



**DESIGN AND CONSTRUCTION GROUP
THE GOVERNOR NELSON A. ROCKEFELLER
EMPIRE STATE PLAZA
ALBANY, NY 12242**

ADDENDUM NO. 3 TO PROJECT NO. 44983

**HVAC WORK
INSTALL ENERGY MANAGEMENT SYSTEM
BARE HILL CORRECTIONAL FACILITY
181 BRAND ROAD
MALONE, NY**

January 5, 2016

<p>NOTE: This Addendum forms a part of the Contract Documents. Insert it in the Project Manual. Acknowledge receipt of this Addendum in the space provided on the Bid Form.</p>
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SPECIFICATIONS

1. SECTION 019113 COMMISSIONING REQUIREMENTS: Discard the Section bound in the Project Manual and substitute the attached section (pages 019113-1 thru 019113-20) noted "REVISED 12/09/2015".
2. SECTION 019113 SYSTEMS COMMISSIONING: Discard the Section bound in the Project Manual and substitute the attached section (pages 019114-1 thru 019114-14) noted "REVISED 12/09/2015".
3. Page 230593-2, Paragraph 3.02 B.: Add the following Subparagraph:
"6. Cleaning and flushing is required only for the Work of this Contract. Cleaning and flushing of the entire existing system is not required."
4. Page 230594-3, ARTICLE 3.01 FIELD QUALITY CONTROL: Add the following Paragraph:
"C. Balance all air and water systems for the buildings included in the scope of the Work for this Project. Refer to Drawing No. M-04 for a list of equipment requiring to be balanced."
5. Page 230923-6, ARTICLE 1.07 BASIC SYSTEM ARCHITECTURE: Add the following Paragraph:
"K. Location of miscellaneous system architecture devices: (1) desktop workstation in Building 42, (1) rack-mounted server in Building 1, (1) notebook style workstation in Building 1, (1) touchscreen alarm/monitor panel-mounted tablet in Building 1 and (1) notebook style workstation (service)."

6. Page 230923-43, PART 2 PRODUCTS: Add the following Articles:

“2.22 BACnet COMMUNICATION CARDS

- A. Provide manufacturer’s standard BACnet communication cards for all existing equipment identified to be integrated.

2.23 LEAK DETECTION SYSTEM FOR DATA CLOSET 1-88

- A. Provide Liebert Liqui-tect 460 Module leak detection system with 100 feet of cable or equal. The LT460 Module shall be a metal enclosure with a hinged top door providing access to the internal circuit board for wiring termination and configuration of DIP switches. DDC communication shall be via dry contacts.
- B. Provide LT500Y Leak Detection cable material. Construction shall allow the cable to lie flat when used with hold-down clips. The LT500Y shall be plenum-rated and UL-listed for safe operation. Cables shall be able to be connected incrementally. Provide an end terminator and hold-down clips for the cable installation. A minimum of two clips are required for each 6-8 ft. of cable.”

DRAWINGS

7. Drawing Nos. 001-M-03, 002-M-02, 004-M-03, 005-M-02, 006-M-02, 007-M-02, 008-M-03, 009-M-02, 010-M-02, 011-M-02, 012-M-02, 013/019-M-02, 030/031-M-02, 032/038-M-02, 042-M-02, and 119-M-02: Reference Notes 1, 2 and 3 are general notes that apply to all buildings
8. Drawing Nos. 001-M-03, 002-M-02, 004-M-03, 005-M-02, 006-M-02, 007-M-02, 008-M-03, 009-M-02, 010-M-02, 011-M-02, 012-M-02, 013/019-M-02, 030/031-M-02, 032/038-M-02, 042-M-02, & 119-M-02: Remove all existing Siemens controllers and end devices per note 2 on drawings.
9. Drawing No. M-01, MECHANICAL SITE PLAN: Add the following drawing scale to Site Plan: “SCALE: 1 inch equals 170 feet”.
10. Drawing M-04, GENERAL NOTES: Add the following Note:
- “I. PROVIDE 12-STRAND FIBER PATCH PANELS AND LAND ALL FIBER STRANDS. NETWORK GEAR SUCH AS FIBER PATCH PANELS, MEDIA CONVERTERS, NETWORK SWITCHES, NETWORK ROUTERS, SHALL BE INDUSTRY-STANDARD, RACK MOUNTED EQUIPMENT AS REQUIRED TO PROVIDE A COMPLETE AND FUNCTIONAL NETWORK FOR THE DDC SYSTEM.”

