon; Division of Kele Incorporated.
        h. RDF Corporation.
        i. Veris Industries
    2. Accuracy: Plus or minus 0.36 degrees F at calibration point.
    3. Wire: Twisted, shielded-pair cable.
    4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 square feet.
    5. Averaging Elements in Ducts: 72 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.

6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2-inches.
7. Type (1) Room Sensor
    a. Cover Construction: Manufacturer's standard locking covers.
    b. Set-Point Adjustment: Exposed.
        1) Provide ability to limit setpoint adjustment range or lock out entirely.
    c. Set-Point Indication: Exposed.
    d. Thermometer: Digital.
    e. Color: White.
    f. Orientation: Vertical.

C. RTD's and Transmitters:
1. Manufacturers:
    a. BEC Controls Corporation.
    b. MAMAC Systems, Incorporated
    c. RDF Corporation.
    d. Veris Industries
2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 8-inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.
5. Averaging Elements in Ducts: 24 feet long, flexible; use where prone to temperature stratification or where ducts are larger than 9 square feet length; length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.
7. Room Sensor Cover Construction: Manufacturer's standard locking covers.
8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.
1. Manufacturers:
    a. BEC Controls Corporation.
    b. General Eastern Instruments.
    c. MAMAC Systems, Incorporated
    d. Precon; Division of Kele Incorporated.
    e. ROTRONIC Instrument Corporation
    f. TCS/Basys Controls.
    g. Vaisala.
    h. Veris Industries
2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 0 to 100 percent relative humidity.
4. Room Sensor Cover Construction: Manufacturer's standard locking covers.
    a. Set-Point Adjustment: Concealed.
    b. Set-Point Indication: Concealed.
    c. Color: White.
5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.
6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of minus 22 to plus 185 degrees F
7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:
1. Manufacturers:
    a. Air Monitor Corporation
    b. BEC Controls Corporation.
    c. General Eastern Instruments.
    d. MAMAC Systems, Incorporated
    e. ROTRONIC Instrument Corporation
    f. TCS/Basys Controls.
    g. Vaisala.
    h. Veris Industries

2. Static-Pressure Transmitter: Non-directional sensor with suitable range for expected input, and temperature compensated.
    a. Accuracy: 1 percent of full scale with repeatability of 0.5 percent.
    b. Output: 4 to 20 mA.
    c. Building Static-Pressure Range: 0- to 0.50-inch water gage.
        1) Indoor shielded static air probe: 316 stainless steel recessed probe with integral volume chamber capable of sensing room pressure within 1 percent of actual pressure. (Example: Air Monitor Corporation model S.A.P. /3)
        2) Outside static air probe: 316 stainless steel round probe with parallel plates capable of sensing pressure within 1 percent of actual pressure. Sensing accuracy unaffected by rain or snow or wind velocities less than 40 MPH. (Example: Air Monitor Corporation model S.O.A.P.)
    d. Duct Static-Pressure Range: 0- to 5-inch water gage.
3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Status Sensors
1. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch water gage.
2. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.
3. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
4. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
5. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
6. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
7. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
8. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.
    a. Manufacturers:
        1) BEC Controls Corporation.
        2) I.T.M. Instruments Incorporated

G. Gas Detection Equipment
1. Manufacturers:
    a. B. W. Technologies.
    b. Critical Environment Technologies
    c. CEA Instruments, Incorporated
    d. Ebtron, Incorporated
    e. Gems Sensors Incorporated
    f. Greystone Energy Systems Incorporated
    g. Honeywell International Incorporated; Home & Building Control.
    h. INTEC Controls, Incorporated
    i. I.T.M. Instruments Incorporated
    j. MSA Canada Incorporated
    k. QEL/Quatrosense Environmental Limited.
    l. Sauter Controls Corporation.

m. Sensidyne, Incorporated
n. TSI Incorporated.
o. Vaisala.
p. Vulcain Incorporated

2. Carbon Monoxide Detectors: Single or multi-channel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of minus 20 to 104 degrees F; zero to 250 ppm.
3. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; zero to 2,000 ppm, suitable over a temperature range of 23 to 130 degrees F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.
4. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

2.7 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
   1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
   3. Non-spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
   4. Spring-Return Motors for Valves Larger than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.
   5. Non-spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
   6. Spring-Return Motors for Dampers Larger than 25 Sq. Ft.: Size for running and breakaway torque of 150 inches x lbf.

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
   1. Manufacturers:
      a. Belimo Aircontrols (USA), Incorporated
      b. Bray International Incorporated.
      c. Delta Control Products.
      d. Honeywell, Incorporated; Home & Building Control.
      e. Siemens Building Technologies
      f. Johnson Controls, Incorporated; Controls Group.
   2. Valves: Size for torque required for valve close off at maximum pump differential pressure.
      a. Run Time: Hydronic terminal units 3-inches and smaller: 90 seconds open, 90 seconds closed.
   3. Dampers: Size for running torque calculated as follows:
      a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
      b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.
      c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.
      d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.
      e. Dampers with 2- to 3-Inch w.g of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
      f. Dampers with 3- to 4-Inch w.g of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
   4. Coupling: V-bolt and V-shaped, toothed cradle.
   5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
   6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
   7. Power Requirements (Two-Position Spring Return): 120-V ac.
   8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
   9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.

10. Temperature Rating: Minus 22 to plus 122 degrees F.
11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 degrees F.
12. Run Time: 12 seconds open, 5 seconds closed.

2.8 CONTROL VALVES

A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.

B. Hydronic Globe Valves
   1. Manufacturers:
      a. Belimo Aircontrols (USA), Incorporated
      b. Delta Control Products
      c. Honeywell, Incorporated; Home & Building Control.
      d. Johnson Controls, Incorporated; Controls Group.
      e. Siemens Building Technologies

C. Hydronic system globe valves shall have the following characteristics:
   1. NPS 2 and Smaller: Class 125 or 250 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with back-seating capacity repackable under pressure.
   2. NPS 2-1/2 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   3. NPS 4 and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
   4. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
      a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
   5. Sizing 5-psig maximum pressure drop at design flow rate or the following:
      a. Two Position: Line size.
      b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.
      c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.
   6. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.
   7. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Steam System Globe Valves
   1. Manufacturers:
      a. Belimo Aircontrols (USA), Incorporated
      b. Delta Control Products
      c. Honeywell, Incorporated; Home & Building Control.
      d. Johnson Controls, Incorporated; Controls Group.
      e. Siemens Building Technologies

E. Butterfly Control Valves
   1. Manufacturers:
      a. Apollo Valves
      b. Belimo Aircontrols (USA), Incorporated
      c. Delta Control Products
      d. Honeywell, Incorporated; Home & Building Control.
      e. Johnson Controls, Incorporated; Controls Group.
      f. Siemens Building Technologies

F. Butterfly Valves NPS 4 and larger: 200-psig, 150-psig maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
   1. Body Style: Lug.

2. Disc Type: Nickel-plated ductile iron, Aluminum bronze, Elastomer-coated ductile iron, or Epoxy-coated ductile iron.
3. Sizing:
   a. 5-psig maximum pressure drop at design flow rate. Two-position valves shall be line size.
   b. Pressure drop; 2-psig greater than the controlled heating or cooling device pressure drop.

G. Ball Pattern Control Valves
1. Manufacturers:
   a. Apollo Valves
   b. Belimo Aircontrols (USA), Incorporated
   c. Delta Control Products
   d. Johnson Controls, Incorporated; Controls Group.
2. NPS 3 and Smaller: Class 150, 580-psig rated, ASTM B 584 bronze body and bonnet, two-piece construction; stainless steel ball, standard or modified port, blowout proof, stainless steel stem, RPTFE seats and seals, threaded or flanged end connections.
3. Sizing:
   a. 5-psig maximum pressure drop at design flow rate. Two-position valves shall be line size.
4. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics. Select operators to close valves against pump shutoff head plus system static pressure (but not less than 50-psig).
5. Torque: 45 in-lbs. maximum torque; open to close.

H. Terminal Unit Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.
1. Rating: Class 125 for service at 125 psig and 250 degrees F operating conditions.
2. Sizing: 3-psig maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

2.9 DAMPERS

A. Manufacturers: Manufacturers: Subject to compliance with requirements, provide control damper products by one of the listed manufacturers:
1. Arrow United Industries
2. Belimo Aircontrols (USA), Incorporated
3. Cesco Products
4. Honeywell, Incorporated; Home & Building Control.
5. Johnson Controls, Incorporated; Controls Group.
6. Ruskin Manufacturing Company
7. Siemens Building Technologies
8. Vent Products Co., Incorporated

B. Construction:
1. Frames: Extruded aluminum hat channels, 0.125-in. minimum thickness.
2. Blades: Extruded aluminum airfoil type, 6-inch maximum blade width.
3. Hardware: Molded synthetic bearings. Zinc plated steel axles, linkage brackets, connecting rods, and mounting bolts.
4. Seals: Flexible metal compression seals on the frame at blade end; extruded vinyl inflatable blade edge seals.
5. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.
6. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 8 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

C. Operating Limits:
1. Temperature: -20 to 200 degrees F.
2. Pressure: 6 inches w.g. differential.
3. Velocity: Up to 4000 FM.

D. Select Parallel blade dampers for proportional service. Opposed blade dampers shall be used for two-position service.

E. Damper sizes will be provided as indicated on the drawings. Damper sizes may be provided differently from those shown on the drawings, if improved performance can be demonstrated with calculations.

2.10 SMOKE CONTROL EQUIPMENT REQUIREMENTS

A. Building level controllers and unit level controllers monitoring and/or transmitting fire alarm points shall have UL 864 UOJZ listing with Underwriters Laboratories. The controls contractor shall provide a copy of the UL certificate for their controllers.

B. Controllers used for smoke control shall be UL 864 UUKL listed.

C. If the DDC system is controlling a piece of equipment that is on emergency power, the DDC panel shall be connected to the same source of emergency power.

D. DDC primary LAN controllers, PCs and communication equipment that monitor life safety and critical points (such as fire alarm and elevator emergency) shall be connected to emergency power and have an online four-hour uninterruptible power supply (UPS) with full-load rectification and inversion (double conversion).

2.11 WIRE, CABLE, AND TRANSFORMERS

A. Provide low voltage interlock wiring between supply and exhaust fans, electrical wiring for relays for temperature and pressure indication.

B. Provide wiring and connections for low temperature thermostats, high temperature thermostats, alarms, flow switches, actuating devices for temperature, humidity, pressure and flow indication, point resets and user disconnect switches for electric heating, appliances controlled by this Section.

