

REQUEST FOR PROPOSAL

Sauk County Buildings Services

Improved Operation and Energy Efficiency Testing and Balancing

Tuesday, November 14th, 2017

- I. Point of contact: Ian Crammond
Sauk County Courthouse
510 Broadway
Baraboo, Wisconsin 53913
(608) 355-3200
- II. Proposal Due Date: Proposals must be received and date stamped no later than 2:00 p.m., Central Standard Time, November 29th, 2017. Faxes, email or electronic submissions are not acceptable. Proposals or amendments received by Sauk County after that time will not be considered. Public Opening of Proposals will be conducted at the Sauk County Courthouse – EMBS Meeting Room at 2:15 p.m., Tuesday, December 5th, 2017 at 510 Broadway, Baraboo, Wisconsin 53913.

III. ALL PROPOSALS MUST BE ADDRESSED TO:

**Sauk County Clerk
Sauk County West Square Building
505 Broadway
Baraboo, Wisconsin 53913**

The words **TESTING AND BALANCING** must be marked on the sealed envelope.

PART ONE
INTRODUCTION AND GENERAL INFORMATION

1.0 INTRODUCTION

- 1.1 This document constitutes a request for, sealed Proposals from qualified vendors to complete Testing and Balancing (TAB) of the following Sauk County facilities: Health Care Center located at 1051 Clark St, Reedsburg, Wisconsin, Law Enforcement Center at 1300 Lange Court, Baraboo, WI, and West Square Administration Building located at 505 Broadway, Baraboo, WI for Improved Operation and Energy Efficiency of the facilities .

2.0 ORGANIZATION

- 2.1 This document, referred to as a Request for Proposals (RFP), has been divided into the following parts for the convenience of the contractor:
- | | |
|------------|---|
| Part One | - Introduction and General Information |
| Part Two | - Scope of work |
| Part Three | - General Requirement - Standard Terms & Conditions |
| Part Four | - Evaluation Information |
| Part Five | - Pricing & Information |

3.0 DEFINITIONS

- 3.1 For the purpose of this RFP the Vendor will be referred to as Vendor and Sauk County will be referred to as County.

4.0 BACKGROUND INFORMATION

- 4.1 Sauk County is one of 72 units of county government in the State of Wisconsin and is a municipal corporation existing pursuant to the authority of Chapter 59 of the Wisconsin Statutes. County operations currently include a skilled nursing facility, a human services department, a law enforcement agency, a state circuit court system, a highway department, a tax administration and collection effort, and other government related functions.
- 4.2 Additional Documentation Provided in Conjunction with this RFP
- a. Specification Section 019113 – Commissioning Requirements
 - b. Specification Section 230020 – Basic Mechanical Requirements
 - c. Specification Section 230923 – Temperature Controls

5.0 TENTATIVE SCHEDULE OF EVENTS

EVENT	DATE	TIME
Request for Proposal released	November 14 th , 2017	
Pre-Bid Meeting (Facilities / 510 Broadway, Baraboo, WI Room 128)	November 21 th , 2017	1:00 pm
Questions Due	November 28 th , 2017	10:00 am
Proposals Due	December 5 th , 2017	2:00 p.m.
Proposals opened	December 5 th , 2017	2:15 p.m.
Approve resolution awarding contract	December 7 th , 2017	4:30 p.m.
County Board Approval	December 19 th , 2017	6:00 p.m.

6.0 AMENDMENTS AND QUESTIONS:

- 6.1 Sauk County reserves the right to modify this RFP prior to the Proposal due date.
- 6.2 If Amendments are of such a nature as to require substantive changes in the scope of work or Proposal price, the Proposal due date may be postponed by such a time that will enable vendor to revise their Proposals. In such case, the Amendment will include an announcement of the new Proposal due date.
- 6.3 Interpretations or clarifications in response to questions received prior to the Proposal due date may be issued by Addenda to all parties recorded as having received this RFP, if considered necessary by the County.
- 6.4 Questions received after the Question due date of November 28th, 2017 may not be answered.
- 6.5 Only formal written responses to questions issued by letter or addenda are binding. Oral and other interpretations or clarifications are not binding.

7.0 CONTRACT

- 7.1 Sauk County intends to award one contract for all work described in this Request for Proposal.
- 7.2 Contract type shall be a single fixed-priced (lump sum) contract. Lump sum should include any necessary reimbursables.

8.0 CONTACT INFORMATION

- 8.1 Each vendor obtaining a copy of this Request for Proposal/Bid either in person, via the Sauk County Web Site, or by other means, must submit an email to icrammond@co.sauk.wi.us that contains the Vendor name & contact information. This will assure that any Addenda, questions/answers or other information related to this Request for Proposal/Bid is received by all interested bidders. If this information is not submitted five (5) business days prior to the Due Date of this Proposal/Bid, the County retains the right to reject the bid solely for this reason or accept the bid.

PART TWO

SCOPE OF WORK

1.0 OVERVIEW

Sauk County is considering a series of upgrades to the building management system operation at the Health Care Center (HCC), Law Enforcement Center (LEC) and West Square for the purposes of improved operation and energy efficiency. In order to perform these requirements, the services of a qualified Testing and Balancing (TAB) firm will be required. We are requesting that a letterhead proposal be provided by your firm to provide the necessary scope of services, due at County Clerk's office no later than 2pm Tuesday, December 5th, 2017. Proposal should include individual pricing for each item noted below, and a separate lump sum pricing in the event that the entire scope is accepted.

Sauk County will be providing the services of a 3rd party Commissioning Authority to provide ongoing project technical support and supervise and validate the results of the system updates. This will not be a formal commissioning process. The outcome of each scope item will be verified ("Functionally Tested") assure that the intent of each proposed upgrade is achieved and tuned to best affect. The Commissioning Authority shall provide technical support and assistance during the startup of each task item below, and assist the BMS and TAB contractors in evaluating conflicts in the original project construction documents.

Coordination of schedule and site requirements for TAB activity will be performed by the BMS Contractor (Johnson Controls at the HCC and West Square, Siemens at the LEC), the Commissioning Authority, and Sauk County.

Proposal shall provide a lump sum Base Bid which assumes the entirety of the scope described. Where Alternates are requested, these are to be presented as a fixed sum add or deduct from the Base Bid.

Questions regarding this RFP are to be directed by email to icrammond@co.sauk.wi.us

2.0 SPECIFICS

Health Care Center

The TAB Contractor shall provide necessary Testing and Balancing assistance to the setup and calibration of each of the following items:

Fan Tracking and Outdoor Air Intake Control – Rooftop Units One Through Five

The fan tracking for the five rooftop systems does not meet the requirements for proper operation. Correction of the current conditions will require:

1. Calibration of air flow stations (supply and return fan)
2. Rooftop Unit #5 provides portions of the makeup air for the kitchen hood equipment. The software for this unit requires separate fan tracking and outdoor air intake calculations for

both when the kitchen hood is in operation and when it is disabled. TAB assistance in the setup of these values is required.

The outdoor air control software in place does not maintain consistent ventilation rate over the range of unit operation. TAB assistance in with the following setup procedures is required.

1. Place all air terminals at minimum scheduled air flow. Determine correct outdoor air damper position to provide required outdoor air flow rate. Record damper position and air flow as measured by the supply air flow station.
2. Place all air terminals at maximum scheduled air flow. Determine correct outdoor air damper position to provide required outdoor air flow rate. Record damper position and air flow as measured by the supply air flow station.

Bid Alternate HCC#3 – Variable Volume Kitchen Hood Control

The intent of this alternate is to provide variable volume control of the kitchen hood system at the HCC. The current configuration consists of two, two section hoods, total 8100cfm, with a single constant speed exhaust fan. The existing hoods shall be each retrofitted with both smoke and heat detection systems which will be integrated through the BMS to modulate the hood fan speed between a programmable minimum and design maximum levels to maintain a fixed temperature and / or smoke threshold within the hood.

The existing kitchen hood is 7 ½ hp, and will require provision of a variable speed drive for the purpose of this retrofit. The existing combination starter / disconnect is to be modified through removal of the starter (or replacement with a dedicated disconnect, at the contractor's option).

There is existing wall space within a few feet of the existing starter / disconnect for the new VFD. The VFD shall be ABB ACH550 or approved equal, with 3-contactor bypass arrangement (not electronic bypass).

It is the intent to retrofit the makeup air unit with a VFD to coordinate operation with the hood operation. The existing MUA starter / disconnect is directly adjacent to the kitchen hood starter / disconnect, and is to be similarly retrofitted. Again, wall space exists within a few feet of the existing starter / disconnect location for the new VFD (5hp).

Sequence of operation changes for this portion of the project will also require integration with the RTU5 minimum outdoor air damper position and kitchen VAV air terminals, given that this equipment also serves for kitchen makeup air duty. Final parameters and sequence details will be provided by Sauk County prior to implementation if this alternate is accepted. Sauk County will solicit and provide the services of a testing and balancing agent under separate RFP for the necessary startup and adjustment of this system retrofit.

The testing and balancing scope shall be limited to technical assistance and setup of the following components:

- 1.Measurement and setup of the minimum kitchen hood VFD speed corresponding to the minimum flow rate for the kitchen hoods for use in the sequence of operation.
- 2.Measurement and setup of the minimum makeup air unit speed corresponding to the minimum flow rate for tracking to the kitchen hood operation.
- 3.Measurement of return fan operation vs outdoor air flow rates for RTU5 to coordinate setup of the makeup air component of this system in the variable speed hood algorithm

West Square:**Air Handlers 1-3 – Air Flow Station and Static Pressure Sensor Calibration**

1. The minimum outdoor air flow stations do not read correctly. These are to be cleaned by the BMS contractor and calibrated by this contractor.
2. New primary (main duct) air flow stations are to be provided by the BMS contractor. These shall be calibrated by this contractor for proper operation
3. Building static pressure sensors for AHU1 and AHU2 are to be calibrated by this contractor.
4. Perform supply duct traverse and assist BMS contractor in calibration of the existing supply air flow stations.

Alternate WS #3 – Chilled Water Coil Balancing

There is no record of the chilled water coils being balanced at the west square building. Each AHU contains two slab coils, each with individual balance valves. There are an additional five (four pipe) fan coil units, each with a single balance valve requiring adjustment. These are to be balanced to design requirements under this alternate.

Law Enforcement Center:**Rebalance of Energy Recovery Units (ERU)**

The intent of this portion of the work is to correctly adjust the total exhaust and outdoor air intake rate for the Energy Recovery Units (ERU's). This shall be performed by main traverse, fan curve, or most convenient method that can be derived by the TAB contractor meeting NEBB or AABC procedures. No downline proportioning of inlets (exhaust) is to be provided. Where adjustable pulleys or VFD's are in place, this contractor shall adjust them to within the existing capacity. In the event that new pulleys and belts are required, this contractor shall provide necessary calculations and selections for the revision. The Owner shall arrange for installation of any required belts and pulleys, and this contractor shall validate the outcome in their final report.

All ERU's have dedicated exhaust fans.

All constant volume air handlers use the air handler supply fan to draw through the ERU (i.e. – the ERU has no supply fan). This contractor shall coordinate with the temperature control contractor to determine the correct position of the economizer dampers to provide the design outdoor air intake flow. Typical 11 units.

The variable volume units (D1 and D2) have constant volume outdoor air supply fans in the ERU. Typical 2 units.