11. Drawing No. M-04, RACK DETAIL: Add the following to the Note:

“RACK HEIGHT SHALL BE MANUFACTURER’S STANDARD, APPROXIMATELY 49”.
ACCESSORIES SUCH AS FANS, POWER, LIGHTS, ETC. ARE ONLY REQUIRED IF THE
GEAR TO BE MOUNTED INSIDE THE RACK REQUIRE THESE ACCESSORIES.
PROVIDE RACKS WHERE THERE IS NO EXISTING RACK OR THE EXISTING RACK
HAS NO AVAILABLE ROOM.”

12. Drawing No. 001-M-01:

- a. Change “VAV-19 and associated sensor” located in Room 1-83 to read “VAV-18”.
- b. Add VAV-8 and associated sensor to Room 1-43.
- c. Add the following:

“GENERAL NOTES

1. IN ADDITION TO CONTROLS SHOWN ON THE DRAWINGS FOR BUILDING 4, PROVIDE CONTROLS FOR A TOTAL OF THREE (3) ADDITIONAL VAV BOXES AND SENSORS FOR THIS BUILDING. LOCATIONS FOR THE THREE ADDITIONAL VAV BOXES AND SENSORS TO BE DETERMINED IN THE FIELD.”

13. Drawing No. 001-M-02: Add the following:

“GENERAL NOTES

1. IN ADDITION TO CONTROLS SHOWN ON THE DRAWINGS FOR BUILDING 4, PROVIDE CONTROLS FOR A TOTAL OF THREE (3) ADDITIONAL VAV BOXES AND SENSORS FOR THIS BUILDING. LOCATIONS FOR THE THREE ADDITIONAL VAV BOXES AND SENSORS TO BE DETERMINED IN THE FIELD.”

14. Drawing No. 004-M-04, AIR HANDLING UNITS (HEATING AND VENTILATING UNITS), SEQUENCE OF OPERATIONS: Add the following Note:

“4. MONITOR THE RETURN AIR TEMPERATURE.”

15. Drawing 004-M-01: Add the following:

“GENERAL NOTES

1. PROVIDE CONTROLS FOR HV UNIT 12A, LOCATION TO BE DETERMINED IN THE FIELD.”

16. Drawing No. 042-M-42, POINTS LIST: Add the following Note:

“5. PROVIDE MANUFACTURER’S STANDARD BACNET INTERFACE CARD FOR THE MASTER BOILER PANEL, MAIN FACILITY B&G PUMP CONTROL PANEL, ANNEX B&G PUMP CONTROL PANEL, WATER TOWER CONTROL PANEL AND THE FUEL OIL TANK LEVEL CONTROL PANEL. PROVIDE INTEGRATION FOR POINTS LISTED.”

17. Addendum Drawings:
 - a. Drawing No. M-06, noted “ADDENDUM DRAWING 12/09/2015” accompanies this Addendum and forms part of the Contract Documents.

END OF ADDENDUM

Margaret F. Larkin
Executive Director
Design and Construction

JRC;jc

SECTION 019113

COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions apply to this Section.
- B. Section 019114 – Systems Commissioning

1.02 DESCRIPTION

- A. Commissioning. Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the owner’s operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of performance. The commissioning process shall encompass and coordinate the traditionally separate functions of system documentation, equipment startup, control system calibration, testing and balancing, performance verification and training.
- B. Commissioning during the construction phase is intended to achieve the following specific objectives according to the Contract Documents:
 - 1. Verify that applicable equipment and systems are installed according to the manufacturer’s recommendations and to industry accepted minimum standards and that they receive adequate operational checkout.
 - 2. Verify and document proper performance of equipment and systems.
 - 3. Verify that O&M documentation left on site is complete.
 - 4. Verify that the Owner’s operating personnel are adequately trained.
- C. The commissioning process does not take away from or reduce the responsibility of the system designers or contractor to provide a finished and fully functioning product.
- D. Abbreviations. The following are common abbreviations used in the Specifications. Definitions are found in Section 1.3.