C. Provide all other wiring required for the complete operation of the specified systems.

D. Wire and cable shall meet the requirements of NFPA 70 and NFPA 90A.

E. Terminal blocks, which are not integral to other equipment, shall be insulated, modular, feed-trough, clamp style with recessed captive screw-type clamping mechanism, shall be suitable for rail mounting, and shall have end plates and partition plates for separation or enclosed sides.

F. Control wiring for binary sensors shall be 18 AWG copper and shall be rated for 300-volt service.

G. Control wiring for analog signals shall be 18 AWG, copper, single or multiple strand, twisted (minimum 50 mm lay of twist), 100% shielded pairs and shall have 300 volt insulation. Each pair shall have a 20 AWG tinned-copper drain wire and individual overall pair insulation.

H. Provide Unshielded Twisted Pair (UTP) Horizontal Cable:
   1. Data.
      a. Category 6.
      b. Four thermoplastic-insulated, individually twisted pairs of conductors.
      c. Center pair isolating separator.
      d. 23-24 AWG, color-coded.
      e. Jacket color: Yellow
      f. Plenum rated and non-plenum rated as it applied for the space installed.

I. Transformers shall be UL 1585 approved and shall be sized so that the connected load is no greater than 80% of the transformer rated capacity.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that power supply is available to control units and operator workstation.

B. Verify existing conditions before starting work. The beginning of installation implies that the contractor accepts the existing conditions.

C. The contractor shall thoroughly examine the project plans for control device and equipment locations, and any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

D. The contractor shall inspect the site to verify that equipment is installable as shown, and any discrepancies, conflicts, or omissions shall be reported to the Engineer for resolution before rough-in work is started.

E. The contractor shall examine the drawings and specifications and if head room or space conditions appear inadequate or if any discrepancies occur between the plans for work under this contract and the plans for the work of others, the discrepancies shall be reported to the Engineer and the contractor shall obtain written instructions for any changes necessary to accommodate the work under this contract with the work of others.

F. Verify that existing equipment to be reused such as field end devices, wiring, and pneumatic tubing is installed and in working condition prior to installation proceeding.

3.2 CYBERSECURITY RISK MITIGATION STRATEGY

A. Coordinate with Owner's IT Department to restrict external network access to Internet connected system through virtual private network (VPN) connections only.

B. Disable any protocols for remote connectivity, unless constantly required for day-to-day operations. Secure VPN connections shall be the only acceptable form of remote connectivity unless otherwise approved by the Owner and Engineer.

C. Protect data in transit and at rest. All external transport data shall be routed through encrypted channels using Transport Layer Security (TLS 1.2).

D. Coordinate with Owner's IT Department to implement a Web server-based human machine interface (HMI) that relies on IT technologies to secure access and restrict ports that can be opened on the firewall. Coordinate with Owner's IT Department to restrict access to known IP addresses only.

E. Where building system networks are not physically separate from IT business networks, coordinate with Owner's IT Department to segregate networked and Internet connected systems from the IT business network using virtual local area network (VLAN) IT technologies to restrict internal attacks/breakdowns.

F. Set unique, strong passwords for administrator and user accounts. Default passwords must be changed before systems and devices are connected to the Owner's network.

G. Collect only the data that is necessary for analytics and optimization.

H. Refer to the Niagara 4 Hardening Guide and apply the most stringent manufacturer recommendations.

I. Adhere to the following compliance requirements:
   1. ISO/IEC 27001
   2. IEC 62443: Industrial Network and System Security
   3. SOC-2 (for hosted services)

J. Abide by best practices outlined in the following references:
   1. NIST Special Publication 800-14 – Generally Accepted Principles and Practices for Securing Information Technology Systems
   2. NIST Special Publication 800-54 Revisions 4 – Security and Privacy Controls for Federal Information Systems and Organizations
   3. Defense Security Service Office of the Designated Approving Authority – Master System Security Plan (MSSP) Template for Peer-to-Peer Networks (June 2011, Version 3.0)

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install all control components in accordance with manufacturer's instructions and recommendations:

1. Mount control panels adjacent to associated equipment on vibration-free walls or freestanding angle iron supports. One cabinet may accommodate more than one system in same equipment room. Provide nameplates for instruments and controls inside cabinet and nameplates on cabinet face.
2. Install equipment, piping, wiring/conduit parallel to building lines (i.e., horizontal, vertical, and parallel to walls) wherever possible.
3. Provide sufficient slack and flexible connections to allow for vibration of piping and equipment.
4. Verify integrity of all wiring to ensure continuity and freedom from shorts and grounds.
5. 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.

3.4 DATA COLLECTION

A. Provide mapping of points from various automated systems. Provide the ability to read and display any value of any used property of any object from any networked device including properties available and supported optional properties, as well as proprietary extensions.

B. Trending
   1. See control drawings and sequence of operation for points to be trended.
   2. Analog points: 15 minute averages
   3. Binary points: change of state.
   4. Normalize and archive data.

C. Timestamp all data.

D. Normalize data points shown in contract documents for ease of database management, graphic displays, readability, and simple identification.

E. Provide real-time dynamic screen updates for all points

F. Provide real-time rates for all utilities.

3.5 DATABASE GENERATION

A. Develop relational database of data objects, time stamps, events, alarms, and transactions.

B. Provide the ability to modify loop Object setpoints, alarm limits, alarm acknowledgement and audit notes, tuning parameters, routing, scheduling etc. initiated through operator interaction with graphics displays.

C. Archive all data points, graphics, reports, alarms, trends, events, and transactions.
   1. Store archive data indefinitely.
   2. Make data available for industry standard 3rd party applications and application implementation.

D. Develop databases including:
   1. Applications
   2. Configuration
   3. Trending and historical data
   4. Event storage

E. Coordinate point naming standards with owner, prior to any database generation. Example designators include, at a minimum:
   1. First designator is the campus designation. (ie, 1 = Campus 1, 2= Campus 2, etc.)
   2. Second designator is the building identifier.
   3. Third designator is the system identifier (ie, Mechanical, Electrical, Lighting, Security, etc.).
   4. Fourth designator is the floor number.
   5. Fifth designator is the room number.
   6. Sixth designator is the point identifier.

3.6 GRAPHICS GENERATION

A. Prior to generation/submission of graphics, coordinate with Owner. Meet with the Owner for a minimum of eight (8) hours in at least two sessions to review graphic layouts and document the meeting with minutes and owner feedback markups on graphics images. Utilize Graphic Library to generate color graphics including but not limited to:

1. Legend:
    a. Color codes
    b. Definitions
    c. Symbols
2. Common Points (for every system)
    a. Time/Date
    b. Outside Air Temperature/Humidity
3. Site and Floor plans including integrated systems:
    a. Automated Temperature Controls system
    b. Room numbers and names
4. Dashboards including (coordinate symbols with Owner):
    a. Picture of facility
    b. Facility weather
    c. Facility Pressurization
    d. Facility cost per hour
    e. Facility alarms
    f. Facility utility usage
    g. Links to various major systems such as: Floor, Air Systems, Water Systems, Energy, Reports, Scheduling, etc.
5. Schedules
    a. Configuration of schedule based on days of the week
    b. Create intuitive controls for selecting open/closed scheduled based on time-of-day and day-of-the-week.
6. Provide system graphics such as:
    a. AHU, FCU, and RTU equipment, displaying real-time operating data
7. Include other points such as:
    a. Calculated points
    b. Alarms and Limits
    c. Shared points
    d. Integrated points
    e. Setpoints
8. Visualize Trends
    a. Temperature Trends
        1) By zone
    b. Pump energy trends
9. Reports
    a. Temperature Trend report
        1) By Zone
        2) By RTU
10. Alarms
    a. Coordinate with the Owner
11. User configuration capability
    a. Create user-configurable set points, outside air, and mechanical operations controls interface
12. Site Plan:
    a. Showing City buildings
    b. Allow penetration to floor plan graphics
13. Floor Plans:
    a. Coordinate with as-built drawings to include
        1) Room name and numbers
    b. Identify
        (a) AHU's/RTU's, Boilers, VAVs, Thermostats
        2) HVAC rooms served by singe space sensor.
    c. Allow penetration to associated system graphic

d. Thermographics
e. Color Scheme

14. Risers:
    a. Systems service and status
    b. Hardware service and status
15. Summaries:
    a. Alarms
    b. Overrides
    c. Transactions
    d. Events
16. Links:
    a. Link to previous screen (top left corner)
    b. Link to associated master system from sub-system

B. Manufacturer's Field Service Technician shall provide a complete installation and provide full service installation including:

1. Manufacturer's Field Service Technician shall install all software, licensing, and configure all software to communicate with all system devices including but not limited to power monitors and intelligent breakers regardless of manufacturer.
2. Setup and map all communicating devices to communicate with the power monitoring software system.
3. Setup and configure all communications interfaces and gateways and IP addresses.
4. Verify and assist contractor troubleshoot communications, data integrity and correct as necessary.

3.7 ALARM MANAGEMENT

A. Provide alarms including:

1. Any point reaching a high or low limit.
2. Anytime feedback does not equal command.
3. Points overridden through user interface.

B. Provide alarms for points as shown in point list. Coordinate with Owner and include the following:

1. Point Name and Description
2. Alarm differentials (automatically adjust with setpoints)
3. Units
4. Coordinate settings (limits or state) with Owner
5. Instrument tag
6. Priority
7. Message

C. Coordinate alarm notifications and routing with the Owner. Include any of the following:

1. Email
2. Text Messaging
3. Paging
4. Telephony
5. Network notifications
6. Alarm acknowledgement.
7. Maintenance Management System

D. Provide hardware or interface required to implement alarm notification and routing.

E. Provide alarms suppression, to minimize nuisance alarms resulting from higher level alarms.

1. Hot water and chilled water alarms master to AHU temperatures.
2. AHU alarms master to associated VAV and room temperatures.
3. Fire alarms master to associated HVAC equipment.

F. Provide state-based alarming to prevent alarms during specific equipment states.

1. Interlock equipment status and/or modes to lock out associated alarms during shutdowns.
2. Interlock acknowledgement to lock out associated alarm for limited adjustable time period.

G. Provide and implement alarm escalation for alarms.

H. Filter and route alarms based on user log in.

I. Allow alarms to be sorted and displayed chronologically, priority, filtering, etc.

J. Provide alarms for conditions such as offline and poor communication performance.

K. Archive all data in standard database platform Microsoft SQL. Including but not limited to:
   1. I/O points
   2. Software points such as:
      a. Alarm limits
      b. Setpoints
      c. Parameters
   3. Schedules
   4. Alarm messages

3.8 COORDINATION

A. Site:
   1. The contractor shall assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will possibly interfere with work of other trades. If installation with coordination causes interference with work of other trades, the contractor shall correct conditions without extra charge.
      a. Coordinate and schedule work with work in the same area and with work that is dependent upon other work to facilitate mutual progress.