Variable Speed Drive Retrofit - Boiler Primary Pumps

Under this item, the temperature controls contractor is to provide variable speed drives on each of two primary pumps. The operating sequence is to be modified such that when one boiler operates, the lead primary pump is fixed to a speed appropriate for a single boiler operation. When the second boiler operates (and the isolation valve is opened), the pump indexes to the speed correct for 2 boiler operation. When a 3rd boiler comes on line (and the isolation valve is opened), the 2nd primary pump is started and the two pumps are modulated in unison to a speed appropriate for 3 boiler module operation.

This contractor shall provide the testing and balancing requirements to determine the appropriate pump speeds to achieve the design flow rates through the equipment necessary to support this sequence of operation.

3.0 SCHEDULE

The work included in this requests for proposal shall be completed no later than May 2018

4.0 PROPOSAL

This Request for Proposal in its entirety shall be returned with signatures as noted along with all other requested information. Failure to do so will be cause to reject the bid.

PART THREE **GENERAL REQUIREMENTS**

STANDARD TERMS AND CONDITIONS (REQUESTS FOR PROPOSAL)

- 1.0 SPECIFICATIONS: The specifications in this request are the minimum acceptable. Sauk County shall be the sole judge or equivalency. Contractors are cautioned to avoid proposing alternates to the specifications which may result in rejection of their proposal.
- 2.0 DEVIATIONS AND EXCEPTIONS: Deviations and exceptions from terms, conditions, or specifications shall be described fully, on the contractor's letterhead, signed, and attached to the request. In the absence of such statement, the proposal shall be accepted as in strict compliance with all terms, conditions, and specifications and the contractors shall be held liable.
- 3.0 ACCEPTANCE-REJECTION: Sauk County reserves the right to accept or reject any or all proposals, to waive any technicality in any proposal submitted, and to accept any part of a proposal as deemed to be in the best interests of Sauk County.
 - 3.1 Proposals MUST be date stamped by the County Clerk, on or before the date and time that the proposal is due. Proposals dated and time stamped in another office will be rejected. Receipt of a proposal by the mail system does not constitute receipt of a proposal by the Administrator.

- 3.2 Proposals shall be submitted on company letterhead and signed by an officer of the company. Mark sealed envelope "**TESTING AND BALANCING**"
- 4.0 TAXES: Sauk County and its agencies are exempt from payment of all federal tax and Wisconsin state and local taxes on its purchases except Wisconsin excise tax on alcoholic beverages which is excepted by State Statutes.
- 5.0 ENTIRE AGREEMENT: These Standard Terms and Conditions shall apply to any contract or order awarded as a result of this request except where special requirements are stated elsewhere in the request; in such cases, the special requirements shall apply. Further, the written contract shall constitute the entire agreement and no other terms and conditions in any document, acceptance, or acknowledgment shall be effective or binding unless expressly agreed to in writing by the contracting authority.
- 6.0 APPLICABLE LAW: The contractor shall at all times comply with and observe all federal and state laws, local laws, ordinances, and regulations which are in effect during the period of this contract and which in any manner affect the work of its conduct. The Sauk County Circuit Court shall be the court of exclusive jurisdiction for any litigation between the parties arising out of the performance of this contract. This contract shall be interpreted in accordance with the laws of the State of Wisconsin. It is understood that requirements of Wis. Stat. § 59.52(29) do not apply to this solicitation as the contract awarded will not involve "public work" as defined by Wisconsin law.
- 7.0 ASSIGNMENT: No right or duty in whole or in part of the contractor under this contract may be assigned or delegated without the prior written consent of Sauk County.
- 8.0 SUBCONTRACTORS: If subcontractors are planned to be used, this should be clearly explained in the proposal. Sauk County reserves the right to reject any subcontractor. However, the prime contractor will be responsible for contract performance whether or not subcontractors are used.
- 9.0 ARBITRATION/APPEALS PROCESS: Notice of intent to protest and protests of any award made must be made in writing and filed with Sauk County Clerk, Sauk County West Square Building, 505 Broadway, Baraboo, Wisconsin 53913, within five (5) calendar days after discussion and recommendation of award. The provisions of Chapter 68 of the Wisconsin Statutes shall apply.
- 9.1 Any dispute arising after award as to performance, quality and/or quantity shall be subject to arbitration as provided under Chapter 788 of the Wisconsin Statutes.
- 9.2 Sauk County reserves the right to have claims, disputes, or other matters in question decided by litigation. If Sauk County waives its right to litigation, then the arbitration provisions shall apply.
- 10.0 NONDISCRIMINATION: In connection with the performance of work under this contract, the contractor agrees not to discriminate against any employee or applicant for employment because of age, race, religion, color, handicap, sex, physical condition, developmental disability as defined in s. 51.01(5), Wis. Stats., sexual orientation or national origin. This provision shall include, but not be limited to, the following: employment, upgrading, demotion or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship.

- 10.1 Failure to comply with the conditions of this clause may result in the contractor becoming declared an "ineligible" contractor, termination of the contract, or withholding of payment.
- 11.0 **SAFETY REQUIREMENTS:** All materials, equipment, and supplies provided to Sauk County must comply fully with all safety requirements as set forth by the Wisconsin Administrative Code, Rules of the Industrial Commission on Safety, and all applicable OSHA Standards.
- 12.0 **HOLD HARMLESS:** Contractor agrees to indemnify, hold harmless, and defend Sauk County, its officers, agents and employees from any and all liability including claims, demands, losses, costs, expenses and damages of every kind arising out of or in connection with services provided pursuant to this contract where such liability is founded upon or grows out of acts or omissions of any agents or employees of the contractor.
- 13.0 **INSURANCE RESPONSIBILITY:** The contractor performing services for Sauk County shall comply with the insurance requirements contained herein.
- 13.1 Provide own insurance, countersigned by an insurer licensed to do business in the State of Wisconsin, covering the period of the agreement/contract indicating that Contractor is insured under professional liability insurance in an amount not less than minimum amounts reasonably necessary and sufficient within the profession.
- 13.2 Provide insurance certificates indicating required coverage, countersigned by an insurer licensed to do business in Wisconsin, covering the period of the agreement/contract. The insurance certificate is required to be presented prior to the issuance of the purchase order or before commencement of the contract.
- 14.0 **CANCELLATION:** Sauk County reserves the right to cancel any contract in whole or in part without penalty due to non-appropriation of funds, or for failure of the contractor to comply with the terms, conditions, and specifications of this contract.
- 15.0 **AUDIT:** During the term of the contract, the contractor shall, upon the request of the Sauk County Controller, make available at reasonable times and places, such information as may be required for the purpose of auditing submitted bills for the service provided under the contract.
- 16.0 **INDEPENDENT CONTRACTOR STATUS:** None of the officers, employees, or agents of the contractor are employees of Sauk County for any purpose, including but not limited to compensation, fringe benefits, or insurance coverage.
- 17.0 **PUBLIC RECORDS ACCESS:** It is the intention of the county to maintain an open and public process in the solicitation, submission, review, and approval of procurement activities.
- 17.1 Proposal/proposal openings are public unless otherwise specified. Records may not be available for public inspection prior to issuance of the notice of intent to award or the award of the contract.
- 17.2 Vendor agrees to assist Sauk County in complying with open records requests.
- 18.0 **PROPRIETARY INFORMATION:** Any restrictions on the use of data contained within a request, must be clearly stated in the proposal itself. Proprietary information submitted in response to a request will be handled in accordance with applicable Sauk County procurement regulations and the Wisconsin public records law. Proprietary restrictions normally are not

accepted. However, when accepted, it is the Contractor's responsibility to defend the determination in the event of an appeal or litigation.

- 18.1 Data contained in a proposal, all documentation provided therein, and innovations developed as a result of the contracted commodities or services cannot be copyrighted or patented. All data, documentation, and innovations become the property of the Sauk County.
- 18.2 Any material submitted by the proposer in response to this request that the proposer considers confidential and proprietary information and which qualifies as a trade secret, as provided in s. 19.36(5), Wis. Stats., or material which can be kept confidential under the Wisconsin public records law, must be identified. Proposal prices cannot be held confidential.
- 19.0 DISCLOSURE: If a public official (s. 19.42, Wis. Stats.), a member of the public official's immediate family, or any organization in which a public official or a member of the official's immediate family owns or controls a ten percent (10%) interest, is a party to this agreement, and if this agreement involves payment of more than three thousand dollars (\$3,000.00) within a twelve (12) month period, this contract is voidable by the county unless appropriate disclosure is made according to s. 19.45(6), Wis. Stats., before signing the contract.
- 20.0 MATERIAL SAFETY DATA SHEET: If any item(s) on an order(s) resulting from this award(s) is a hazardous chemical, as defined under 29 CFR 1910.1200, provide one (1) copy of Material Safety Data Sheet for each item with the shipped container(s) and one (1) copy with the invoice(s).
- 21.0 TERMINATION FOR CONVENIENCE: Sauk County reserves the right to terminate this contract for convenience upon 60 days notice.
- 22.0 TERMINATION FOR DEFAULT: Sauk County reserves the right to terminate the contract for default if, after twenty days written notice to cure default, contractor fails to satisfactorily cure the default.

The Vendor has examined and carefully prepared the Proposal from the plans and specifications and has checked the same in detail before submitting the Proposal to Sauk County, including the Standard Terms and Conditions. The Vendor has had the opportunity to view the installation site and has obtained all necessary information to properly complete this Proposal:

(Company Name/Firm)

(Witness)

(Company Representative)

(County Representative)

(Signature)

(Signature)

(STATE OF WISCONSIN)

)ss.

SAUK COUNTY)

Personally came before me this _____ day of _____, 2017, the above named
_____ to me known to be the person who executed
the foregoing instrument and acknowledge the same.

Signature of Notary Public

Typed or Printed Name of Notary PublicMy Commission (expires) (is) _____

PART FOUR
EVALUATION INFORMATION

I.0 EVALUATION PROCESS

- I.1 The award of a contract resulting from this Request for Proposal shall be based on the most advantageous proposal received by the most responsive vendor.
- I.2 Completeness of proposal. All requested information is included as noted.
- I.3 In the event that only one proposal is received in response to this Request for Proposal, Sauk County reserves the right to negotiate the terms and conditions, including the price, as proposed in the sole vendor's proposal. In addition, as part of such negotiations, Sauk County reserves the right to require supporting cost, pricing and other data from the vendor in order to determine the reasonableness and acceptability of the proposal.
- I.4 Sauk County may conduct interviews with selected vendors should it be deemed necessary to further enhance the selection process.
- I.5 Sauk County reserves the right to reject any and all proposals.

PART FIVE
PRICING & INFORMATION

PRICING	PRICE
HCC Item# 1 - Fan Tracking and Outdoor Air Intake Control – Rooftop Units One Through Five	\$
HCC Item #2 – Place all air terminals at minimum scheduled air flow. Determine correct outdoor air damper position to provide required outdoor air flow rate. Record damper position and air flow as measured by the supply air flow station	\$
HCC Item #3 – Place all air terminals at maximum scheduled air flow. Determine correct outdoor air damper position to provide required outdoor air flow rate. Record damper position and air flow as measured by the supply air flow station.	\$
Bid Alternate HCC#3 – Variable Volume Kitchen Hood Control	\$
WS Item #1 – Air Handlers 1-3 – Air Flow Station and Static Pressure Sensor Calibration	\$
BID Alternate WS #3 – Chilled Water Coil Balancing	\$
	\$
LEC Item #1 – Rebalance of Energy Recovery Units (ERU)	\$
LEC Item #2 – Variable Speed Drive Retrofit - Boiler Primary Pumps	\$
Total Price	\$

Sauk County Provided Materials

Any materials and/or services that Sauk County will need to provide to the vendor to complete this project must be listed below.