Eng -	Design Engineers	GC -	Contractor
CxA -	Commissioning Authority	MC -	Mechanical representative
Cx -	Commissioning	PC -	Prefunctional checklist
Cx Plan -	Commissioning Plan Document	PM -	Project manager (of the Owner)
EC -	Electrical representative	TAB	Testing Adjust Balance
FT -	Functional performance verification	TC -	Temperature Control representative

1.03 COORDINATION

- A. Commissioning Team: The members of the commissioning team consist of the Commissioning Authority (CxA), the Project Manager (PM) (by definition “the owner”), and design engineers (Eng) (particularly the mechanical engineer), the Contractor (GC), Mechanical representative (MC), Electrical representative (EC), Plumbing representative (PC), TAB representative (TAB), Controls (TC) representative, any other installers or suppliers of equipment. If known, the Owner’s building or plant operator/engineer is also a member of the commissioning team.
- B. Management: The CxA is hired by the Owner directly. The CxA directs and coordinates the commissioning activities and the reports to the Owner. All members work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents. The CxA’s responsibilities are the same regardless of who hired the CxA.
- C. Scheduling: The CxA will work with the Owner according to established protocols to schedule the commissioning activities. The CxA will provide sufficient notice to the Contractor for scheduling commissioning activities. The CxA will integrate all commissioning activities into the schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. The CxA will provide the initial schedule of primary commissioning events at the commissioning scoping meeting. As construction progresses more detailed schedules are developed by the Owner and CxA.

1.04 COMMISSIONING PROCESS

- A. Commissioning Plan: The commissioning plan provides guidance in the execution of the commissioning process. Just after the initial commissioning scoping meeting, the CxA will update the plan which is then considered the “final” plan, though it will continue to evolve and expand as the project progresses. The Contract Documents will take precedence over the Commissioning Plan.
- B. Commissioning Process: The following narrative provides a brief overview of the typical commissioning tasks during construction and the general order in which they occur.
 - 1. Commissioning during construction begins with a scoping meeting conducted by the CxA where the commissioning process is reviewed with the commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA with necessary parties attending, to plan, scope, coordinate, schedule future activities and resolve problems.
 - 3. Equipment documentation is submitted by the contractor to the CxA during normal submittals, including detailed start-up procedures.
 - 4. The CxA works with the Contractor in developing startup plans and startup documentation formats, including providing the Contractor with prefunctional checklists to be completed by the contractor during the startup process.
 - 5. In general, the checkout and performance verification proceeds from simple to complex; from component level to equipment to systems and intersystem levels with prefunctional checklists being completed before functional verification.

6. The Contractor, under their own direction, shall execute and document the prefunctional checklists and perform startup and initial checkout. The CxA documents that the checklists and startup were completed according to the approved plans. This may include the CxA witnessing start-up of selected equipment.
7. The CxA develops specific equipment and system functional performance verification procedures.
8. The prefunctional checklists are executed by the Contractor, under the direction of the CxA, and documented by the Contractor. The functional verifications are executed by the Contractor, under the direction of, and documented by the CxA.
9. Items of non-compliance in material, equipment, installation or setup are corrected and the system re-verified at the Contractor's expense.
10. The CxA reviews the O&M documentation for completeness.
11. Commissioning is completed before Substantial Completion.
12. The CxA reviews, pre-approves and coordinates the training provided by the Construction Manager and verifies that it was completed.
13. Deferred verification is conducted, as specified or required.

1.05 RELATED WORK

- A. Commissioning shall be included in the following sections of these specifications. All of the following sections apply to the Work of this section.

019114 Systems Commissioning	Describes additional the Cx responsibilities of the Contractor, focusing on TC and TAB tasks and the prefunctional verification and startup responsibilities.
230594 Balancing of Systems	Describes the TAB requirements.
230923 Direct Digital Building Control Systems	Describes the Temperature Control requirements.
260502 Basic Electrical Materials and Methods	Describes the electrical requirements For Direct Digital Building Control Systems

1.06 RESPONSIBILITIES

- A. **SUBMITTAL:** The Contractor shall provide a commissioning qualifications submittal demonstrating that the person(s) or entity that will be designated with contractor commissioning responsibilities for the project has previous commissioning experience, and has worked on at least two previous projects that included commissioning.
- B. The responsibilities of various parties in the commissioning process are provided in this section. The responsibilities of the Contractor are included. It is noted that the services for the Eng and CxA are not provided for in this contract. That is, the Contractor is not responsible for providing their services. Their responsibilities are listed here to clarify the commissioning process. Refer to 019114 Systems Commissioning also.
- C. **All Parties:** Attend commissioning scoping meeting and additional meetings, as necessary.
- D. **Engineer**
 - 1. **Construction and Acceptance Phase**
 - a. The Owner manages the CxA contract.
 - b. Attend the commissioning scoping meeting and selected commissioning team meetings.
 - c. Perform normal submittal review, construction observation, etc., as contracted.
 - d. Provide any design narrative documentation requested by the CxA.
 - e. Coordinate resolution of system deficiencies identified during commissioning, according to the contract documents.
 - f. Provide pertinent RFI, change order, etc. documentation to the CxA for items impacting the functional performance of the systems and equipment included in the Cx process.
 - g. Prepare and submit final as-built design intent documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
 - h. Furnish a copy of all construction documents, addenda, change orders and approved submittals and shop drawings related to commissioned equipment to the CxA.
 - 2. **Warranty Period**
 - a. Coordinate resolution of design non-conformance and design deficiencies identified during warranty-period commissioning.
 - b. Ensure that any seasonal or deferred verification and any deficiency issues are addressed.
- E. **Mechanical and Electrical Designers/Engineers**
 - 1. **Construction and Acceptance Phase**
 - a. Perform normal submittal review, construction observation, as-built drawing review, etc., as contracted. One site observation should be completed just prior to system startup.