B. Submittals: See Part 1.

C. Test and Balance
   1. The contractor shall provide the Test and Balance Contractor a single set of necessary tools to interface with the control system for testing and balancing.
   2. The contractor shall provide a minimum of 4 hours of training on the use of the interface tools.
   3. The contractor shall provide a qualified technician to assist with the testing and balancing of one system controlled by a programmable controller and the first twenty terminal units.
   4. The Test and Balance contractor is obligated to return the interface tools undamaged and in working condition at completion of the testing and balancing.

D. Life Safety
   1. The contractor shall interlock existing duct smoke detectors with the air handlers for unit shutdown upon smoke detection.

E. Coordination with other controls specified in other sections or divisions: Other sections and/or division of this specification include controls and control devices that are to be part of or interfaced to the control system specified in this section. The contractor shall coordinate his integration of these devices as follows.
   1. Each supplier of a controls product is responsible for the configuration, programming, start-up and testing of that product to meet the sequence of control.
   2. 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.
   3. The contractor is responsible for providing all controls described in the Contract Documents regardless of where within the Contract Documents these controls are described.
   4. The contractor is responsible for the interface of control products provided by multiple suppliers regardless of where this interface is described within the Contract Documents.

3.9 TEMPERATURE SENSORS

A. Temperature sensor assemblies shall be readily accessible and adaptable to each type of application in such manner as to allow for quick, easy replacement and servicing without special tools or skills.

B. Strap-on mountings shall not be permitted.

C. Outdoor installations shall be; of weatherproof construction or in appropriate NEMA enclosures. These installations shall be protected from solar radiation and wind effects.

D. Sensors shall be with enclosure where located in finished space.

E. Sensors in ducts shall be mounted in locations to sense the correct temperature of the air only and shall not be located in dead air spaces or positions obstructed by ducts, equipment, and so forth. Locations where installed shall be within the vibration and velocity limit of the sensing element. Ducts shall be securely sealed where elements or connections penetrate ducts to avoid measuring false conditions.

F. All sensors measuring temperatures in pipes larger than 2 inches in diameter or in pressure vessels shall be supplied with wells properly fabricated for the service. Wells shall be noncorrosive to the medium being measured and shall have sufficient physical strength to withstand pressures and velocities to which they are subjected. Wells shall be installed in the piping at elbows where piping is smaller than the length of the well to effect proper flow across the entire area of the well.

G. All field sensors, transmitters, actuators, switches, etc. shall be field calibrated. The calibration shall be guaranteed for the period of the control system warranty. Any corrections or re-calibration required during the warranty will be performed at no cost to Owner. Calibration methods, means, instruments, and standards shall be in strict accordance with ISO-9000 standards.

H. Space Temperature Sensor Schedule:
   1. Type 1: All spaces.

3.10 CONTROL VALVES, CONTROL DAMPERS AND ACTUATORS

A. Control Valves:
   1. Prior to start of work, the control valves shall be verified they are in suitable condition to be re-used and a new DDC actuator and valve linkage is able to operate the existing valve stem. If the valve is not in working order or the valve is not compatible with a DDC valve actuator/linkage, a new control valve shall be provided and installed by the contractor.
   2. Coordinate with the contractor and verify that each control valve can be serviced, including adjustment and removal of the actuator.
   3. All control valves shall have unions installed at each inlet and outlet to permit removal of the valve for servicing.
   4. Valves shall be installed with stems vertical where possible. Where space conditions require valves to be mounted with stems greater than 45° off vertical the actuator shall be externally supported. In no case will the control valve be mounted with the stem greater than 90° off of vertical.

B. Control Dampers:
   1. Prior to start of work, the control dampers shall be verified they are in suitable condition to be re-used and a new DDC actuator/linkage is able to operate the existing damper. If the damper is not in working order or the damper is not compatible with a DDC valve actuator/linkage, a new control damper shall be provided and installed by the contractor.
   2. Coordinate with the Mechanical contractor the service access requirements of the control dampers, and verify that each control damper can be serviced, including adjustment and removal of the actuator.
   3. Contractor shall provide necessary blank-off plates required for installation of reduced-size dampers (dampers that are smaller than duct size).
   4. Furnish interconnecting hardware, linkages, etc. for installation of multiple section dampers by Mechanical Contractor.

3.11 ELECTRICAL SYSTEM INSTALLATION

A. Wiring Method: Install cables in raceways unless otherwise indicated.
   1. Except raceways are not required in accessible indoor ceiling spaces and attics.
   2. Except raceways are not required in hollow gypsum board partitions.
   3. Conceal raceways and wiring except in unfinished spaces.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. Splices, Taps, and Terminations: For power and control wiring, use numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Install power supply wiring in addition to, or different from electrical power supply wiring specifically shown on the electrical drawings. Include disconnects, and required electrical devices. Power supply wiring for controls will extend from separate circuits on emergency power panels located as indicated on the electrical drawings.

F. Install control wiring between field-installed sensing and control devices controlled equipment and unit control panels. Include disconnects, and required electrical devices.

G. Install interlock wiring between electrically-operated equipment units, and between equipment and field installed control devices in addition to, or different from, interlock wiring specifically shown on the electrical drawings.

H. Where required install all wiring raceway systems complying with the requirements of the National Electrical Code. All required conduit shall be installed in EMT.

I. Provide electrical disconnecting means for servicing, for each control panel, digital controller, transformer, power supply, and other devices that are served by 120VAC or higher voltage.

J. Enclosures shall be fabricated of 14ga. steel with sub-panels for component mounting and have removable, hinged doors. Enclosures shall be sized to house the controllers, power supplies, transformers, wire duct and miscellaneous equipment required to support the application. Enclosures shall be provided for all controllers that are not located within an OEM provided mechanical equipment or on a VAV box. Control panels shall be fabricated as UL-508A listed assemblies.

K. Input/Output Control Wiring
   1. Platinum 1k ohms and 10k ohms thermistor type II wiring shall be, stranded, twisted pair, shielded, minimum number 18 wire gauge.
   2. Other analog inputs shall be a minimum of number 18 wire gauge, stranded, twisted pair.
   3. Digital inputs shall be a minimum of number 18 wire gauge, stranded, twisted pair.
   4. Analog outputs shall be a minimum of number 18 wire gauge, stranded, twisted pair.
   5. Digital outputs shall be a minimum of number 18 wire gauge, stranded, twisted pair.

L. All input and output wiring between controllers and field devices shall be splice-free.

M. Conduit and Fittings
   1. Conduit for Control Wiring, Control Cable and Transmission Cable: Electrical metallic tubing (EMT) with compression fittings, cold rolled steel, zinc coated or zinc-coated rigid steel with threaded connections.
   2. Outlet Boxes (Dry Location): Sheradized or galvanized drawn steel suited to each application, in general, four inches square or octagon with suitable raised cover.
   3. Outlet Boxes (Exposed to Weather): Threaded hub cast aluminum or iron boxes with gasket device plate.
   4. Pull and Junction Boxes: Size according to number, size, and position of entering raceway as required by National Electrical Codes. Enclosure type shall be suited to location.
   5. Install low voltage power and LON and LAN communication trunks in conduit in the following locations regardless of local building code allowances otherwise.
      a. Mechanical rooms.
      b. Electrical rooms.
      c. Vertical risers (exception: fire rated continuous closet like a telephone closet).
      d. Open Areas where the wiring will be exposed to view or tampering.

6. Conceal conduit within finished shafts, ceilings and wall as required. Install exposed conduit parallel with or at right angles to the building walls.

N. Where Class 2 wires are in concealed and accessible locations including ceiling return air plenums, approved cables not in raceway may be used provided that:
   1. Circuits meet NEC Class 2 (current-limited) requirements. (Low-voltage power circuits shall be sub-fused when required to meet Class 2 current-limit.)
   2. All cables shall be UL listed for application, i.e., cables used in ceiling plenums shall be UL listed specifically for that purpose.

O. Do not install Class 2 wiring in conduit containing Class 1 wiring. Boxes and panels containing high voltage may not be used for low voltage wiring except for the purpose of interfacing the two (e.g., relays and transformers).

P. Where Class 2 wiring is run exposed, wiring to be run parallel along a surface or perpendicular to it, and neatly tied at 3m (10 ft.) intervals.

Q. All wire-to-device connections shall be made at a terminal blocks or terminal strip. All wire-to-wire connections shall be at a terminal block, or with a crimped connector. All wiring within enclosures shall be neatly bundled and anchored to permit access and prevent restriction to devices and terminals.

R. Plug or cap all unused conduit openings and stub-ups. Do not use caulking compound.

S. Route all conduit to clear beams, plates, footings and structure members. Do not route conduit through column footings or grade beams.

T. Set conduits as follows:
   1. Expanding silicone fire stop material sealed watertight where conduit is run between floors and through walls of fireproof shaft.
   2. Oakum and lead, sealed watertight penetration through outside foundation walls.

U. Cap open ends of conduits until conductors are installed.

V. Where conduit is attached to vibrating or rotating equipment, flexible metal conduit with a minimum length of 18 inches and maximum length of 36 inches shall be installed and anchored in such a manner that vibration and equipment noise will not be transmitted to the rigid conduit.

W. Where exposed to the elements or in damp or wet locations, waterproof flexible conduit shall be installed. Installation shall be as specified for flexible metal conduit.

X. Provide floor, wall, and ceiling plates for all conduits passing through walls, floors or ceilings. Use prime coated cast iron, split-ring type plates, except with polished chrome-plated finish in exposed finished spaces.

3.12 FIELD EQUIPMENT ENCLOSURES

A. Securely mount all control panels and enclosures to wall or structure using bolts, anchors, etc. Mount enclosures and control panels with top at 72 inches above finished floor, unless noted otherwise. Locate enclosures and control panels to ensure full door swing.

B. Wiring shall be installed in a neat and organized manner. Bundle cables and route cabling within enclosures using fingerduct or channel raceway. Route cables at 90 degree angles throughout the enclosure.

C. Splicing of cabling using wirenuts is unacceptable. Cable splicing shall take place on screw termination blocks.

D. Maintain the UL listed environmental rating of each control panel by using the correct fittings and hardware for conduit penetrations into enclosures.

E. Locate enclosures indoors where possible.

3.13 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 a cable identifier and other descriptive information.