The vendor hereby agrees to provide the services and/or items at the prices quoted, pursuant to the requirements of this document and further agree that when this document is countersigned by an authorized official of Sauk County, a binding contract, as defined herein, shall exist between the vendor and Sauk County.

VENDOR

AUTHORIZED SIGNATURE

Date

PRINTED NAME

Title

Ian Crammond, Sauk County Facilities Director

Date

4.2.A Additional Documentation

019113 – COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Commissioning. Commissioning (Cx) is a systematic process of ensuring that all building systems perform interactively according to the design intent and the Owner's operational needs. The commissioning process shall coordinate components of the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training.
- B. The commissioning process to be provided under this RFP is to be generally modeled upon the requirements of the 2015 International Energy Conservation Code (IECC), Chapter 408. This focuses upon functional testing, creation of a commissioning plan, creation of an issues log, and provision of an abbreviated commissioning report. The outline provided in the IECC, as augmented or modified by this specification will be followed as it applies to systems and equipment effected by the work of this RFP.
- C. The commissioning of this project shall concentrate upon verification of equipment / systems operation, optimization of operating parameters and sequences, and obtaining the design intent for the project outcome. The commissioning authority shall work in close conjunction with the contractors, and to integrate necessary revisions and optimization of software and control parameters to achieve design intent.
- D. The commissioning process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functioning product.

1.2 COORDINATION

- A. Commissioning Team.
 - 1. The commissioning team members shall include Commissioning Authority (CA), the Owner's Construction Manager / Representative (CM) and the various construction contractors on the project with work associated with the systems to be commissioned ("contractor"). In the case of this project, the contractors shall include the Testing and Balancing Contractor (TAB), the Controls Contractor (CC) and any other installing Subcontractors or suppliers of equipment. The Owner may designate facilities staff as members of the commissioning team.
 - 2. The contents of these specifications describe the roles and responsibilities for each of the traditional commissioning team members.

In the event that individuals serve multiple roles, the responsibilities shall equally apply.

B. Management.

1. The CA shall be provided directly by the Owner. The CA directs and coordinates the commissioning activities and reports to the CM. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.

C. Scheduling.

1. The CA shall work with the CM to schedule commissioning activities. The CM shall regularly update the CA regarding construction progress, changes to commissioned systems, and expected completion. All parties shall address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.

1.3 COMMISSIONING PROCESS

A. Commissioning Plan. The Commissioning Plan provides guidance in the execution of the commissioning process.

1. The commissioning plan for this project shall consist of:
 - a. This specification 019113.
 - b. Functional Testing Procedures for each piece of equipment, to be developed and distributed to contractors within 30 days of project start.
 - c. Any additional documentation developed by the CA for the purpose of clarifying the intent of the Functional Testing Procedures.
 - d. Special conditions under which testing is to be performed
 - e. Calibrations necessary to assure accuracy of system control.

B. The following provides a brief overview of typical construction phase commissioning tasks and the general order in which they occur.

1. Commissioning during construction begins with the ongoing development of the Commissioning Plan by the CA. This includes formalizing testing procedures and processes.
2. A Pre-Commissioning meeting may be conducted by the CA. The commissioning testing procedures are reviewed at this time and opened for comment by additional team members.
3. Additional meetings may be required during construction to plan, coordinate, schedule future activities, and resolve issues. The additional

meetings will be scheduled through the CM with necessary parties attending.

4. Appropriate documentation and communication paths (project dependent) are developed with all team members.
5. The CA will perform progress compliance inspections to determine deviations from contract documents, construction issues which may adversely affect the ability to commission the systems, and / or make recommendations to improve project outcome. In the event that observations require clarification from other members of the Commissioning Team, these requests for information shall be placed in writing and become part of the commissioning record.
6. The Functional Performance Tests are executed by the Contractors under the direction of the CA. The CA documents functional performance test results.
7. Items of contract non-compliance in material, installation or setup are documented by the CA and forwarded in appropriate report format for correction at the Contractor's expense. Non-compliance issue resolutions shall be documented in a Commissioning Issues Log (or other acceptable format) by the CA. This log shall be maintained throughout the project, and include items noted during site inspections and functional performance testing.
8. Seasonal or other deferred testing may be required to optimally test the systems, and shall be conducted as required for system performance verification. These tests, and participation by all commissioning team members, shall be provided at no additional costs to the Owner
9. The CA prepares a final report to document the results of the commissioning process.

1.4 RESPONSIBILITIES

A. The general roles and responsibilities of the primary Cx team members toward the Cx process are outlined in this section.

B. Commissioning Authority (CA)

1. The Design Engineer for this project is providing the Commissioning Services. Therefore, customary commissioning process responsibilities of both entities are conferred upon the CA.
2. Construction and Acceptance Phase:
 - a. Respond to contractor Requests for Information (RFI's).
 - b. Review contractor submittals for clarity, completeness and conformance to the contract documents.

- c. Coordinate and direct the commissioning activities in a logical, sequential, and efficient manner using technical expertise, consistent protocols, centralized documentation, clear and regular communications/consultation with all necessary parties, and frequently updated timelines/schedules.
- d. Coordinate the commissioning work and, with the CM, ensure that commissioning activities are being scheduled into the master schedule.
- e. Develop the Commissioning Plan document that describes construction phase commissioning activities.
- f. Review as-installed systems for compliance to construction documents and industry standard prior to testing. Report deviations to the Commissioning team in the Issues log.
- g. Write the Functional Performance Test procedures and develop test forms for equipment and systems.
- h. Work closely with the contractors through periodic site visits to assist in setup of proposed software revisions.
- i. Supervise manual Functional Performance Tests with installing Contractors. Coordinate retesting as necessary until satisfactory performance is achieved.
- j. Maintain a master Commissioning Issues Log and testing records. Communicate test results and non-compliance issues to the CM. Recommend actions to resolve non-compliance issues.
- k. Provide a final Commissioning Report providing the following information:
 - 1) Reports of functional testing outcome (completed testing reports)
 - 2) Disposition of deficiencies found during testing, including details of corrective measures used or proposed.
 - 3) Outcome of deferred tests that could not be performed at the time of preliminary report preparation because of climatic conditions, and the conditions under which the tests were performed
 - 4) Functional performance test procedures used during the commissioning process, including measurable criteria for test acceptance (provided in report for repeatability).

3. Warranty Period:

- a. Coordinate and supervise required seasonal or deferred testing and deficiency corrections.

C. Construction Manager - (CM)

1. Construction and Acceptance Phase:

- a. Facilitate the coordination of the commissioning work by the CA. Maintain commissioning activity in the master schedule.
- b. Where requested by the CA, coordinate and attend commissioning team meetings.
- c. When requested by the CA, observe startup and functional testing of selected equipment.
- d. Coordinate the resolution of non-compliance deficiencies.
- e. Review Commissioning Issues Log and follow up Contractors to achieve resolution of non-compliance issues.

2. Warranty Period:

- a. Assist the CA as necessary in the seasonal or deferred testing and
- b. Ensure that any seasonal or deferred testing and any deficiency issues are addressed.

D. Contractors

1. Construction and Acceptance Phase:

- a. The Contractors shall provide all tools and instrumentation or the use of tools and instrumentation to start, check-out, and functionally test equipment and systems.
- b. Execute commissioning responsibilities according to the Contract Documents and schedule.
- c. Where requested by the CA, a representative shall attend a commissioning meetings scheduled by the CM and CA to facilitate the Cx process.
- d. Provide to the CA detailed start-up procedures, all requested submittal data, and specific Owner responsibilities required to keep warranties in force.
- e. Execute Functional Performance Tests under the direction of the CA. The CA documents the Functional Performance Test process and results.

- f. Correct non-compliance issues.
 - g. Prepare O&M Manuals according to the Contract Documents; clarify and update the original control sequences to as-built conditions.
- 2. Warranty Period:
 - a. Execute seasonal or deferred Functional Performance Testing, witnessed by the CA, according to the specifications.
 - b. Correct non-compliance issues and document resolutions in the Commissioning Issues Log and make necessary adjustments to O&M Manuals and as-built drawings for applicable issues identified in any seasonal testing.

1.5 SYSTEMS TO BE COMMISSIONED

- A. The work of this project shall consist of a total of five entities (in addition to the CA and CM):
 - 1. Siemens (Law Enforcement Center, Alternate #WS1 for West Square)
 - 2. Johnson Controls (Health Care Center and West Square Buildings)
 - 3. Testing and Balancing (all three facilities)
 - 4. Mechanical Contractor (demand based kitchen hood controls)
 - 5. Boiler Vendor (coordination of HCC item # 4 – correction of boiler reset schedule and sequencing operation)
- B. It is the intent to verify performance and operation of all work described in the RFP documents distributed for solicitation of each of these five entities. Each contractor shall be prepared to participate in commissioning activity related to all work described in their respective RFP documents

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required Functional Performance Testing shall be provided by the Contractor for the equipment being tested. For example, the Controls Contractor shall ultimately be responsible for all standard testing equipment for the HVAC system controls, except for equipment specific to and used by TAB in their commissioning responsibilities.

- B. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5°F and a resolution of + or - 0.1°F. Pressure and humidity sensors shall have an accuracy of + or - 2.0% of the value being measured (not full range of meter) and have been calibrated within the last year. All equipment shall be calibrated according to the manufacturer's recommended intervals and when dropped or damaged. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION

3.1 MEETINGS

- A. Commissioning Scoping Meeting. At the discretion of the CA, a pre-commissioning meeting (through the CM) shall be scheduled with the entire commissioning team in attendance.
- B. Miscellaneous Meetings. Other meetings may be planned and conducted by the CA (through the CM) as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with particular Contractors. The CA will plan these meetings and will minimize unnecessary time being spent by the Contractors.

3.2 REPORTING

- A. The CA will coordinate commissioning meetings and activities through the CM. The CA will develop and maintain the Commissioning Issues Log to document non-compliance issues and deficiencies noted throughout the Cx process. The CA will regularly submit the Commissioning Issues Log to the CM who shall assist the CA in communicating deficiencies to the responsible Contractors and coordinating resolution to issues. The CM and all Contractors are responsible for detailing the resolution of issues in the Commissioning Issues Log and returning it regularly to the CA as issues become resolved.

3.3 FUNCTIONAL PERFORMANCE TESTING

- A. The commissioning activities described in the Functional Performance Tests as contained in the commissioning plan shall be performed by the contractor under the direction of the CA. These tasks may require dynamic modifications throughout system setup and testing to best assure project outcome. Each task shall be assigned to the appropriate trade, generally the specific contractor providing the equipment. Only skilled tradesmen knowledgeable in the operation of the equipment and systems shall be perform each of the FT requirements.
- B. Objectives and Scope. The objective of Functional Performance Testing is to demonstrate that each system is operating according to the Design Intent. Functional Performance Testing facilitates bringing systems from a state of substantial completion to full dynamic operation. Additionally, during the testing

process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

C. Coordination and Scheduling.

1. The Contractors via the CM shall provide sufficient notice to the CA regarding their completion schedule for the startup of all equipment and systems.
 - a. In general, functional testing is conducted after preliminary testing and startup have been satisfactorily completed by the construction team. The control system is to be sufficiently tested before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing to be is completed and debugged before functional testing of air-related or water-related equipment or systems
2. Problem Solving. The CA may recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the CM, GC, Contractors and A/E.