- b. Provide any design narrative and sequences documentation requested by the CxA. The designers shall assist (along with the contractor) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed verification procedures.
 - c. Attend commissioning scoping meetings and other selected commissioning team meetings.
 - d. Participate in the resolution of system deficiencies identified during commissioning, according to the contract documents.
 - e. Prepare and submit the final as-built design intent and operating parameters documentation for inclusion in the O&M manuals. Review and approve the O&M manuals.
 - f. Provide a presentation at one of the initial training sessions for the Owner's personnel.
2. Warranty Period
- a. Participate in the resolution of non-compliance, non-conformance and design deficiencies identified during commissioning during warranty-period commissioning.
- F. Commissioning Authority (CxA)
- 1. The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. The CxA may assist with problem-solving non-conformance or deficiencies, but ultimately that responsibility resides with the contractor and the Eng. The primary role of the CxA is to develop and coordinate the execution of a verification plan, observe, verify and document performance—that systems are functioning in accordance with the documented design intent and in accordance with the Contract Documents. The Contractor will provide all trending, tools or the use of tools to start, check-out and functionally verification equipment and systems.
 - 2. Construction and Acceptance Phase
 - a. Coordinates and directs the commissioning activities in a logical, sequential and efficient manner using consistent protocols and forms, centralized documentation, clear and regular communications and consultations with all necessary parties, frequently updated timelines and schedules and technical expertise.
 - b. Coordinate the commissioning work and, with the OWNER, ensure that commissioning activities are being scheduled into the master schedule.
 - c. Revise, as necessary, the Commissioning Plan.
 - d. Plan and conduct a commissioning scoping meeting and other commissioning meetings.
 - e. Request and review additional information required to perform commissioning tasks, including O&M materials, as built drawings, contractor start-up and checkout procedures.
 - f. Before startup, gather and review the current control sequences and interlocks and work with contractor and design engineers until sufficient clarity has been obtained, in writing, to be able to write detailed verification procedures.
 - g. Review and approve normal Contractor submittals applicable to systems being commissioned for compliance with commissioning needs, concurrent with the ENG reviews.

- h. Write and distribute prefunctional checklists.
 - i. Develop an enhanced start-up and initial systems checkout plan.
 - j. Perform site visits, as necessary, to observe component and system installations. Attend selected planning and job-site meetings to obtain information on construction progress. Assist in resolving any discrepancies.
 - k. Witness initial testing of the HVAC piping testing and flushing procedure, sufficient to be confident that proper procedures were followed. Document this verification and include the documentation in O&M manuals. Notify owner's project manager of any deficiencies in results or procedures.
 - l. Witness initial testing of any ductwork testing and cleaning procedures, sufficient to be confident that proper procedures were followed. Document this verification and include the documentation in O&M manuals. Notify owner's project manager of any deficiencies in results or procedures.
 - m. Approve prefunctional checklist completion by reviewing prefunctional checklist reports and by selected site observation and spot checking.
 - n. Approve systems startup by reviewing start-up reports and by selected site observation.
 - o. Review TAB execution plan.
 - p. Oversee sufficient functional verification of the control system and approve it to be used for TAB, before TAB is executed.
 - q. Approve air and water systems balancing by spot verification, by reviewing completed reports and by selected site observation.
 - r. With necessary assistance and review from the contractor, write the functional performance verification procedures for equipment and systems. This may include energy management control system trending, or manual functional verification.
 - s. Analyze any functional performance trend logs and monitoring data to verify performance.
 - t. Coordinate, witness and approve manual functional performance verifications performed by the contractor. Coordinate re-verification as necessary until satisfactory performance is achieved. Perform actual functional verification with the contractor on equipment so specified.
 - u. Maintain a master deficiency and resolution log and a separate verification record. Provide the PM and Eng with written progress reports and verification results with recommended actions.
 - v. Review equipment warranties, spare parts, turn-over items, etc to ensure that the Owner's responsibilities are clearly defined.
 - w. Oversee and approve the training of the Owner's operating personnel.
 - x. Compile and maintain a commissioning record and building systems book(s).
 - y. Review and approve the preparation of the O&M manuals.
 - z. Provide a final commissioning report (as described in this section).
3. Warranty Period
- a. Coordinate and supervise required seasonal or deferred verification and deficiency corrections.
 - b. Return to the site at 10 months into the 12 month warranty period and review with facility staff the current building operation and the condition of outstanding issues related to the original and seasonal commissioning.