B. Permanently label or code each point of field terminal strips to show the instrument or item served.

C. Identify control panels with nameplates.

D. Identify all other control components with permanent labels. Identifiers shall match record documents.

E. Identify room sensors relating to terminal box or valves.

3.14 CLEANING

A. This contractor shall clean up all debris resulting from his or her activities daily. The contractor shall remove all cartons, containers, crates, etc. under his control as soon as their contents have been removed. Waste shall be collected and placed in a location designated by the Construction Manager or General Contractor.

B. At the completion of work in any area, the Contractor shall clean all of his/her work, equipment, etc., making it free from 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 metal cabinet or enclosure that has been deformed shall be replaced with new material and repainted to match the adjacent areas.

3.15 PROTECTION

A. The Contractor shall protect all work and material from damage by his/her work or workers, and shall be liable for all damage thus caused.

B. The Contractor shall be responsible for his/her work and equipment until finally inspected, tested, and accepted. The Contractor shall protect his/her work against theft or damage, and shall carefully store material and equipment received on-site 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.

3.16 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. 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 Section.

C. Contractor shall continually monitor the field installation for code compliance and quality of workmanship. All visible piping and/or wiring runs shall be installed parallel to building lines and properly supported.

D. Contractor shall arrange for field inspections by local and/or state authorities having jurisdiction over the work.

E. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
   2. Test and adjust controls and safeties.
   3. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.
   4. Test each point through its full operating range to verify that safety and operating control set points are as required.
   5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.
   6. Test each system for compliance with sequence of operation.
   7. Test software and hardware interlocks.

F. DDC Verification:

1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
4. Check temperature instruments and material and length of sensing elements.
5. Check control valves. Verify that they are in correct direction.
6. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.
7. Verify software including automatic restart, control sequences, scheduling, reset controls, and occupied/unoccupied cycles.
8. Verify operation of operator workstation.
9. Verify local control units including self-diagnostics.

G. De-activate all occupied / unoccupied settings, set-back etc. functions during start-up and testing activities. Re-activate these functions as directed by the Owner's representative during Owner training activities.

H. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.17 ADJUSTING

A. Calibrating and Adjusting:
1. Calibrate instruments.
2. Make three-point calibration test for both linearity and accuracy for each analog instrument.
3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
4. Control System Inputs and Outputs:
    a. Check analog inputs at 0, 50, and 100 percent of span.
    b. Check analog outputs using milliampere meter at 0, 50, and 100 percent output.
    c. Check digital inputs using jumper wire.
    d. Check digital outputs using ohmmeter to test for contact making or breaking.
    e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a precision-resistant source.
5. Flow:
    a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
    b. Manually operate flow switches to verify that they make or break contact.
6. Pressure:
    a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
    b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
7. Temperature:
    a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
    b. Calibrate temperature switches to make or break contacts.
8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
10. Provide diagnostic and test instruments for calibration and adjustment of system.
11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.

B. Adjust initial temperature and humidity set points.

C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to three visits to Project during other than normal occupancy hours for this purpose.

3.18 VALIDATION

A. The contractor shall furnish all labor and test apparatus required to execute a start up testing plan. Key tasks to be executed and documented in the start up testing report include:
   1. Verification of all primary and secondary voltages.
   2. Verification that power wiring for all devices conforms to manufacturer's instructions.
   3. Verification that all labeling is in place.
   4. Inspection of wiring for loose strands and tight connections.
   5. Verification of field bus topology, grounding of shields (if used) and installation of termination devices.
   6. Verification that each I/O device is landed per the submittals and functions per the sequence of control.
      a. Analog sensors shall be properly scaled and a value reported to the OWS.
      b. Binary sensors shall have the specified normal position and the state is reporting properly to the OWS.
      c. Analog outputs have the specified normal position and move full stroke when so commanded.
      d. Binary outputs have the specified normal state and respond to energize/de-energize commands.
   7. Analog sensors calibrated with high quality instrumentation suitable for the sensor being calibrated.
      a. The instruments shall display a current (12 month) NIST traceable calibration sticker. Associated instrument calibration certificates shall be made available within 24 hours of a request.
      b. The measured value, reported value, and the calculated offset that was entered into the database shall be recorded.
      c. The calibration criteria shall be:
         1) Space Temperature: +/- 0.5 degrees F
         2) Air Temperature: +/- 0.5 degrees F
         3) Fluid Temperature: +/- 0.5 degrees F
         4) Air Flow Rate: +/- 5 %
         5) Liquid Flow Rate: +/- 5 %
         6) Differential Pressure: +/- 3 %
         7) Gauge Pressure: +/- 5%
         8) Relative Humidity: +/- 3 % relative humidity
         9) CO2: +/- 2 %
   8. Loop Tuning
      a. The contractor shall tune all P, PI and PID control loops.
      b. The loop tuning criteria shall be a stable control loop where the average error over 15 minutes and 30 samples shall be less than:
         1) Space Temperature: +/- 0.75 degrees F
         2) Air Temperature: +/- 1.50 degrees F
         3) Air Humidity: +/- 5 % relative humidity
         4) Hot Water Temp: +/- 1.00 degrees F
         5) Duct Pressure: +/- 0.2 inches w.g.

B. Validation report: The validation report shall include all testing activities and test reports.

C. Entire automatic control system / building automation system including graphical user interface (GUI) shall be complete and fully functional prior to any inspections, demonstrations or acceptance testing including punch list activities.

3.19 DEMONSTRATION

A. Engage a factory trained representative to demonstrate, to the Owner and engineer, that all system components have been calibrated and adjusted and are functioning properly.

B. General: Acceptance of the control system depends in part upon successful demonstration of control system performance:
   1. Sequence of Operation - Demonstrate all sequences of operation.
   2. Test Documentation - Provide standard formatted documentation for each controlled system and element test.
   3. Pre-Testing - The control system installer shall have performed pre-testing of all tests on all components before final testing. If during final testing more than 10 percent of the points or sequences checked are found to be faulty, the Contractor shall halt the test and re-check all parts of the system test.

C. Testing - Inform the Engineer and Owner of all test dates for attendance, so that the Engineer and/or Owner may attend the test if desired. Perform all tests. Correct all system maladies found in the testing procedure. Retest as required. If Owner's representative does not witness test, provide performance certification.

D. Acceptance- The control systems will not be accepted as meeting the requirements of Completion until all tests described in this specification have been performed to the satisfaction of both the Engineer and Owner. 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 Owner's representative.

3.20 TRAINING

A. Meet all applicable Training requirements:
   1. Instruct the operators how to accomplish control of the system. Include basic troubleshooting and override of equipment and controls in the event of system failure.
   2. Training Allowance: Provide not less than four (4) hours formal training to the Owner's designated operations personnel. The first training session shall be at the time of project completion, and the second shall be within 4-6 months of turnover.
      a. Additional training shall be available for purchase and attendance by the Owner or designee. This additional training shall be of the same curriculum as the training courses provided by the manufacturer to the System Integrator. An advanced Niagara 4 certified instructor shall give all training classes. A list of training courses and the associated cost shall be provided as part of the BAS submittals.
   3. Trainers - Persons conducting the training shall hold an advanced Niagara 4 certification, be knowledgeable in the workings of the system, and shall be regularly engaged in training exercises, so as to provide effective training. Submit names and qualifications of trainers for Owner review prior to scheduling the training.
   4. Training Manuals - Include the following in training manuals.
      a. Manufacturer's training brochures.
      b. Operation and maintenance manuals.
      c. Completed Field Acceptance Test Procedure.
      d. "As-installed" Drawings.
      e. Manufacturer's Operation Manuals.
      f. Software interaction sheets to be used in instructing students how to use the control system, on a command-by-command basis.
   5. Training Classes - Prior to conducting training, prepare and submit for approval the proposed training literature and topics. Submit this information at least two weeks prior to the first class.
   6. Provide approved training manuals to the Owner at least one week prior to the first class.
   7. Provide multimedia Turtorials both in a USB drive format and on the manufactures website instructing on the operation of the programming software tools as provided under this specification.
      a. As part of the training deliverable provide short video clips (each clip shall be a file) of various procedures such as but not limited to the following: Changing a Set point, Making Schedule Adjustments, Modifying Holiday Schedules Adding Special Events, Creating a Backup of the Database Running on the Supervisor, Adding a Schedule to the Database and Linking the Schedule to a Piece of Equipment, Adding a new Schedule to the Graphical User Interface, Using History Chart Builder to Save Your Trends on the Supervisor, Adding a Point to the Existing System, Adjusting the Value of a Point that has been Added to the System,.

b. Video files shall be accessible thru the terminal in such a manner to allow for viewing in order to perform such changes on the BAS.

3.21 SERVICE AND SPARE PARTS

A. After the warranty period, the controls contractor shall provide service on hardware and software components with technical staff located in a local service office.

B. All service items and spare parts shall be available from the manufacturer or Contractor's stock for a minimum of seven (7) years following the expiration of the warranty period.