3.4 DOCUMENTATION, NON-COMPLIANCE AND APPROVAL OF TESTS

A. Documentation. The CA shall witness and document the results of all Functional Performance Tests.

B. Non-Compliance.

1. All deficiencies or non-compliance issues shall be noted and reported to the CM via a Commissioning Issues Log, developed by the CA.
2. Minor deficiencies identified during testing may be corrected during testing at the discretion of the CA. In such cases the deficiency and resolution will be documented on the Commissioning Issues Log.
3. Every effort will be made to expedite the testing process without compromising the integrity of the test procedures. However, the CA shall not be pressured into overlooking deficiencies or loosening acceptance criteria to satisfy scheduling or cost issues unless the Owner provides a written request to do so.
4. Cost of Retesting.
 - a. The cost for the CA to retest / re-verify a Functional Test, after a second round of testing on a piece of equipment shall be provided by the party responsible for the defect or deficiency. In the event that multiple parties are responsible for test failures, any cost recovery for retesting shall be negotiated with the CM and subsequently assigned to the responsible parties.
5. Any required retesting by any Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

3.5DEFERRED TESTING

A.Unforeseen Deferred Tests. If any check or test cannot be completed due to the building structure, required occupancy condition or other reason, execution of checklists and Functional testing may be delayed upon approval of the CM. These tests shall be conducted in the same manner as the seasonal tests as soon as practicable.

B.Seasonal Testing. During the warranty period, seasonal testing (tests delayed until weather conditions are closer to the system's design conditions) shall be completed as part of this contract. The CA shall coordinate this activity through the CM. Appropriate Contractors shall perform functional testing under the direction of the CA, who shall also document the testing procedures and results. Any final adjustments to the O&M Manuals and as-built drawings due to the testing shall be made by the

END OF SECTION 019113

4.2.B Additional Documentation

SECTION 230020 - BASIC MECHANICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. This project is a Design / Build collaboration between the Engineer / Commissioning Agent, Owner and the Contractor(s).
- B. The Engineer has provided only specific specification sections for this project, which include:
 - 1. 230020 – Basic Mechanical Requirements
 - 2. 230923 – Temperature Controls
 - 3. 019113 – Commissioning Requirements.

1.2 SCOPE OF WORK

- A. Include all labor, materials, tools, transportation, equipment, insurance, temporary protection, permits, taxes, services and all necessary and related items required to provide complete and operational systems described.
- B. It is the intent of this project is to provide a turnkey result for all items as described in the RFP. The adequacy and completeness of the work shall be at the sole discretion of Sauk County and the Engineer. The contractor shall develop all comments and questions during the bidding phase of the RFP response to obtain a clear understanding of project requirements. All questions and comments will be responded to in writing. This information shall be incorporated by reference into the documents.

1.3 REGULATIONS AND CODE COMPLIANCE

- A. All work and materials shall conform to and be installed, inspected and tested in accordance with the governing rules and regulations of federal, state and local governmental agencies having jurisdictional authority. In the event of conflict between these contract documents and the governing rules, regulations, and codes, the most stringent standards shall apply as directed by the Engineer and/or Authorities having jurisdiction.

1.4 LICENSING & PERMITS

- A. The Contractor shall hold a license all necessary licenses to perform the scope of work at the project location.
- B. Apply for and obtain all required permits and inspections, include costs for all fees and charges.

1.5 DEFINITIONS

Approved / Approval As Called For	Written permission to use a material or system. Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Equipment	Refer to the article, BASIS OF DESIGN
Design Make	Refer to the article, BASIS OF DESIGN.
Equal or Equivalent	Equally acceptable as determined by Owner's Representative
Exposed	Work not identified as concealed.
Final Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnish	Supply and deliver to installation location.
Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's Site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.
Or Approved Equal	Approved equal or equivalent as determined by Owner's Representative.
Owner's Representative	The Prime Professional
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Roughing	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.

1.6 QUALITY ASSURANCE

- A. Manufacturers of equipment shall be firms regularly and currently engaged in the production of equipment and accessories provided. The design and size/capacity of each item of equipment provided for this project needs to have been in satisfactory and efficient operation on at least three (3) installations for not less than three (3) years.

- B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.
- C. Apply and install materials, equipment, and specialties in accordance with manufacturer's written instructions. Conflicts between the manufacturer's instructions and the contract documents shall be referred to the Engineer for resolution.
- D. All work shall be done in a neat and workmanlike manner. All methods of construction or details of workmanship, not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner and Engineer. Equipment and materials shall be of the quality and construction indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIAL MINIMUM REQUIREMENTS

- A. Provide materials that meet the following minimum requirements:
 - 1. Materials shall have a flame spread rating of 25 or less and a smoke developed rating of 50 or less, in accordance with NFPA 255.
 - 2. All equipment and material for which there is a listing service shall bear a UL label.
- B. Electrical equipment and systems shall meet UL Standards and requirements of the N.E.C. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with UL Standards and the requirements of the N.E.C.
 - 1. Communications equipment shall meet all FCC Regulations
 - 2. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.
 - 3. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems must conform to the Specifications.

2.2 SUBSTITUTIONS

- A. The materials, products and equipment described in the Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.
- B. Approval by the Engineer to proceed with a substitution does not relieve the

contractor from meeting all of the dimensional requirements and maintaining the full functionality and performance of the material, product or equipment used as the basis of design.

2.3 FACTORY-ASSEMBLED PRODUCTS

- A. Provide maximum standardization of components to reduce spare part requirements.
- B. Manufacturers of equipment assemblies which include components made by others shall assume complete responsibility for final assembled unit.
 - 1. All components of an assembled unit need not be products of the same manufacturer.
 - 2. Constituent parts which are alike shall be products of a single manufacturer.
 - 3. Components shall be compatible with each other and with the total assembly for intended service.
 - 4. Contractor shall guarantee performance of assemblies of components, and shall repair or replace elements of the assemblies as required to deliver specified performance of the complete assembly.
- C. Components of equipment shall bear the manufacturer's name or trademark, model number and serial number on a name plate securely affixed in a conspicuous place, or cast integral with, stamped or otherwise permanently marked upon the components of the equipment.
- D. Major items of equipment which serve the same function must be the same make and model. Exception will be permitted if performance requirements cannot be met.

2.4 COMPATIBILITY OF RELATED EQUIPMENT

- A. Equipment and materials installed shall be compatible in all respects with other items being furnished and with existing items so that a complete and fully operational system will result.

2.5 SPECIAL TOOLS

- A. If any part of equipment requires a special tool for assembly, adjustment or maintenance thereof and such tool is not readily available in the commercial tool market, it shall be furnished by the Contractor as required for the duration of the project and turned over to the Owner in serviceable condition upon completion of the scope of work. Contractor shall obtain written sign off by the Owner certifying that the Owner is in receipt of such tools.

2.6 FIRE STOPPING

- A. Fire-stopping for openings through fire and / or smoke rated walls and floor assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated by ASTM E814.
- B. Each contractor shall be responsible for providing fire stopping of all penetrations created during the course of their scope of work.

PART 3 - EXECUTION

3.1 SUBMITTALS: SHOP DRAWINGS/PRODUCT DATA/SAMPLES

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Indicate deviations from contract requirements on Letter of Transmittal. Corrections or comments made on the Shop Drawings during the review do not relieve the Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.
- B. Approval of shop drawings will not relieve this contractor from responsibility for deviations from the contract documents. It is the responsibility of the Contractor to meet the requirements of these documents. All errors or omissions in the product data are to be corrected by this contractor irrespective of any approvals by the Architect or Engineer.

3.2 PROTECTION OF PERSONS AND PROPERTY

- A. Contractor shall assume responsibility for Construction Safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature(s) required to provide safe conditions for all workmen and site visitors.

3.3

EXISTING SYSTEMS AND CONDITIONS

- A. Prior to beginning work, inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the Owner prior to beginning work. If existing damage is not documented and submitted, the Contractor shall repair all damage found at the completion of the project that is determined to have been caused by the work of this contract. Repairs shall restore the area to like new condition.
- B. The Owner and Engineer shall determine if the Contractor has damaged existing systems or construction and shall approve the repairs.

3.4

REMOVALS

- A. Demolition of mechanical systems will include removal and deprogramming / reprogramming of multiple control system devices and sensors. Coordinate with Owner for quantity and type of devices which they desire to retain. Remove all components in good condition and turn over to the Owner's representative.
- B. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all pipe, valves, fittings, insulation, conduit, panels, and all hangers, including the top connection and any fastenings to building structural systems. Seal all openings, after removal of equipment. Structural integrity of the building system shall be maintained.

3.5 STORAGE AND PROTECTION OF MATERIALS

- A. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.

3.6FREEZING AND WATER DAMAGE

- A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no change in contract, any such damage to equipment, systems and building.

3.7CUTTING AND PATCHING

- A. Each trade shall include their required cutting and patching work. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch, cut or abandoned holes left by removals of equipment or fixtures. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

3.8CONCEALMENT

- A. **Conceal all contract work** above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

3.9 CHASES

- A. In Existing Buildings:

1. Drill holes for floor and/or roof slab openings.
2. Multiple pipes smaller than 1" properly spaced and supported may pass through one 6" or smaller diameter opening.
3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2" above floors.

- B. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

3.10 FIRE-STOPPING

A. Fire-stopping for openings through fire and smoke rated wall and floor assemblies:

1. Provide materials and products listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.
2. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire-rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for drywall construction.
3. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.
4. The methods used shall incorporate qualities, which permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting reduction in fire rating.
5. Apply fire stopping within the temperature and humidity limits permitted by the manufacturer.
6. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.11 PAINTING

A. This Contract Includes the following:

1. Painting required for touch-up of surfaces damaged due to the installation of work.
2. Painting as required to repair finish of equipment furnished.

3.12 CLEANING

A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations.

- 1.Thoroughly clean entire installation, both exposed surfaces and interiors.
- 2.Remove all debris caused by work.
- 3.Remove tools, surplus, materials, when work is finally accepted.

3.13 CONTINUITY OF SERVICES

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical facilities or services.

3.14 OPERATION AND MAINTENANCE MANUALS

- A.In addition to requirements stated elsewhere in these specifications, provide Operating and Maintenance manual(s) which include the following:

- 1.Approved Submittal documentation for all equipment stating size and selected options for each piece of equipment requiring maintenance.
- 2.Manufacturer's operation manuals and maintenance manuals for each piece of equipment requiring maintenance (excepting equipment not furnished as part of this project). Routine maintenance actions shall be clearly identified. The data shall include internal wiring diagrams and spare parts lists.
- 3.Name and address of each equipment supplier and at least one service agency for each piece of equipment.
- 4.HVAC and service water controls system maintenance and calibration information, including wiring diagrams, schematics, and control sequence descriptions. Desired or field-determined setpoints shall be permanently recorded on control drawings and at control devices or, for digital control systems, in programming instructions.
- 5.A narrative of how each system is intended to operate, including recommended setpoints. Include emergency operating instructions, seasonal changeover, freeze protection and precautions necessary for Owner operations of systems.
- 6.As-built drawings for the project.

- B.Provide copy of O&M Manual in electronic format on CD or other media format acceptable to the Owner. All documents shall be in PDF format, with the exception of record drawings which shall be provided in both PDF and AutoCAD compatible drawing format.

3.15 SALVAGEABLE MATERIALS

A. Salvageable materials will be reviewed and identified by the Owner. Instruction shall be given to the Contractor whether the Owner will remove salvageable materials, or whether contractor is to remove and deliver salvageable materials to a pre-designated site.