END OF SECTION

EXHIBIT 1

ABBREVIATIONS

A	
ADJ	ADJUSTABLE
AFF	ABOVE FINISHED FLOOR
AFMS	AIRFLOW MEASURING STATION
AHU	AIR HANDLING UNIT
ALT	ALTERNATE
AP	ACCESS PANEL(S)
APD	AIR PRESSURE DROP
ARCH	ARCHITECT(URAL)
B	
BAS	BUILDING AUTOMATION SYSTEM
BHP	BRAKE HORSE POWER
BLDG	BUILDING
BTUH	BRITISH THERMAL UNIT PER HOUR
BWV	BACK WATER VALVE
C	
CD	CONDENSATE
CFH	CUBIC FOOT PER HOUR
CFM	CUBIC FOOT PER MINUTE
CIP	CAST IRON PIPE
CLG	CEILING
CO	CARBON MONOXIDE
CO2	CARBON DIOXIDE
COMB	COMBINATION
CONC	CONCRETE
COND	CONDENS(ATE) (ER)
CONN	CONNECTION
CONT	CONTINU(E) (OUS) (ATION)
CONTR	CONTRACT(OR)
CORR	CORRIDOR
D	
DB	DRY BULB
DDC	DIRECT DIGITAL CONTROL (PANEL)
DEG	DEGREE(S)
DET	DETAIL
DI	DEIONIZED WATER
DIFF	DIFFUSER
DMPR	DAMPER
DN	DOWN
DP	DIFFERENTIAL PRESSURE
DWG(S)	DRAWING(S)
E	
EA	EACH
EA	EXHAUST AIR
EAT	ENTERING AIR TEMPERATURE
ECM	ELECTRONICALLY COMMUTATED MOTOR
EFT	ENTERING FLUID TEMPERATURE
ELEC	ELECTRIC(AL)
EMER	EMERGENCY
ESP	EXTERNAL STATIC PRESSURE
EWT	ENTERING WATER TEMPERATURE
EXG	EXISTING
EXH	EXHAUST
EXT	EXTERIOR
F	
F	FAHRENHEIT
FA	FROM ABOVE
FB	FROM BELOW
FDC	FIRE DEPT CONNECTION
FFE	FINISHED FLOOR ELEVATION
FLR	FLOOR
FLEX	FLEXIBLE
FPB	FAN POWERED VAV BOX
FPM	FEET PER MINUTE
F&T	FLOAT AND THERMOSTATIC (TRAP)
FT	FOOT, FEET
FTG	FOOTING
FTR	FINNED TUBE RADIATION
G	
GA	GAUGE
GAL	GALLON
GALV	GALVANIZED
GEN	GENERATOR
GPH	GALLON(S) PER HOUR
GPM	GALLON(S) PER MINUTE
H	
HB	HOSE BIB
HP	HIGH PRESSURE
HP	HORSEPOWER
HTG	HEATING
HTR	HEATER
HVAC	HEATING, VENTILATION AND AIR CONDITIONING
I	
ID	INSIDE DIAMETER/DIMENSION
IN	INCH(ES)
INSUL	INSULATION
INV	INVERT
ISOL	ISOLATOR
L	
LAT	LEAVING AIR TEMPERATURE
LBS/HR	POUNDS PER HOUR
LF	LINEAL FOOT, FEET
LFT	LEAVING FLUID TEMPERATURE
LVR	LOUVER
LWT	LEAVING WATER TEMPERATURE
M	
MAX	MAXIMUM
MBH	1,000 BTUH
MECH	MECHANICAL(LY)
MEZZ	MEZZANINE
MFR	MANUFACTURER
MIN	MINIMUM
MIN	MINUTE
MISC	MISCELLANEOUS
N	
NC	NOISE CRITERIA
NIC	NOT IN CONTRACT
NO	NUMBER
NTS	NOT TO SCALE
O	
OA	OUTSIDE AIR
OD	OUTSIDE DIAMETER/DIMENSION
P	
PD	PRESSURE DROP
PLBG	PLUMBING
PPM	PARTS PER MILLION
PRES	PRESSURE
PSI	POUNDS PER SQUARE INCH
PVC	POLYVINYL CHLORIDE
R	
R	RADIUS
RA	RETURN AIR
REG	REGISTER
REQD	REQUIRED
RH	RELATIVE HUMIDITY
RM	ROOM
RO	REVERSE OSMOSIS
RPM	REVOLUTIONS PER MINUTE
RPZ	REDUCED PRESSURE BACKFLOW PREVENTER
RTU	ROOFTOP UNIT
S	
SA	SUPPLY AIR
SF	SQUARE FEET
SHT	SHEET
SP	STATIC PRESSURE
SPEC(S)	SPECIFICATION(S)
SQ	SQUARE
SS	STAINLESS STEEL
STRUC	STRUCTUR(E) (AL)
T	
T	THERMOSTAT
TA	TO ABOVE
TB	TO BELOW
TCP	TEMPERATURE CONTROL PANEL
TEMP	TEMPERATURE
TMV	THERMOSTATIC MIXING VALVE
TSP	TOTAL STATIC PRESSURE
TYP	TYPICAL
U	
UNO	UNLESS OTHERWISE NOTED
V	
VAV	VARIABLE AIR VOLUME
VENT	VENTILATION OR VENTILATOR
VERT	VERTICAL
VOL	VOLUME
VSD /VFD	VARIABLE SPEED DRIVE (MOTOR CONTROLLER)
VTR	VENT THROUGH ROOF
W	
W	WASTE
W/	WITH
W/O	WITHOUT
WB	WET BULB
WC	WATER COLUMN
WG	WATER GAUGE
WH	WALL HYDRANT
WS	WASTE STACK
WTR	WATER

NOTE:
REFER TO PIPING SYSTEM DESIGNATIONS, CONTROL DRAWINGS, AND EQUIPMENT SCHEDULES FOR ADDITIONAL ABBREVIATIONS.

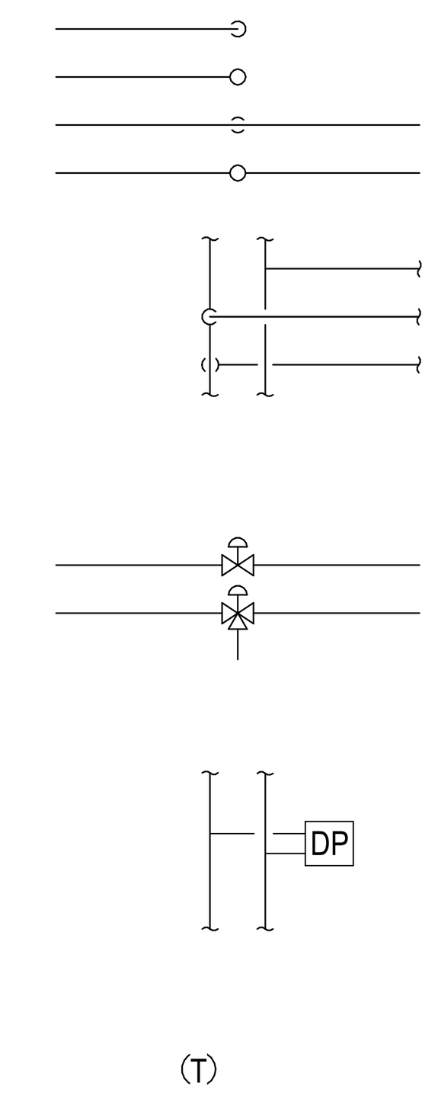
MECHANICAL GENERAL NOTES

A. IN ALL AREAS WITH EXPOSED CEILINGS, SPECIAL CARE MUST BE TAKEN IN THE INSTALLATION OF PIPING AND ANY OTHER MECHANICAL / PLUMBING EQUIPMENT. LAYOUTS MUST BE ARRANGED TO COMPLIMENT THE AESTHETICS OF THE SPACE. REFER ALSO TO ARCHITECTURAL DRAWINGS, SPECIFICATIONS, AND COORDINATION REQUIREMENTS FOR FURTHER INFORMATION FOR AESTHETIC INTENTS AND PAINTING REQUIREMENTS IN EXPOSED AREAS.
B. CAREFULLY COORDINATE ALL PIPING, DUCTWORK, FIRE PROTECTION, EQUIPMENT, CONTROLS, SUPPORTS, ELECTRICAL, CABLE TRAY, AV DEVICES, ETC. TO SUPPORT ACCESS, SERVICE, INSTALLATION AND MAINTENANCE OF EQUIPMENT, DEVICES, VALVES, DAMPERS, CONTROLS, ETC. REFER ALSO TO COORDINATION REQUIREMENTS IN DRAWINGS AND SPECIFICATIONS.
C. DUCTWORK, HYDRONIC PIPING SHALL BE INSULATED TO AT LEAST MINIMUM INSULATION LEVELS REQUIRED IN THE MOST CURRENT STATE ENERGY CODE AT THE TIME OF THE BIDDING.
D. MOTORIZED DAMPERS ARE REQUIRED AT ALL DUCTWORK PENETRATIONS TO EXTERIOR AND TO INTAKE / RELIEF PLENUMS. DAMPERS SHALL BE INTERLOCKED WITH ASSOCIATED SYSTEM OPERATION. INSULATE DUCTWORK FROM EXTERIOR, THROUGH THE EXTERIOR PENETRATION TO DAMPER WITH A MINIMUM OF 2" INSULATION.
E. COORDINATE MOUNTING OF ANY WALL DEVICES WITH EXISTING CONDITIONS.
F. WHERE CONNECTING TO EXISTING SYSTEMS OR RECONFIGURING EXISTING SYSTEMS, MEASURE AND DOCUMENT IMPACTED SYSTEMS PRIOR TO START OF WORK. AT COMPLETION OF WORK, BALANCE/ADJUST SYSTEM SO THAT IMPACTED SYSTEM MEETS PERFORMANCE CONDITIONS MEASURED PRIOR TO START OF WORK.

MECHANICAL DEMOLITION NOTES

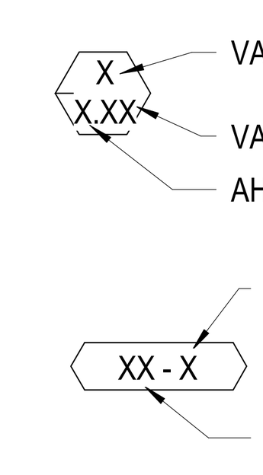
1. THE INFORMATION SHOWN PERTAINING TO EXISTING CONDITIONS SUCH AS LOCATIONS OF EQUIPMENT, THERMOSTATS, VALVES, DAMPERS, ETC, AND OTHER BUILDING CONDITIONS HAS BEEN BASED ON "AS-BUILT" RECORDS AND FIELD VERIFICATION WITH LIMITED ACCESS. LAYOUT AND DISTRIBUTION OF DUCTWORK AND PIPING SHOWN MAY BE DIFFERENT THAN WHAT IS ACTUALLY INSTALLED.
2. VERIFY EXISTING CONDITIONS AND DIMENSIONS. COORDINATE THE EXTENT OF DEMOLITION WORK AND EXISTING WORK TO REMAIN WITH PROJECT SITE PRIOR TO PRICING, FABRICATION, AND INSTALLATION. NOTIFY ENGINEER OF ANY CONFLICTS IMMEDIATELY.
3. REPAIR / PATCH OPENINGS IN WALLS, PARTITIONS, FLOORS, AND CEILINGS THAT ARE EXISTING OR WHERE DEMOLITION OCCURS TO MATCH EXISTING ADJACENT FINISH SURFACE. MAINTAIN CODE AND FIRE RATING REQUIREMENTS.
4. AVOID DISRUPTION TO ADJACENT FLOORS / AREAS AS MUCH AS POSSIBLE. KEEP NOISE TO A LEVEL ACCEPTABLE TO THE OWNER BY SCHEDULING EXCESSIVE NOISE TASKS WITH OWNER. ALL SAW-CUTTING AND NOISE / VIBRATION PRODUCING CONSTRUCTION TO BE SCHEDULED WITH OWNER AS NOT TO INTERFERE WITH BUILDING OPERATIONS. THIS MAY REQUIRE AFTER HOURS WORK.
5. ALL SHUTDOWNS OF MECHANICAL, SPRINKLER, FIRE ALARM, AND / OR ELECTRICAL SYSTEMS SHALL BE COORDINATED WITH OWNER AND MAY OCCUR DURING NON-BUSINESS HOURS.
6. CAP, SEAL, AND INSULATE PIPING AND DUCTWORK IMPACTED BY SCOPE OF WORK.
7. WHERE CONNECTING TO EXISTING SYSTEMS OR RECONFIGURING EXISTING SYSTEMS, MEASURE AND DOCUMENT PERFORMANCE OF SYSTEMS PRIOR TO WORK.

MECHANICAL PIPING SYMBOLS



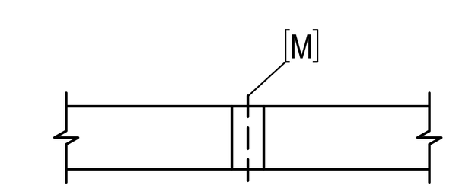
ELBOW DOWN
ELBOW UP
TEE DOWN
TEE UP
CONNECTION
CONNECTION (TOP)
CONNECTION (BOTTOM)
2-WAY MODULATING CONTROL VALVE
3-WAY MODULATING CONTROL VALVE
DIFFERENTIAL STATIC PRESSURE SENSOR
THERMOSTAT OR TEMP SENSOR

GENERAL SHEET ANNOTATIONS



AIR TERMINAL UNIT
EQUIPMENT

DAMPER SYMBOLS



MOTORIZED DAMPER

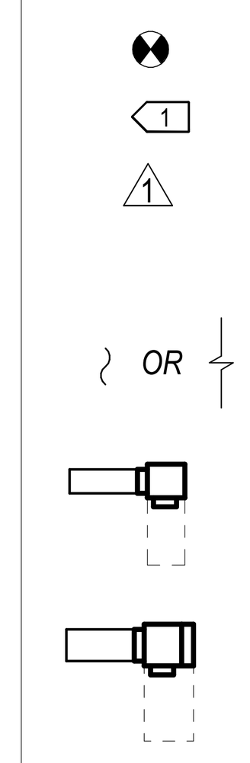
NOTE:
CONTRACTOR SHALL COORDINATE LOCATION OF ACTUATOR AND ACCESS WITH PROJECT AND CODE REQUIREMENTS BASED ON DESIGN DOCUMENTS AND FIELD CONDITIONS.

THERMAL DESIGN CONDITIONS

OUTDOOR DESIGN CONDITIONS
- WINTER OUTDOOR: -15° F
- SUMMER OUTDOOR: 90.4°F DB / 74.7°F WB

INDOOR DESIGN CONDITIONS
- ALL SPACES:
  SUMMER: 75° F, 50% RH
  WINTER: 72° F

GENERAL MECHANICAL & PLUMBING SYMBOLS



CONNECT TO EXISTING
KEY NOTE
REVISION TRIANGLE
BREAK SYMBOL
VARIABLE AIR VOLUME TERMINAL UNIT SHOWN WITH REQUIRED 3 DIAMETERS OF INLET DUCT AND ACCESS/SERVICE CLEARANCE
VARIABLE AIR VOLUME TERMINAL UNIT WITH HEATING COIL SHOWN WITH REQUIRED 3 DIAMETERS OF INLET DUCT AND ACCESS/SERVICE CLEARANCE

MECHANICAL SHEET LIST

SHEET NUMBER	SHEET NAME
M001	MECHANICAL GENERAL NOTES AND SYMBOLS
M200	LOWER LEVEL PLAN
M201	FIRST LEVEL PLAN
M800	MECHANICAL SPECIFICATIONS
M801	MECHANICAL SPECIFICATIONS

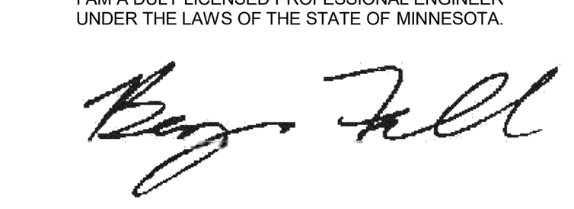
EXHIBIT 2

HGA
420 North 5th Street, Suite 100
Minneapolis, Minnesota 55401
Telephone 612.758.4000

City of Plymouth

PLYMOUTH CITY HALL BAS SYSTEM UPGRADE
3400 PLYMOUTH BLVD.
PLYMOUTH, MN 55447

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.



NAME: BENJAMIN R. FULLER
DATE: 10/20/20
REGISTRATION NUMBER:47953

NO	DESCRIPTION	DATE

ISSUANCE HISTORY - THIS SHEET

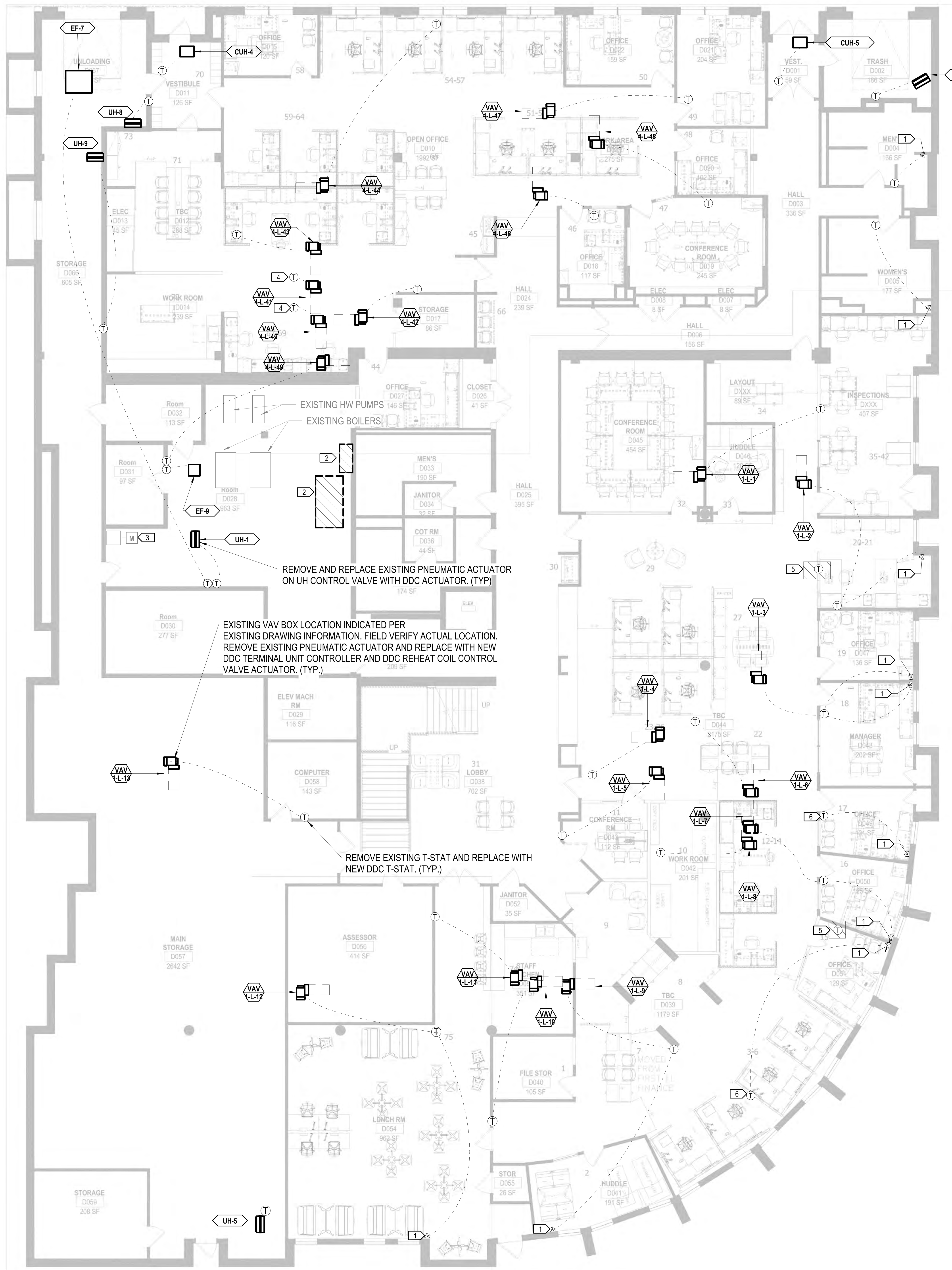
HGA NO: 3948-004-00

MECHANICAL GENERAL NOTES AND SYMBOLS

DATE: OCTOBER 20, 2020
ISSUED FOR BID

M001

EXHIBIT 3



1 LOWER LEVEL PLAN
1/8" = 1'-0"

KEYNOTES:

1. EXISTING FINNED TUBE RADIATION CONTROL VALVE WITH NEW DDC ACTUATOR.
2. DEMO EXISTING PNEUMATIC AIR COMPRESSOR, PNEUMATIC CONTROL PANEL, ASSOCIATED AIR TUBING, WIRING, ETC. INSTALL NEW BAS PANELS AT THIS LOCATION.
3. EXISTING BOILER ROOM COMBUSTION AIR INTAKE DAMPER.
4. FIELD VERIFY EXISTING T-STAT LOCATION.
5. HATCH PATTERN INDICATE EXISTING PNEUMATIC T-STAT DEMOLITION, NOT BEING REPLACED.
6. FTR T-STAT CONTROL SHALL BE LOCKED OUT WHEN THE ZONES ASSOCIATED VAV BOX IS IN COOLING MODE.

HGA
420 North 5th Street, Suite 100
Minneapolis, Minnesota 55401
Telephone 612.758.4000

City of Plymouth

PLYMOUTH CITY HALL BAS SYSTEM UPGRADE

3400 PLYMOUTH BLVD.
PLYMOUTH, MN 55447

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NAME: BENJAMIN R. FULLER
DATE: 10/20/20
REGISTRATION NUMBER:47953

NO	DESCRIPTION	DATE

ISSUANCE HISTORY - THIS SHEET

HGA NO: 3948-004-00

LOWER LEVEL PLAN

DATE: OCTOBER 20, 2020
ISSUED FOR BID

M200

Author 10/19/2020 8:17:30 AM C:\Users\mebert\Documents\Revit Local Files\MP20-PLYMOUTH_BAS_mebert.rvt

EXHIBIT 4

KEYNOTES:

1. EXISTING FINNED TUBE RADIATION CONTROL VALVE. REMOVE EXISTING PNEUMATIC ACTUATOR AND REPLACE WITH NEW DDC ACTUATOR.
2. EXISTING FLOOR PLAN DOES NOT SHOW MEDICINE LAKE CONF ROOM/LOBBY AREA SERVED BY RTU-5. FIELD VERIFY BOX AND T-STAT LOCATIONS ASSOCIATED WITH RTU-5, DUAL DUCT BOXES,AND FINNED TUBE RADIATION.
3. HATCH PATTERN INDICATE EXISTING PNEUMATIC T-STAT DEMOLITION, NOT BEING REPLACED.
4. FTR T-STAT CONTROL SHALL BE LOCKED OUT WHEN THE ZONES ASSOCIATED VAV BOX IS IN COOLING MODE.