B. HVAC items normally accepted as salvage by the Owner:

1. Temperature control and automation hardware

END OF SECTION 230020

4.2.C. Additional Documentation

SECTION 230923 – TEMPERATURE CONTROLS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. The scope of work generally consists of upgrades and modifications to existing temperature control systems as described in the RFP.
- B. Provide labor, materials, equipment, services and warranty for a complete installation. Provide wiring and conduit required to connect devices furnished as a part of, or integral to the automatic temperature control system. Control wiring includes, as required, 120 volt and lower voltage wiring for control signals directing equipment operation. Control circuits shall be 24VAC in general, and no more than 120 VAC where required. Provide wiring in accordance with the requirements specified in the National Electrical Code. Provide all devices required for proper system operation including electrical switches, transformers, disconnect switches, relays, device controllers and control modules, hubs, switches, routers, temporary servers, actuators, transducers, sensors, safety devices, power supplies, mode selecting switches, enclosures, and circuit breakers
- C. The Engineer / Commissioning Agent has made reasonable effort in the RFP to describe an operating sequence which will provide necessary project results. It is anticipated that dynamic modifications to software may be required during system startup and commissioning, and that additional adjustments may be required through seasonal system operation. This contractor shall include labor necessary to achieve these project goals, and shall work with the project team through the warranty period to provide the required project outcome.
- D. Project construction shall be a close collaboration between the contractor, the Owner and the Commissioning Agent / Engineer. The contractor shall include all labor necessary to perform field verification of the installed project which meets the requirements of a commissioning process as described under C408 of the 2015 International Energy Construction Code.

1.2 ACCEPTABLE MANUFACTURERS

- A. Basis of Design
 - 1. Law Enforcement Center – Siemens
 - 2. West Square / Health Care Center – Johnson Controls, Inc. (JCI)

1.3 QUALITY ASSURANCE

- A. Acceptable Products: All products shall be proven to be functional and suitable in

accordance with this specification for a period of warranty commencing on the day of transfer of completed project to the Owner. Demonstration of such warranty may be required prior to the submittal approval.

- B. Contractor Qualifications: The Controls Contractor shall be factory-authorized by the respective manufacturer to provide pertinent installation and service.
- C. Field Representation: The Controls Contractor shall staff the project with a field representative that has been factory-trained in the installation, programming and commissioning of the equipment specified. This representative must be in the direct employ of the Controls Contractor.
- D. Coordination of Work During Construction:
 - 1. The Controls Contractor shall repair any damage caused by his work
 - 2. The Control Contractor shall promptly correct all work that Engineer finds as defective or failing to conform to Contract Document
 - 3. The Control Contractor shall bear all cost of correcting of work found defective as described above.
 - 4. The contractor shall closely coordinate BACNet instance ID's and IP addresses with existing equipment to avoid address replication. Instance ID's and IP addresses shall be clearly stated in all submittal and as-built documentation.

1.4 SHOP DRAWINGS AND SUBMITTALS

- A. Product Data: Submit for approval the manufacturer's technical product data for each component furnished as part of the control system. Data shall include dimensions, capacities, performance characteristics, electrical requirements, and material finishes. Data shall also include installation and start-up requirements.
- B. Shop Drawings: Submit for approval control drawings detailing the following:
 - 1. Network Block Diagrams and System Riser Diagrams: These diagrams shall depict all DDC components that make up the network. They shall provide specific detail on network terminations, and panel power requirements, including breaker allocation. Each DDC panel within the diagram shall list the equipment that it is controlling.
 - 2. Point-to-point Termination Detail: These drawings shall be created for each unique control application type. Drawings that are typical for similar application shall state the application and quantity of that they represent, and the specifics for each. All wiring and piping required to install and operate the system shall be represented in these details. For terminations that are unknown at the time of submittal, or introduced over the course of project, properly designate these as "Field determined terminations," and include in the As-built Drawings after completion. All wiring and piping shall be number coded on the drawings. These tag numbers shall be used during the installation, and shall appear at both ends of all conductors, including within any junction boxes.
 - 3. Provide individual details for each control type, as described in the Sequence of

Operation.

4. Provide spreadsheets of schedules for dampers, valves, wiring, fans and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.
 5. For prefabricated control panels, provide panel's interior and exterior layout details. These details shall depict the equipment layout and shall detail the panel wiring and piping.
- C. Database Information: The submittal package shall contain detailed information on the point naming convention that is to be used.
- D. Provide documentation for all sequences of operation that cannot be performed by stand-alone controllers and require non-controller-resident programs, or programs requiring retransmission to be effective on the controller's output. Wherever possible, sequences of operation and associated inputs and outputs shall be contained on a single controller,
- E. Where applicable, based on the hardware revisions to be provided under the scope of work, provide BACnet Protocol Implementation Conformance Statement (PICS) for each submitted type of controller and operator interface. All controllers and operator interface shall fully conform to ANSI/ASHRAE 135, minimum 2008 revision: Data Communication Protocol for Building Automation and Control Systems (BACNET)

1.5 OPERATION AND MAINTENANCE MANUALS FOR COMPLETE PROJECT

- A. Upon completion of installation and prior to the training, provide manuals containing the following information:
1. Installation and Service Manuals for all products and components
 2. Calibration and Troubleshooting Procedures for all installed equipment and components.
 3. List of location of all enclosures, controllers, sensors, transformers and other components as specified above
 4. As-built Control Drawings with all modifications, changes and wiring details that depict actual installation. These shall include all final controller and device names, wire tags, etc.
 5. Sequence of operation – Describing in detail the operation of every piece of equipment subject to control by the DDC system. Each section of the sequence should contain the following:
 - a. Overview – describes what the intent is, what components are involved and provides a concise description of the piece of equipment to be described.
 - b. Occupied Mode – Describes the operation of this system during occupied periods.
 - c. Unoccupied Mode – Describes the operation of this system during unoccupied periods.
 - d. Alarm Mode - Describes operation of the system in the event of alarm condition and steps to restore system to normal operation. List all anticipated alarm conditions.

- e. Each Component's individual Sequence - Describes the detailed operation of each component and how it interacts with the entire system.
- 6. Listing of the entire DDC controllers with database, software and programs and program locations.
- 7. Provide spreadsheets of schedules for enclosures, control modules, dampers, valves, wiring, fans, well, tap and other miscellaneous components if they are part of this control contract showing sizes, characteristics, model numbers and specific locations.
- B. Electronic media backup of all software is to be left on-site that will allow the Owner to fully download the entire DDC System software, including programming point database, configuration, graphic screens and all library of typically composed objects, and details supporting navigation, screens and graphics.
- C. Within 15 working days from the time of the final system commissioning, Operation and Maintenance Manuals shall be turned directly to the Engineer in PDF format, readily indexed and searchable by the end user.
- D. Section for each Major Piece of equipment – Contains the cut sheets for the controllers, custom programs, and relevant information pertaining to that piece of equipment. (IE: schedules for VAV boxes or AHUs showing Equipment Tag, Controller address, serial #, airflow, and pertinent engineering units like MBH, GPM, etc...).
- E. Wiring Details – Contains 8-1/2" x 11" drawings of all the wiring details shown throughout the set of drawings.
- F. Instrumentation Cut sheets – Contains the Manufacturer's original cut sheets for all the instrumentation used on the job. (IE: Well sensor, transformers, enclosures, pressure sensors, etc.).
- G. AutoCAD Drawings – All drawings shall be provided in Auto CAD format (i.e. each file format should have the ".dwg" extension), made as set of both, a set 11"x17" black and white and a set of 24"x36" (1 color set and 3 black and white sets). Drawing Sets consists of the following:
 - 1. System Description Drawing – Shows the overview of the job and what is being controlled.
 - 2. Network Riser Drawings – Shows how the network is connected between all the devices on the job
 - 3. Detail drawing(s) – Shows all the wiring and piping details for the entire job – all other drawings refer to these drawings.
 - 4. Individual Control panel drawings & Schematics (1 or 2 drawings per piece of equipment) Shows the EXACT wiring and layout of each control panel. Also shows the schematic representation of the system that is being controlled. (IE: AHU, HW Plant, CHW Plant, VAV Box, Heat pump, Etc.)
 - 5. Controls Floor plans (at least 1 for each floor) – Shows the approximate location of the control panels, thermostats, equipment, network wiring, thermostat wiring and any specific controls required for the job. All this information is overlaid on top of the mechanical floor plan showing the architectural layout (Wall and room #'s).

- H. All above shall be provided in an acceptable electronic media format and released to the Owner for record.

1.6 SYSTEM COMMISSIONING

- A. All points connected to the BMS shall operate fully in accordance with this specification before final completion is determined.
- B. The contents of this section is in addition to any other project commissioning described in the project specifications.
- C. Equipment Start-up: Upon completion of installation, all equipment being controlled shall be initially started and tested on site:
 - 1. Measure, calibrate and adjust all analog inputs.
 - 2. Stroke all analog outputs from 0% to 100% and verify that all linkage adjustments are set properly.
 - 3. Valves and Dampers shall fully close and provide tight shut-off.
 - 4. Verify that all digital outputs are properly energizing the controlled device.
 - 5. Adjust setpoints so that equipment operates properly. Tune all PID control loops to avoid unnecessary cycling of control equipment, it's overheating, sub-cooling, tripping the freezestats and other limit switches and safeties. Create trends and print the results to verify tuning operation.
 - 6. Provide reasonable control and operational assistance to the balancing personnel as needed to achieve reliable and energy-efficient system operation.
- D. Communication Network Start-up: Verify from a host computer that all configured controllers are engaged in proper communication passing all configured points to viewing stations. Verify communication speed and level of transactions until it is acceptable and meets the requirements of this specification.
- E. Software Verification: All programs and software functions shall be verified for proper sequence of operation.
- F. Contractor shall, during the ensuing four seasons (one year), conduct periodic inspections to fine-tune all dynamic elements of the system with all costs of testing to be included in this scope of work.
- G. Coordination: Work with the air-balancing contractor, ventilation contractor, piping contractor and electrical contractor to provide a proper and obstruction free component location, and a complete system commissioning.
- H. As built Drawings: All drawings shall be reviewed after the final installation and corrected to provide accurate, as-built representation of the complete system.
- I. Systems Startup Report: A report shall be provided to the Engineer and Commissioning Authority detailing the dates, times and person(s) performing the start-up. This report shall detail when and who performed the individual processes mentioned above.

- J. Commissioning is considered completed only if the physical walk-through of the project, together by Controls Contractor and the Owner was concluded and the complete set of required documentation and software has been transferred to the Owner. The Owner has no right to refuse or delay a reasonably scheduled walk through meeting, during which time every major components should be inspected if the Owner wishes so.

1.7 TRAINING

- A. Provide BMS training of eight hours each for up to (4) Owner selected personnel.
- B. This session shall also include but not be limited to:
 - 1. Fundamental operation of the system
 - 2. Training on setpoint adjustment and scheduling modifications
 - 3. Operation and sequencing of control loops for all mechanical equipment being controlled
- C. Provide telephone support and answer system relevant questions throughout the warranty period.

1.8 WARRANTY

- A. Warranty for the entire control system shall commence upon completion and acceptance by the Engineer of the system commissioning as specified. The warranty includes fine-tuning of all dynamic elements of control system to achieve reasonable, efficient end equipment protective mode of operation.
- B. Provide a one-year warranty on all DDC controllers.
- C. Provide a one-year warranty on all other components.
- D. Disclose to Owner and accommodate longer warranty periods if provided by components manufactured at the time of purchasing.