1 FIRST LEVEL PLAN
1/8" = 1'-0"

HGA
420 North 5th Street, Suite 100
Minneapolis, Minnesota 55401
Telephone 612.758.4000

City of Plymouth

PLYMOUTH CITY HALL BAS SYSTEM UPGRADE

3400 PLYMOUTH BLVD.
PLYMOUTH, MN 55447

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NAME: BENJAMIN R. FULLER
DATE: 10/20/20
REGISTRATION NUMBER:47953

NO	DESCRIPTION	DATE

ISSUANCE HISTORY - THIS SHEET

HGA NO: 3948-004-00

FIRST LEVEL PLAN

DATE: OCTOBER 20, 2020

ISSUED FOR BID

M201

Author 10/19/2020 8:17:32 AM C:\Users\mebert\Documents\Revit Local Files\M\P20-PLYMOUTH_BAS_mebert.rvt

MECHANICAL SPECIFICATIONS / SCOPE DOCUMENT

BASIC REQUIREMENTS

1. Coordinate all work including phasing, demolition, tie-ins, shutdowns, staging areas, work areas, cable routing paths, support locations etc. with City of Plymouth.
2. All work shall be in accordance with facility requirements, manufacturers written instructions and applicable codes.
3. Install all equipment in accordance with manufacturers written instructions.
4. Project closeout: Include clean up, start-up, testing, adjusting and balancing, training & instructions for City of Plymouth.
5. Demolition shall include demolition of all related supports, controls and accessories.
6. Hangers and Supports: Comply with requirements of state and local building codes and special requirements included in the documents. Unless otherwise noted match existing installations.
7. Coordinate and install control devices in piping and ducts.
8. Provide fire stopping at all penetrations of rated elements including floors with UL listed system suitable for the application.
9. Provide power and control wiring for all equipment including controls, pumps, fans, etc. not indicated on drawings in accordance with applicable codes.
10. Unless otherwise indicated or noted all piping, insulation, valves, accessories etc. shall match existing.
11. Cutting and Patching: Perform as required, patching shall restore to previous condition using matching materials. Seal penetrations with owner approved sealant. Fire stopping at floor penetrations to be owner approved water tight fire barrier sealant.

CONTROLS

1. Summary:
    a. Plymouth City Hall currently uses a combination of a pneumatic control system and a Tridium Niagara BAS system for the control and actuation of various HVAC system components. The pneumatic system serves the terminal unit boxes, reheat coil and finned tube radiation control valves, dampers, thermostats. The following components are controlled via the existing Tridium Niagara BAS system housed in the adjacent Public Safety building:
        i. Boiler 1 and 2
        ii. EF-6
        iii. FCU-1
        iv. RTU-2
        v. Council RTU

        vi. Heaters: UH-1, UH-2, UH-3, CUH-1, CUH-2
    b. New Scope:
        i. Provide new DDC terminal unit controllers, valve and damper actuators, and DDC thermostats served by a new Niagara BAS control system.
        ii. Demolish existing pneumatic controls including devices, air tubing, air compressors, sensors, supports, etc.
        iii. Transfer all City Hall equipment control points and functionality from the existing Niagara BAS system to the new platform.
2. Refer to specification section 230900 for BAS control system requirements and components.
3. Adjust controls, sensor and alarm response rates and VSD acceleration & deceleration rates to provide smooth continuous operation and avoid nuisance alarms.
4. Time Schedule:
    a. Confirm HVAC equipment schedule for occupied and unoccupied status with owner.
    b. The daily scheduler will allow the system operator to switch between occupied and unoccupied status a minimum of five times per day. Holidays and weekends will be scheduled separately.
    c. The initial schedule will incorporate HVAC and designated plumbing equipment. Coordinate the initial scheduled occupied/unoccupied hours with the owner and incorporate the schedules before substantial completion.
5. Control Descriptions / Sequences: Incorporate the following including removal, demolition, wiring, devices including controllers, sensors, actuators, terminations, programming, conformation of set-points, etc. All setpoints shall be adjustable.
    a. RTU-1: Multi-zone Variable Air Volume Unit
        i. Unit operated using existing packaged controller.
        ii. Provide supply air duct pressure reset control.
            1. Utilize the existing duct static pressure sensor / transmitter provide a signal to maintain the supply air duct static pressure at the setpoint by signaling the variable speed drives through the local control panel to vary the supply fan rotational speed.
            2. A single duct static pressure sensor /transmitter shall be provided if one does not already exist. Duct static pressure sensor/transmitter shall be located near the end of the supply air ductwork but before any fire/smoke dampers. The control signal from the duct static pressure sensor /transmitter shall be hardwired into the rooftop unit control panel.
            3. The setpoint of the sensor / transmitter shall be equal to the minimum static pressure necessary to operate the most remote air terminal unit. Initial setpoint shall be 0.5 inches w.g. positive

            pressure. Actual setpoint shall be field determined with the most hydraulically remote air terminal unit.
            4. The supply fan shall be soft-started through the variable speed drive. Normal position shall be zero RPM. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive.
            5. The supply air static pressure setpoint shall be reset to satisfy the space with the greatest demand based on polling all VAV terminal units damper position. Adjust static pressure setpoint until one VAV terminal unit is 90% open.
        iii. Connect to existing BacNet interface card to provide link between unit controls and DDC temperature-control system.
    b. RTU-2: Multi-zone Variable Air Volume Unit
        i. Unit operated using existing packaged controller.
        ii. Provide supply air duct pressure reset control.
            1. Utilize the existing duct static pressure sensor / transmitter provide a signal to maintain the supply air duct static pressure at the setpoint by signaling the variable speed drives through the local control panel to vary the supply fan rotational speed.
            2. A single duct static pressure sensor /transmitter shall be provided if one does not already exist. Duct static pressure sensor/transmitter shall be located near the end of the supply air ductwork but before any fire/smoke dampers. The control signal from the duct static pressure sensor /transmitter shall be hardwired into the rooftop unit control panel.
            3. The setpoint of the sensor / transmitter shall be equal to the minimum static pressure necessary to operate the most remote air terminal unit. Initial setpoint shall be 0.5 inches w.g. positive pressure. Actual setpoint shall be field determined with the most hydraulically remote air terminal unit.
            4. The supply fan shall be soft-started through the variable speed drive. Normal position shall be zero RPM. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive.
            5. The supply air static pressure setpoint shall be reset to satisfy the space with the greatest demand based on polling all VAV terminal units damper position. Adjust static pressure setpoint until one VAV terminal unit is 90% open.
        iii. Provide a BacNet interface card to provide link between unit controls and DDC temperature-control system.
    c. RTU-3: (Formerly Council RTU) – Single Zone Constant Volume Unit
        i. Unit operated using existing packaged controller. Map over points from existing BAS system to the new BAS interface, including:

            1. Return Air Temperature
            2. Cooling Mode/Compressor Operation
                a. Stage.
            3. Supply fan status
            4. Heating Mode
            5. Discharge Air Temperature
            6. Space Temperature Setpoint
            7. Cooling Setpoint
            8. Heating Setpoint

        ii. Connect to existing BacNet interface card to provide link between unit controls and DDC temperature-control system.
    d. RTU-4: Multi-zone Variable Air Volume Unit
        i. Unit operated using existing packaged controller.
        ii. Provide supply air duct pressure reset control.
            1. Utilize the existing duct static pressure sensor / transmitter provide a signal to maintain the supply air duct static pressure at the setpoint by signaling the variable speed drives through the local control panel to vary the supply fan rotational speed.
            2. A single duct static pressure sensor /transmitter shall be provided if one does not already exist. Duct static pressure sensor/transmitter shall be located near the end of the supply air ductwork but before any fire/smoke dampers. The control signal from the duct static pressure sensor /transmitter shall be hardwired into the rooftop unit control panel.
            3. The setpoint of the sensor / transmitter shall be equal to the minimum static pressure necessary to operate the most remote air terminal unit. Initial setpoint shall be 0.5 inches w.g. positive pressure. Actual setpoint shall be field determined with the most hydraulically remote air terminal unit.
            4. The supply fan shall be soft-started through the variable speed drive. Normal position shall be zero RPM. Fan acceleration and deceleration rates shall be adjustable at the variable speed drive.
            5. The supply air static pressure setpoint shall be reset to satisfy the space with the greatest demand based on polling all VAV terminal units damper position. Adjust static pressure setpoint until one VAV terminal unit is 90% open.
        iii. Provide a BacNet interface card to provide link between unit controls and DDC temperature-control system.
    e. RTU-5: (Formerly RTU-2) – Multi zone Dual Duct Unit.

        i. RTU-5 is hot deck/cold deck unit serving three zones. Unit operated using existing packaged controller. Map over points and functionality on existing BAS system to the new BAS interface, including:
            1. Economizer OA Enable Setpoint (adjustable)
            2. Economizer Status
            3. Economizer damper position
            4. Economizer damper position setpoint (adjustable).
            5. Mixed Air Plenum Temperature
            6. Mixed Air Plenum Low Limit
            7. Supply Fan Start/Stop
            8. Supply Fan Status
            9. Supply Fan Speed
            10. Supply Fan Alarm
            11. Supply Air Flow rate and Velocity
            12. Return Fan Start/Stop
            13. Return Fan Status
            14. Return Fan Speed
            15. Return Fan Alarm
            16. Return Air Flow rate and Velocity
            17. Return Air relative humidity
            18. Return Air Temperature
            19. Filter DP measurement.
            20. Duct Static Pressure Hi Limit.
            21. Cooling Enable
            22. Cooling Stage Status
            23. Cold Deck Discharge Air Temperature Setpoint (adjustable)
            24. Cold Deck Discharge Air Temperature
            25. Heating Enable
            26. Heating Valve position
            27. Hot Deck Discharge Air Temperature Setpoint (adjustable)
            28. Hot Deck Discharge Air Temperature
            29. Unoccupied Hot Deck Air Temperature Setpoint. (adjustable)
            30. Duct Static Pressure
            31. Duct Static Pressure Setpoint.
            32. Outdoor Air Temperature
            33. Zone Heating/Cooling Demand status
            34. Zone 1 CO2 Reading
            35. Zone 3 CO2 Reading
            36. CO2 Minimum setpoint, 600 ppm (Adjustable)
            37. CO2 Maximum setpoint, 1000 ppm (Adjustable)
            38. Minimum OA Damper position setpoint. (adjustable)
            39. Maximum OA Damper position setpoint. (adjustable)
        ii. Connect to BacNet interface card to provide link between unit controls and DDC temperature-control system.

    f. Typical RTU Control Points Display: As a minimum include the following on operator BAS display for each unit. Include other available data from the unit controller:
        i. DDC system graphic.
        ii. DDC system on-off indication.
        iii. DDC system occupied/unoccupied mode.
        iv. Outdoor-air-temperature indication.
        v. Supply-fan on-off indication.
        vi. Supply-fan-discharge static-pressure indication.
        vii. Supply-fan-discharge static-pressure set point.
        viii. Supply-fan airflow rate.
        ix. Supply-fan speed.
        x. OA CFM (if available)
        xi. Building static-pressure.
        xii. Duct static pressure
        xiii. Duct static pressure setpoint
        xiv. Cooling mode / compressor operation
            1. Stage
            2. Lead-lag
        xv. Mixed-air-temperature indication.
        xvi. Mixed-air-temperature set point.
        xvii. OA, return air damper positions.
        xviii. Unit-discharge air-temperature indication.
        xix. Unit-discharge air-temperature set point.
        i. Alarms:
            1. Basic alarms available from unit controller.
            2. Unit failure.
            3. Compressor failure.
            4. Supply fan failure.
            5. DAT High (95 Deg. F) and low (45 Deg. F.) temperature limits.
            6. SA smoke detector
            7. RA smoke detector
        ii. Trends: Set up trends for the following points:
            1. Discharge air temperature

    g. RTU-5 Dual Duct Zones:
        i. Space Thermostat: Replace existing space thermostat with new DDC device.
        ii. Zone 1 and Zone 3 Meeting rooms:
            1. The individual zone temperatures are averaged to control the Zone 1 and Zone 3 Dual duct boxes.
        iii. Zone 2 Lobby:
            1. Electronic space temperature sensor and DDC system will modulate cold deck and hot deck damper and fin tube radiation control valve to maintain space temperature set point. On a drop

EXHIBIT 5

HGA
420 North 5th Street, Suite 100
Minneapolis, Minnesota 55401
Telephone 612.758.4000

City of Plymouth

PLYMOUTH CITY HALL BAS SYSTEM UPGRADE

3400 PLYMOUTH BLVD.
PLYMOUTH, MN 55447

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

NAME: BENJAMIN R. FULLER
DATE: 10/20/20
REGISTRATION NUMBER:47963

NO	DESCRIPTION	DATE

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MECHANICAL SPECIFICATIONS

DATE: OCTOBER 20, 2020

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in the zone temperature below the heating setpoint, The area finned tube radiation valve shall open.

iv. OA Damper Control: Modulate RTU-5 OA damper position between the minimum and maximum damper position in a linear relationship with the minimum and maximum Zone CO2 readings.

v. Display:

1. Zone 1 Space Temperature
2. Zone 1 and Zone 3 Average Temperature
3. Zone Temperature setpoint
4. Zone 1 CO2 Reading
5. Zone 3 Space Temperature
6. Zone 3 CO2 Reading
7. Zone 2 Space Temperature
8. Hot Deck Damper Position
9. Cold Deck Damper Position
10. Duct Airflow and Velocity
11. Zone Discharge Air temperature.
12. CO2 Minimum setpoint, 600 ppm (Adjustable)
13. CO2 Maximum setpoint, 1000 ppm (Adjustable)
14. Minimum OA Damper position setpoint.
15. Maximum OA Damper position setpoint

h. VAV Terminal Units:

i. Space Thermostat: Replace existing space thermostat with new DDC device.

ii. Room Temperature: An electronic sensor will indicate space temperature, the control system will modulate the terminal unit damper between maximum and minimum air flow to maintain the cooling set point temperature.

iii. **Add Alternate #1:** Provide duct temperature sensor downstream of each terminal unit to monitor discharge air temperature via BAS.

iv. Initial space temperature setpoints:

1. Occupied Temperature (cooling): 75 degrees F.
2. Occupied Temperature (heating): 72 degrees F.

v. Display:

1. Room/area served.
2. Room occupied/unoccupied.
3. Room temperature indication.
4. Room temperature set point, heating.
5. Room temperature set point, cooling.
6. Room temperature set point, occupied.
7. Room temperature set point, unoccupied heating
8. Room temperature set point, unoccupied cooling

9. Air-damper position as percent open.
10. Terminal unit discharge air temperature (DAT) **(Add Alternate #1)**

vi. Trends: Set up trends for the following points:
1. Room temperature.

vii. Terminal Unit Actuator: Replace existing pneumatic actuator with new DDC terminal unit actuator and controller to modulate air volume.

1. Adjust controller to provide the same maximum and minimum airflow volumes as currently being provided to the space. Refer to existing testing, adjusting, and balancing readings provided by owner.

viii. Terminal Unit Reheat Control Valve Actuator: Replace existing re-heat coil pneumatic control valve actuators w/ new compatible modulating electronic actuators compatible with existing control valve to maintain space thermostat set-point.

ix. Terminal Unit with Hydronic Reheat Coil Control:

1. Electronic space temperature sensor and DDC system will modulate damper and valve to maintain space temperature set point. When the zone temperature is between the adjustable occupied heating and cooling setpoints (inside of the bias), the primary air damper will be at the minimum CFM and there will be no mechanical heating. On a rise in zone temperature above the cooling setpoint, the primary air damper will increase the CFM and there will be no mechanical heating. On a drop in the zone temperature below the heating setpoint, the damper will close to the VAV box minimum airflow setpoint and the reheat coil valve will modulate hot water flow to maintain the zone temperature.

x. Terminal Unit with Hydronic Reheat Coil Control and Perimeter Finned Tube Radiation:

1. Electronic space temperature sensor and DDC system will modulate damper, heating coil control valve and fin tube radiation control valve to maintain space temperature set point. When the zone temperature is between the adjustable occupied heating and cooling setpoints (inside of the bias), the primary air damper will be at the minimum CFM and there will be no mechanical heating. On a rise in zone temperature above the cooling setpoint, the primary air damper will increase the CFM and there will be no mechanical heating. On a drop in the zone temperature below the heating setpoint, the damper will go to the listed minimum CFM of the box. The area finned tube radiation valve shall open. If, after a predetermined period of time the zone is not achieving the desired temperature reheat coil valve will modulate hot water flow to maintain the zone temperature.

i. Finned Tube Radiation Control Valve Actuator:

i. Replace existing pneumatic control valve actuators w/ new compatiable modulating electronic actuators to control valve position.

j. Boiler Plant:

i. Map over points from existing Boiler plant BAS interface, including:

1. Boiler OA lockout.
2. Boiler start/stop
3. Boiler fire rate.
4. Boiler failure alarm.
5. HWS setpoint
6. HWS temperature.

ii. BAS to signal firing rate to boiler based on OA temperature. Interface boiler operation with confirmation that Boiler Combustion Air intake duct is open and Boiler flue exhaust fan is operational.

iii. HWS Temperature Reset: A temperature sensor located in the heating water supply piping shall provide a signal to the boiler control panel to maintain a building heating water supply temperature set-point.

1. The heating water supply temperature set-point shall be reset with the outside air temperature according to the following schedule (confirm schedule with boiler control panel operation):

OA Temperature	HWS Temperature
Above 40 °F	140 °F
40 °F to 0 °F	140 °F to 180 °F(linear relationship)
Below 0 °F	180 °F

k. Heating Water Pump: Existing constant volume pumps.

i. Map over points from existing Boiler plant BAS interface, including:

1. Pump start/stop
2. Pump status
3. Pump speed.
4. Pump failure alarm

ii. Provide a new differential pressure sensor with their sensing elements located in the heating water supply and return piping near the most hydraulically remote end of the system. Provide a differential pressure display at the BAS interface. In the future, this differential pressure sensor can be used to control the heating water pump speed, if the boiler pumps are upgraded to a variable flow system.

l. Cabinet/ Horizontal Unit Heaters:

i. Base scope:

1. Upgrade space thermostat and hot water control valve actuator associated with unit heater to a DDC thermostat and valve actuator.

2. Provide hard wired thermostat with local setpoint control to control unit heater function. When space temperature falls below setpoint, open two-position normally open control valve and cycle fan to maintain space temperature setpoint.

ii. **Add Alternate #2**:

1. Provide Aquastat on heating water return pipe to keep blowers off until return water temp reaches setpoint (adjustable) to prevent cold air delivery to space upon start up.
2. Electronic space temperature sensor and the DDC system will cycle fan and two-position normally-open control valve to maintain space temperature set point.
3. Provide occupied and unoccupied temperature setpoints. Schedules to follow the same occupied/unoccupied status of the RTUs.
4. Close heating water control valve when hot water return temperature is below 100F (adjustable).
5. Display:
a. Fan status
b. Space Temperature

m. Miscellaneous Equipment:

i. Boiler Combustion Air Damper: Controlled via existing boiler controller.

1. Display:
a. Damper Position
2. Alarm:
a. Damper Position Failure.

ii. Boiler Flue Exhaust Fan: Controlled via existing boiler controller.

1. Display:
a. Fan status

iii. Existing Server Room is conditioned via a standalone system. Pull temperature and humidity reading from Existing Server Room air conditioning units control panel to display on BAS.

6. Start-Up & Testing: Perform detailed start-up and testing, as coordinated with City of Plymouth, of all systems and equipment in all operational modes including failure alarms, set-point adjustments, BAS interface, BAS alarms and fire alarm interface to the satisfaction of City of Plymouth.

END OF SECTION

EXHIBIT 6

HGA
420 North 5th Street, Suite 100
Minneapolis, Minnesota 55401
Telephone 612.758.4000

City of Plymouth

PLYMOUTH CITY HALL BAS SYSTEM UPGRADE

3400 PLYMOUTH BLVD.
PLYMOUTH, MN 55447

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

NAME: BENJAMIN R. FULLER
DATE: 10/20/20
REGISTRATION NUMBER:47953

NO	DESCRIPTION	DATE

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HGA NO: 3948-004-00

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