PART 2 – PRODUCTS

2.1 SYSTEM DESCRIPTION

A. GENERAL REQUIREMENTS

- 1. The intent of this project is for all hardware, software, graphical user interface, and system operation to operate as a single integrated extension of the existing BMS. All hardware and software provided shall be of the latest revision, installed in a highly professional manner, and integrate seamlessly with the existing BMS system.

2. Sensing devices, to the extent new components are required, shall conform to the performance characteristics of these specifications.
3. Control loops shall be tuned for accuracy and performance. Loops considered to be tuned too slow in reaction or unable to provide suitable control accuracy as determined at the sole discretion of the Owner and Engineer / Commissioning agent shall be corrected.

2.2 ACCURACY AND STABILITY

1. Control Stability and Accuracy. Control loops shall maintain measured variable at setpoint within tolerances listed below.

Table 1
Reporting Accuracy

Measured Variable	Reported Accuracy
Space Temperature	±1°F
Ducted Air	±1°F
Outside Air	±2°F
Dew Point	±2°F
Water Temperature	±1°F
Delta-T	±0.25°F
Relative Humidity	±2% RH space, 3% RH outdoor
Water Flow	±1% of full scale
Airflow (terminal)	±5% of full scale (see Note 1)
Airflow (measuring stations)	±5% of full scale
Airflow (pressurized spaces)	±3% of full scale
Air Pressure (ducts)	±0.1 in. w.g.
Air Pressure (space)	±0.01 in. w.g.
Water Pressure	±2% of full scale (see Note 2)
Electrical (A, V, W, Power Factor)	±2% of reading (see Note 3)
Carbon Monoxide (CO)	±5% of reading
Carbon Dioxide (CO ₂)	±50 ppm

Note 1: Accuracy applies to 10% - 100% of scale

Note 2: For both absolute and differential pressure

Note 3: Not including utility-supplied meters

Table 2
Control Stability and Accuracy

Controlled Variable	Control Accuracy	Range of Medium
Air Pressure	±0.1 in. w.g.	1-6 in. w.g.
Air Pressure	±0.05 in. w.g.	±0.25-1 in. w.g.
Air Pressure	±0.005 in. w.g.	±0-0.25 in. w.g.
Airflow	±15% of full scale	

Space Temperature	±0.3°F	
Duct Temperature	±0.5°F	
Humidity	±3% RH	
Fluid Pressure	±0.3 psi)	

2.3 TEMPERATURE SENSORS

A. Duct Sensors:

1. Single point duct mounted sensors shall have a minimum 9" rigid probe and be used when the duct size is less than 24".
2. Averaging duct-mounted sensors shall have a minimum 12.5' long averaging element and be used when the duct size is greater than 24". All averaging sensors shall use true averaging elements, such as platinum. Averaging bridges [multi-point sensors] are specifically not permitted. Provide averaging sensors in all locations where specified or where temperature stratification can occur. Minimum element to be provided 1 ft per 4 sq ft of area. Securely support all elements to avoid movement in air stream or long term damage at stress / mounting locations.

B. Well Sensors:

1. Liquid immersion sensors shall have a stainless steel probe and a stainless steel or brass well. Length of the sensor well shall be selected based on the diameter of the pipe to provide accurate, reliable sensing of the liquid temperature. Sensors shall be installed as required in the pipe or an oversized elbow to provide accurate measurement of the media and complete immersion of the sensing element. All wells shall be filled with thermo-conductive media prior to installing the sensor in the well.

C. Outside Sensors:

1. The sensing element shall be sheathed in a stainless steel tube and mounted inside a ventilated, treated, PVC sun shield to minimize the radiant energy and wind effects. Sensor location shall be selected to minimize effects from sunlight, building heat, exhaust systems, etc.

2.4 THERMOSTATS/SPACE TEMPERATURE SENSORS

- A. Low-Voltage Space Thermostats. Low-voltage space thermostats shall be 24 V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.
- B. Line-Voltage Space Thermostats. Line-voltage space thermostats shall be bimetal-actuated, open-contact type or bellows-actuated, enclosed, snap-switch type or equivalent solid-state type, with heat anticipator, UL listing for electrical rating,

concealed setpoint adjustment, 13°C-30°C (55°F-85°F) setpoint range, 1°C (2°F) maximum differential, and vented ABS plastic cover.

- C. Space Temperature sensors shall be equipped with local setpoint adjustment. Increments on the space temperature adjustment shall read control setpoint degrees F. An override pushbutton on the sensor shall place the associated unit and upstream systems into unoccupied override when the button is enabled in software for operation. A second press of the pushbutton shall return the system to normally scheduled operation. Press of the button shall have no effect during normal occupied operation. No local display of space temperature is to be provided.
- D. Wall mounted space sensors shall be mounted at 48" a.f.f. in conformance with ADA requirements.

2.5 HUMIDITY SENSORS

- A. Duct and room sensors shall have a sensing range of 20%-80%, minimum accuracy of +/- 2% over this span.
- B. Outdoor air humidity sensors shall have a sensing range of 20%-95% RH, minimum accuracy of +/-3% over this range, and shall be suitable for ambient conditions of 0°F-140°F.
- C. Humidity sensors shall not drift more than 1% of full scale annually.

2.6 FLOW SWITCHES

Paddle type flow switches are specifically not allowed. ALL flow switches, be for air or water services, shall be provided through properly selected and calibrated differential pressure switches. Select appropriate sensor range and installation location to assure reliable operation. Switches shall be UL listed, SPDT snap-acting, and pilot duty rated (125 VA minimum).

- A. Paddle switches shall have adjustable sensitivity and NEMA 1 enclosure unless otherwise specified.
- B. Differential pressure switches shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

2.7 RELAYS

- A. Control Relays. Control relays shall be UL listed, and shall have dust cover and LED "energized" indicator. Contact rating, configuration, and coil voltage shall be suitable for application.
- B. Time Delay Relays. Time delay relays shall be solid-state, UL listed, and shall have adjustable time delay. Delay shall be adjustable $\pm 100\%$ from setpoint shown. Contact rating, configuration, and coil voltage shall be suitable for application. Provide NEMA 1 enclosure for relays not installed in local control panel.

2.8 OVERRIDE TIMERS

- A. Unless implemented in control software, override timers shall be spring-wound line voltage, UL Listed, with contact rating and configuration required by application. Provide 0-6 hour calibrated dial unless otherwise specified or requested by the Owner or Engineer. Flush mount timer on local control panel face or where shown.

2.9 CURRENT TRANSMITTERS

- A. AC current transmitters shall be self-powered, combination split-core current transformer type with built-in rectifier and high-gain servo amplifier with 4-20 mA two-wire output. Full-scale unit ranges shall be 10 A, 20 A, 50 A, 100 A, 150 A, and 200 A, with internal zero and span adjustment. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
- B. Transmitter shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized.
- C. Unit shall be split-core type for clamp-on installation on existing wiring.

2.10 CURRENT TRANSFORMERS

- A. AC current transformers shall be UL/CSA recognized and shall be completely encased (except for terminals) in approved plastic material.
- B. Transformers shall be available in various current ratios and shall be selected for $\pm 1\%$ accuracy at 5 A full-scale output.
- C. Use fixed-core transformers for new wiring installation and split-core transformers for existing wiring installation.

2.11 VOLTAGE TRANSMITTERS

- A. AC voltage transmitters shall be self-powered single-loop (two-wire) type, 4-20 mA output with zero and span adjustment.
- B. Adjustable full-scale unit ranges shall be 100-130 Vac, 200-250 Vac, 250-330 Vac, and 400-600 Vac. Unit accuracy shall be $\pm 1\%$ full-scale at 500 ohm maximum burden.
- C. Transmitters shall meet or exceed ANSI/ISA S50.1 requirements and shall be UL/CSA recognized at 600 Vac rating.

2.12 VOLTAGE TRANSFORMERS

- A. AC voltage transformers shall be UL/CSA recognized, 600 Vac rated, and shall have built-in fuse protection.
- B. Transformers shall be suitable for ambient temperatures of 4°C-55°C (40°F-130°F) and shall provide $\pm 0.5\%$ accuracy at 24 Vac and 5 VA load.
- C. Windings (except for terminals) shall be completely enclosed with metal or plastic.

2.13 POWER MONITORS

- A. Power monitors shall be three-phase type and shall have three-phase disconnect and shorting switch assembly, UL listed voltage transformers, and UL listed split-core current transformers.
- B. Power monitors shall provide selectable output: rate pulse for kWh reading or 4-20 mA for kW reading. Power monitors shall operate with 5 A current inputs and maximum error of $\pm 2\%$ at 1.0 power factor or $\pm 2.5\%$ at 0.5 power factor.

2.14 CURRENT TRANSDUCER / EQUIPMENT INTERFACE RELAY

- A. Low voltage, single phase:
 - 1. Combined status sensor, command relay, and hand-off-auto switch
 - 2. Sized for monitor and control of small motors.
 - 3. Field selectable relay output.
 - 4. High and low voltage isolation
 - 5. Industrial grade load switching relay
 - 6. Mountable on single or double gang boxes, flush on starter enclosures, or stand-alone.
 - 7. Approved for installation in the following environmental conditions:
 - a. 0-95% relative humidity, non-condensing.
 - b. -15° to 60° C
 - 8. Design equipment: Veris Hawkeye H500.
 - 9. Alternative components combining the total functionality of the specified device may be submitted for approval.

2.15 PRESSURE TRANSMITTERS - AIR

- A. Pressure transmitters shall be of 2-wire, 4-20 mA output type with a capacitance element having an accuracy of $\pm 1\%$ over the entire range. Transmitter shall include protection against reverse polarity and supply voltage transients. Accuracy and zero span adjustment shall be provided with each transmitter to allow for recalibration as necessary.
 - 1. Duct Static Pressure / Building Differential Pressure
 - a. Maximum safe momentary overpressure shall be eight (8) times the pressure range.
 - b. Pressure transmitter shall be of solid-state design.
 - c. Sensor range to be selected so anticipated control setpoint resides in the middle third of the sensor span.
 - d. Approved Manufacturer: Modus T30 series or equivalent.

2. Liquid Differential Pressure

- a. The operating range shall be -40.0 to 176.0 F.
- b. Maximum safe overpressure shall be 150% of the rated pressure.
- c. Sensor range to be selected so anticipated control setpoint resides in the middle third of the sensor span.
- d. Differential pressure sensors shall utilize a five valve manifold to allow proper isolation and service without damage to the sensing device.
- e. Use of two discrete differential pressure sensors and mathematically calculating the differential pressure is acceptable installation practice.
- f. Shall be contained in an aluminum NEMA-1 enclosure.

3. Building Differential Pressure Sensors

- a. Maximum safe overpressure 10psid
- b. Operating range / span +/- 0.1"wc
- c. Approved Manufacturer: Sentra M264

4. Differential Pressure Sensors for Air Flow Measurement

- a. Maximum safe overpressure 2psi
- b. Operating Span to be matched to range of sensing probe
- c. Approved Manufacturer – Sentra M264 accuracy code F (0.25% FS)

2.17 FLOW TRANSMITTERS - AIR

A. Airflow – Velocity over 1000 fpm

1. Constructed of 16 gauge galvanized steel casing, extruded aluminum sensors and copper collectors. Measured velocity pressure converted to air flow shall have an accuracy within $\pm 2\%$ of the full scale from 700 to 4000 fpm. Sized by manufacture, rectangular, round or oval for application. Provide with volume meter with actual flow display, mounted on adjacent wall. Interface with DDC controllers.
2. Provide only where not specified to be provided by equipment manufacturers pre-installed. Monitoring of factory installed transmitters shall be by this contractor.
3. Acceptable Makes: Ebtron, Cambridge, Paragon

B. Airflow – Velocity under 1000 fpm and outdoor air intakes

1. Duct mounted airflow measuring station shall consist of one or more airflow/temperature measuring devices based on size of duct and all required electronics. The complete system shall be factory tested prior to shipment. The airflow measuring station shall not require calibration over the life of the equipment.
2. Provide only where not specified to be provided by equipment manufacturers pre-installed. Monitoring of factory installed transmitters shall be by this contractor.
3. Each sensing point shall measure both airflow and temperature using a pair of instrument grade, hermitically sealed, glass encapsulated thermistors. Airflow rate sensing device shall utilize thermal dispersion technology. Thermistors

resistance/temperature characteristics shall be traceable to NIST calibration standards. Sensors will read and system will compensate for air temperature and impact on velocity or CFM.

4. Each measurement location shall produce a single, linear analog output signal for airflow and temperature where indicated, both of which can be measured at the front end of the DDC control system.
5. The system shall have the ability to perform self-diagnostics and produce an alarm, which can identify the source of malfunction. In the event of a sensor failure, the system shall ignore failed sensor(s), average remaining sensors and shall continue to operate.
6. Sensor range shall be minimum and maximum system airflow rates with an accuracy of $\pm 2\%$. Sensors and electronics shall operate over a temperature range of -20°F and a relative humidity range of 0% to 99% (non-condensing). Size for 125% of anticipated range of air flow. The number of independent sensing points shall be per manufacturer's recommendations for the specified application as shown on drawings.
7. The probe body shall be constructed of extruded aluminum alloy. Provide airflow straightening devices as per manufacturer's recommendations.
8. Provide air flow measuring station transmitter including any 24 VAC transformer to interface with the BAS. Air flow measuring station will provide discrete temperature output and is acceptable for temperature measurement and control as required by specification.
9. Provide required length of cable to location of adjacent transmitter station to be mounted in an accessible, convenient location for operator use. Prior to start-up, a factory trained representative shall visit the site to inspect installation of air flow measuring devices and wiring. A written report shall be submitted to the Engineer for the start-up services.
10. Acceptable Make: Ebtron (Gold Series)
11. Substitutions – Substitutions shall be submitted for review and may be permitted for use at the sole discretion of the Engineer.

2.18 PRESSURE TRANSMITTERS - LIQUID

- A. Pressure transmitters shall be of 2-wire, 4-20 mA output type with a capacitance element having an accuracy of $\pm 1\%$ over the entire range. Transmitter shall include protection against reverse polarity and supply voltage transients. Accuracy and zero span adjustment shall be provided with each transmitter to allow for recalibration as necessary.

1. Liquid Differential Pressure
 - a. The operating range shall be -40.0 to 176.0 F .
 - b. Maximum safe overpressure shall be 150% of the rated pressure.
 - c. Sensor range to be selected so anticipated control setpoint resides in the middle third of the sensor span
 - d. Use of two discrete pressure sensors and mathematical determination of system differential pressure is acceptable.

- e. Differential pressure sensor shall use a five valve manifold to allow proper service without damage.
- f. Shall be contained in an aluminum NEMA-1 enclosure.

2.19 DIFFERENTIAL PRESSURE SWITCHES:

- A. Differential pressure switches (air or water service) shall be UL listed, SPDT snap-acting, pilot duty rated (125 VA minimum) and shall have scale range and differential suitable for intended application and NEMA 1 enclosure unless otherwise specified.

2.20 PRESSURE ELECTRIC SWITCHES

- A. PE switches shall be UL listed, pilot duty rated (125 VA minimum) or motor control rated, metal or neoprene diaphragm actuated, operating pressure rated for 0-175 kPa (0-25 psig), with calibrated scale minimum setpoint range of 14-125 kPa (2-18 psig).
- B. Provide one- or two-stage switch action (SPDT, DPST, or DPDT) as required by application.
- C. Switches shall be open type (panel-mounted). Exception: Switches shall be enclosed type for remote installation. Enclosed type shall be NEMA 1 unless otherwise specified.
- D. Each pneumatic signal line to PE switches shall have permanent indicating gauge.

2.21 FLOW TRANSMITTERS - LIQUID

- A. Liquid Flow
 - 1. Insertion Type - Onicon F3500 or approved equivalent only.
 - 2. Ultrasonic Type – GE Aquatrans AT868 Panametrics Liquid Flow Ultrasonic Transmitter or Micronics Greyline Clampon Flowmeter, Ultraflow 2000.
 - 3. Install in compliance with all manufacturer requirements.
 - 4. Provide type as specified on the contract drawings.
- B. Remote Readout Unit:
 - 1. Provide only where specified or shown on the drawings.
 - 2. Able to accept signals from meter, temperature transmitter and pressure transducer.
 - 3. Shall provide local display of actual flow rate, totalized flow (counter), and percent of full flow.
 - 4. Shall provide a 4-20 mA DC analog signal to read actual flow and totalized flow at DDC controller.
 - 5. 115V or 230V AC operation ($\pm 15\%$).
 - 6. Provide in NEMA 4 enclosure. Mount on adjacent wall.

2.22 FREEZESTATS

- A. Shall be heavy-duty temperature controls that incorporate a vapor charged sensing element. 20 ft long.
- B. The low temperature cutout must be adjustable. 35 to 45 °F.
- C. The sensor shall DPDT open low contact, secondary contacts for monitoring by the DDC system.
- D. Manual reset.
- E. Approved manufacturer: Johnson Controls.

2.23 AIR PROVING SWITCHES

- A. The air proving switches shall have an operating range of 0.15 - 0.5" WC (or as required to meet the actual system conditions) and have a setpoint adjustment.
- B. Wiring connections shall be 3-screw type, common, normally open and normally closed.
- C. Approved manufacturer: Dwyer 1900 series or equivalent.

2.24 LIQUID PROVING SWITCHES

- A. The liquid proving switch shall measure the difference in pressure exerted upon its sensing element(s) and operate a SPDT switch at the differential pressure setpoint.
- B. Paddle switches shall be used where shown. Mount in a 1 ¼" FNPT fitting.
- C. Differential pressure setpoint must be adjustable within the range of 8-60 psid and the switch differential shall be 1.5 psi. Paddle switch to have adjustability over all anticipated operating flow conditions.
- D. Approved Manufacturer – Differential Pressure – Penn A-74 series or equivalent. Paddle – McDonnell and Miller FS7-4S or FS7-4W.

2.25 DAMPER POSITION SWITCHES

- A. Shall be crank mounted and provide two snap-action SPDT contacts. Each switch shall be adjustable with a minimum differential of 9°F.
- B. Approved manufacturer: Barber-Colman AM-321 or equivalent.
- C. Mercury switches are not permitted

2.26 ENCLOSURES

- A. Enclosures shall be NEMA-1 rated steel, finished to control oxidation in a highly humid atmosphere.
- B. Each enclosure shall have a hinged door with handle and keyed lock.
- C. Shall be Johnson Controls M8100 series or better.
- D. Shall provide 25% of free space for future expansion of the system.

2.27 DAMPER MOTORS

- A. Electronic:
 - 1. Electronic actuators shall be used in all locations unless otherwise specified.
 - 2. Electronic actuators shall be driven directly by 0-10 VDC, Supply power: 24 VAC as acceptable to its controller, and provide adequate torque to meet the application.
 - 3. Electronic actuators shall be direct-coupled type.
 - 4. Actuators to have a memory return to a designated position (spring or electronic.
 - 5. For all actuators assure execution of the fail-safe position in case of the Freezestat trip or power loss.
 - 6. Design Make: Belimo

2.28 CONTROL DAMPERS

- A. Blades are extruded aluminum profiles. Aluminum end caps are press fitted to blade ends in order to seal hollow interior and reduce air leakage rates.
- B. Blade and frame seals are extruded silicone and are secured in an integral slot within the aluminum extrusions.
- C. Bearings are composed of a Celcon inner bearing fixed to a 7/16" (11.11mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
- D. Linkage hardware is installed in the frame side and constructed of aluminum and corrosion-resistant, zinc-plated steel, complete with cup-point trunnion screws for a slip-proof grip.
- E. Dampers are designed for operation in temperatures ranging between -40°F (-40°C) and 212°F (100°C).
- F. Dampers are available with either opposed blade action or parallel blade action.
- G. Leakage Class 1A at 1" w.g. static pressure differential. Standard air leakage data is certified under the AMCA Certified Ratings Program.

- H. Pressure drop of a fully open 48" x 48" (1219mm x 1219mm) damper shall not exceed .02" (.004kPa) w.g. at 1000 fpm (5.08 m/s).
- I. Dampers are available in two mounting types: i.e., "Installed in Duct" or "Flanged to Duct".
- J. Provide thermally broken frame design where use of standard frame could cause condensation or operational issues.
- K. Installation of dampers shall be in accordance with current manufacturer's installation instructions
- L. Dampers over 48 in. in length and height shall be made into multiple sections.
- M. Automatic dampers are required at all exterior walls and roof openings. Dampers to open when respective fan starts. Dampers at exterior walls and roof openings shall be insulated blade, thermal break design.
- N. Dampers shall be sized by the temperature control manufacturer. Maximum velocity shall be 1500 fpm and maximum pressure drop shall be 0.1 in w.g.
- O. Design Make: Tamco 1500 series (standard), Tamco 9000 series (insulated, all outdoor air isolation and relief applications)

2.29 CONTROL VALVES

- A. Provide factory fabricated control valves with operators as required by this specification. Provide selection as determined by manufacturer for installation requirements and pressure class, based on maximum pressure and temperature in piping system. Provide valve size in accordance with specified maximum pressure drop across control valve. Equipment control valves with heavy duty actuators, with proper shut off rating for each individual application.
- B. Water Service Valves: Equal percentage characteristics for throttling service, linear characteristics for 3-way mixing or diverting service, with a range of 30 to 1, and maximum full flow pressure drop of 3 psig based on the system fluid. Two-position valves shall be line size. Observe proper wiring diagram of actuator to meet controller's output requirements. Position the valve with the actuator facing up. Allow space to visually inspect the top of actuator. Provide manual handle to indicate and change the valve's position during manual testing. Provide stainless steel ball and stem for valves up to 2 1/2" size diameter. Provide initial setup as required. Prior to valve installation verify its ball position accuracy in alignment with position of the actuator and its control direction, and permanently mark both extreme ball positions on the top of the stem.
- C. Steam Service Valves: Linear characteristics for 90% of closing stroke and equal percentage for final 10 percent with range of 30 to 1, and maximum full flow of 50% of inlet pressure for low pressure systems, and 42% for high pressure systems. Two-position valves shall be line size.

- D. Single Seated Valves: Cage type trim, providing seating and guiding surfaces for plug on "top and bottom" guided plugs.
- E. Valve Trim and Stems: Polished stainless steel.
- F. Packing: Dual O-Ring up to 1 ½", Spring-loaded Teflon, self-adjusting 2" and up.
- G. Bodies, 2" and Smaller: Bronze with screwed end connections, replaceable brass seat. 125 psig rated, minimum.
- H. Bodies, 2 1/2" and Larger: Cast iron with flanged end connections, replaceable brass seat. 125 psig rated, minimum.
- I. Bodies, steam over 50 psi, stainless steel.
- J. Input signal: Electronic actuators shall use 0-10 VDC, equipped with spring failure position return all heating applications. "Floating point" actuation allowed only where specifically noted elsewhere in the contract documents.
- K. The Back-to-back electronic actuations, i.e., where two identical actuators are engaged in operating the rising or rotation of the stem of a valve or damper, are not permitted;
- L. Closeoff:
 - 1. Water – 150% of total system (pump) head.
 - 2. Steam – 200% of system operating (inlet) pressure
- M. Design Make: Belimo

2.30 SAFTEY/STATUS DEVICES

- A. Low Limit Detector: Electric type, with 20' long serpentine element, with manual reset and auxiliary contacts to the DDC, set for 37°F for "freeze" protection and 55°F for fan discharge application. Provide a 20' long element for every 25 sq. ft. of coil face area. Low-Limit Thermostats. Low-limit airstream thermostats shall be UL listed, vapor pressure type. Element shall sense temperature in each 30 cm (1 ft) section and shall respond to lowest sensed temperature. Low-limit thermostat shall be manual reset only.
- B. High Limit Detector: Electric type, with manual reset and auxiliary contacts to the DDC, UL listed for fire, set for 180°F.
- C. Pump status through adjustable range current sensing element on pump motor. Calibrate to actual conditions.
- D. Fan status through adjustable range current sensing element on the fan motor. Calibrate to actual conditions.

PART 3 - EXECUTION

3.1 WIRING

- A. Unless noted otherwise, all electrical wiring required to interconnect the components of the control system shall be furnished and installed by the Controls Contractor. Perform all wiring in accordance with the requirements listed below, manufacturer's requirements and code requirements. In the event of conflict between these standards, the most stringent in the opinion of the Engineer shall apply.

- B. Communication wiring shall be installed using the particular system recommended, plenum rated, jacket shielded cable. The communication network wiring shall be clearly marked with a specific color code. Communication wiring shall not be installed near noise producing equipment, such as ballasts, magnetic starters, etc. Communication wiring shall comply with the optimum requirements necessary to assure communication integrity and speed.
- C. All analog inputs and analog outputs shall be wired using 18 gauge stranded shielded cable.
- D. All digital outputs shall be wired using 18 gauge stranded wire.
- E. All wiring in mechanical rooms, walls shall be installed in EMT conduit. Concealed conduit and wiring is required in all finished spaces. Where impossible to wiring within existing structure, coordinate with owner and architect for use of an acceptable metallic "wiremold" raceway.
- F. Power Supplies
 - 1. Transformers – Each w/ low voltage fuse holder/disconnect
 - 2. Actuators and relays shall use separate transformers from those powering microprocessor control panels.
 - 3. Transformers shall be sized for a minimum of 150% of the connected load.
 - 4. Switched 110vac to panel is fused before transformers (after outlet).
 - 5. Provide at all control panels excepting those for terminal equipment (exclude VAV boxes, reheats, cabinet heaters, fan coils, etc.)
 - 6. Wiring Panduit
 - a. Wire ducts around exterior of panel for cables entering panel
 - b. Wire ducts as necessary to route hookup wires from terminals to controllers and other devices
 - 7. Wire Labeling
 - a. All DDC system wiring shall be individually labeled and permanently tagged at both ends of the conductors, including within all junction boxes between panels.
 - b. All submittal and as-built drawings shall reflect the field installed wire tag numbers.
 - c. All wire numbers shall be unique throughout the system installation.

3.2 DDC EQUIPMENT

- A. All components shall be installed in protective enclosures. All wiring within the DDC enclosure shall be number coded. Both the enclosure and the controller shall be properly grounded in accordance with manufacturer's recommendation. Documentation shall be firmly attached to the enclosure within a plastic envelope. Documentation shall

state point-to-point termination detail, description of each individual point, location of power source for the controller and ID number or address within the network.

- B. All DDC Controllers shall be mounted on walls within equipment rooms, custodial closets or electrical rooms. Only application-specific controllers for VAV boxes, rooftop units or package units may be mounted on the equipment.

3.3 PROTECTION

- A. Controls Contractor shall protect against and be liable for damage to work and to material caused by Contractor's work or employees.
- B. Controls Contractor shall be responsible for work and equipment until inspected, tested, and accepted. Protect material not immediately installed. Close open ends of work with temporary covers or plugs during storage and construction to prevent entry of foreign objects.

3.4 COORDINATION

- A. Site.
 - 1. Assist in coordinating space conditions to accommodate the work of each trade where work will be installed near or will interfere with work of other trades. If installation without coordination causes interference with work of other trades, Contractor shall correct conditions without extra charge.
 - 2. Coordinate and schedule work with other work in the same area and with work dependent upon other work to facilitate mutual progress.
- B. Test and Balance.
 - 1. Provide Test and Balance Contractor a single set of necessary tools to interface to control system for testing and balancing.
 - 2. Train Test and Balance Contractor to use control system interface tools.
 - 3. Provide a qualified technician to assist with testing and balancing of all air handling equipment and terminal units.
 - 4. Test and Balance Contractor shall return tools undamaged and in working condition at completion of testing and balancing.

3.5 GENERAL WORKMANSHIP

- A. Install equipment, piping, and wiring or raceway horizontally, vertically, and parallel to walls wherever possible.
- B. Independently support all temperature control wiring from other systems. Do NOT support from conduits, piping or hangers for equipment.
- C. Provide sufficient slack and flexible connections to allow for piping and equipment vibration isolation.

- D. Install equipment in readily accessible locations as defined by National Electrical Code (NEC) Chapter 1 Article 100 Part A.
- E. Verify wiring integrity to ensure continuity and freedom from shorts and ground faults.
- F. Equipment, installation, and wiring shall comply with industry specifications and standards and local codes for performance, reliability, and compatibility.

3.6 FIELD QUALITY CONTROL

- A. Work, materials, and equipment shall comply with rules and regulations of applicable local, state, and federal codes and ordinances.
- B. Continually monitor field installation for code compliance and workmanship quality.
- C. Contractor shall arrange for work inspection by local or state authorities having jurisdiction over the work.

3.7 COMMUNICATION WIRING

- A. Install communication wiring in separate raceways and enclosures from other Class 2 wiring.
- B. During installation do not exceed maximum cable pulling, tension, or bend radius specified by the cable manufacturer.
- C. Verify entire network's integrity following cable installation using appropriate tests for each cable.
- D. Install lightning arrestor according to manufacturer's recommendations between cable and ground where a cable enters or exits a building.
- E. Each run of communication wiring shall be a continuous length without splices when that length is commercially available. Runs longer than commercially available lengths shall have as few splices as possible using commercially available lengths.
- F. Label communication wiring to indicate origination and destination.
- G. Ground coaxial cable according to NEC regulations article on "Communications Circuits, Cable, and Protector Grounding."

3.8 INSTALLATION OF SENSORS

- A. Install sensors according to manufacturer's recommendations.
- B. Mount sensors rigidly and adequately for operating environment.

- C. Install room temperature sensors on concealed junction boxes properly supported by wall framing.
- D. Air seal wires attached to sensors in their raceways or in the wall to prevent sensor readings from being affected by air transmitted from other areas.
- E. Use averaging sensors in mixing plenums and hot and cold decks. Install averaging sensors in a serpentine manner vertically across duct. Support each bend with a capillary clip.
- F. Install mixing plenum low-limit and duct averaging sensors in a serpentine manner horizontally across duct. Support each bend with a capillary clip. Provide 1 ft of sensing element for each 2 ft² of coil area.
- G. Install pipe-mounted temperature sensors in wells. Install liquid temperature sensors with heat-conducting fluid in thermal wells.
- H. Install outdoor air temperature sensors on north wall at designated location with sun shield.
- I. All sensors to be mounted on externally insulated ductwork or plenums shall be provided with standoff brackets. Insulation and vapor barriers shall be carried continuously beneath the sensor enclosure.
- J. Differential Air Static Pressure.
 - 1. Supply Duct Static Pressure. Pipe duct pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 - 2. Return Duct Static Pressure. Pipe duct pressure tap to duct using a pitot tube. Make pressure tap connections according to manufacturer's recommendations.
 - 3. Building Static Pressure. Pipe pressure sensor's low-pressure port to the static pressure port located on the outside of the building through a high-volume accumulator. Pipe high-pressure port to a location behind a thermostat cover. Outdoor port shall be protected from intrusion by insects or debris.
 - 4. Piping to pressure transducer pressure ports shall contain a capped test port adjacent to transducer.

5. Air pressure transducers, except those controlling VAV boxes, shall be located in control panels, not on monitored equipment or on ductwork. Mount transducers in a vibration-free location accessible for service without use of ladders or special equipment.
 6. Mount gauge tees adjacent to air and water differential pressure taps. Install shut-off valves before tee for water gauges.
- K. Smoke detectors, freezestats, high-pressure cut-offs, and other safety switches shall be hard-wired to de-energize equipment as described in the sequence of operation. Switches shall require manual reset. Provide contacts that allow DDC software to monitor safety switch status.

3.9 ACTUATORS

- A. General. Mount actuators and adapters according to manufacturer's recommendations.
- B. Electric and Electronic Damper Actuators. Mount actuators directly on damper shaft or jackshaft unless shown as a linkage installation. Link actuators according to manufacturer's recommendations.
1. For low-leakage dampers with seals, mount actuator with a minimum 5° travel available for damper seal tightening.
 2. To compress seals when spring-return actuators are used on normally closed dampers, power actuator to approximately 5° open position, manually close the damper, then tighten linkage.
 3. Check operation of damper-actuator combination to confirm that actuator modulates damper smoothly throughout stroke to both open and closed positions.
 4. Provide necessary mounting hardware and linkages for actuator installation.
- C. Valve Actuators. Connect actuators to valves with adapters approved by actuator manufacturer.
- D. Damper Actuators – where exterior duct insulation is applied, provide standoffs for mounting of actuators. DO NOT cut insulation or install actuator directly to duct surface.

3.10 IDENTIFICATION OF HARDWARE AND WIRING

- A. Label wiring and cabling, including that within factory-fabricated panels, with control system address or termination number at each end within 2 in. of termination.
- B. Permanently label or code each point of field terminal strips to show instrument or item served.
- C. Label control panels with minimum ½ in. letters on laminated plastic nameplates.
- D. Label each control component with a permanent label. Label plug-in components such that label remains stationary during component replacement.

- E. Label room sensors related to terminal boxes or valves with nameplates.
- F. Manufacturers' nameplates and UL or CSA labels shall be visible and legible after equipment is installed.
- G. Label identifiers shall match record documents.

3.11 OPERATOR INTERFACE

- A. Standard Graphics. Show on each equipment graphic input and output points and relevant calculated points such as indicated on the applicable Points List / diagram. Point information on graphics shall dynamically update. Graphics shall be reviewed by both the Owner and the Commissioning Authority for accuracy, completeness, logical arrangement, and ease of use. This contractor shall provide necessary labor to update graphics to the reasonable satisfaction of both the Owner and Commissioning Authority.
- B. Install, initialize, start up, and troubleshoot operator interface software and functions (including operating system software, operator interface database, and third-party software installation and integration required for successful operator interface operation).
- C. Provide logical descriptions and engineering units on all data displays. Example: percentage position shall be easily discernable as percent open or closed.
- D. Coordinate all point alarming and reporting requirements with Owner's needs.

3.12 CLEANING

- A. Each day clean up debris resulting from work. Remove packaging material as soon as its contents have been removed. Collect waste and place in designated location.
- B. On completion of work in each area, clean work debris and equipment. Keep areas free from dust, dirt, and debris.
- C. On completion of work, check equipment furnished under this section for paint damage. Repair damaged factory-finished paint to match adjacent areas. Replace deformed cabinets and enclosures with new material and repaint to match adjacent areas.

END OF SECTION 230923