Also interview facility staff and identify problems or concerns they have operating the building as originally intended. Make suggestions for improvements and for recording these changes in the O&M manuals. Identify areas that may come under warranty or under the original construction contract.

G. Contractor

1. Construction and Acceptance Phase

- a. Coordinate the work to ensure that commissioning activities are being scheduled into the schedule.
- b. Include all costs of its commissioning related work in the total contract price.
- c. Satisfy the requirements for submittal data, O&M data, commissioning tasks and training.
- d. Ensure that all commissioning responsibilities are executed according to the Contract Documents and schedule.
- e. A representative shall attend a commissioning scoping meeting and other necessary meetings scheduled by the CxA to facilitate the Cx process.
- f. Complete prefunctional checklist as provided by the Commissioning Authority.
- g. Perform systems startup by completing start-up reports.
- h. Perform functional verifications as directed by the Commissioning Authority.
- i. Perform trend log analysis as directed by the Commissioning Authority.
- j. Provide the training of owner personnel.
- k. Provide as-built drawings, O&M manuals, etc. according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
- l. Provide all requested submittal data, including detailed start-up procedures and specific responsibilities of the Owner to keep warranties in force.
- m. Provide a qualified technical representative for equipment verification.
- n. Provide all special tools, software, hardware and instruments (particularly those only available from manufacturer's representative, specific to a piece of equipment) required for verification equipment according to these Contract Documents in the base bid price to the Contractor.
- o. Provide information requested by CxA regarding equipment sequence of operation and verification procedures.
- p. Review verification procedures for equipment installed by factory representatives.

2. Warranty Period

- a. Ensure that seasonal or deferred functional performance verification is provided; witnessed by the CxA, according to the specifications.
- b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal verification.

1.07 DEFINITIONS (see agreement for additional specific information)

- A. Acceptance Phase - phase of construction after startup and initial checkout when functional performance verifications, O&M documentation review and training occurs. This occurs prior to substantial completion according to the agreement.
- B. Approval - acceptance that a piece of equipment or system has been properly installed and is functioning in the verification modes according to the Contract Documents.
- C. Engineer (Eng) - the prime consultant (Engineer) and sub-consultants who comprise the design team, generally the HVAC mechanical designer/engineer and the electrical designer/engineer.
- D. Basis of Design - The basis of design is the documentation of the primary thought processes and assumptions behind design decisions that were made to meet the design intent. The basis of design describes the systems, components, conditions and methods chosen to meet the intent. Some reiterating of the design intent may be included.
- E. Commissioning authority (CxA) - an independent agent, not otherwise associated with the Eng team members or the Contractor. The CxA directs and coordinates the day-to-day commissioning activities.
- F. Commissioning Plan - an overall plan, developed before or after bidding, that provides the structure, schedule and coordination planning for the commissioning process.
- G. Contract Documents - the documents binding on parties involved in the construction of this project (drawings, specifications, change orders, amendments, contracts, Cx Plan, etc.).
- H. Contractor - the entity named in the agreement.
- I. Control system - the central building energy management control system.
- J. Deferred Functional Verifications – When approved by the consultant, FTs that are performed later, after substantial completion, due to partial occupancy, equipment, seasonal requirements, design or other site conditions that disallow the verification from being performed.
- K. Deficiency - a condition in the installation or function of a component, piece of equipment or system that is not in compliance with the Contract Documents (that is, does not perform properly or is not complying with the design intent).
- L. Design Intent - a dynamic document that provides the explanation of the ideas, concepts and criteria that are considered to be very important to the owner. It is initially the outcome of the programming and conceptual design phases.
- M. Design Narrative or Design Documentation - sections of either the Design Intent or Basis of Design.
- N. Factory Verification - verification of equipment on-site or at the factory by factory personnel with an Owner's representative present.

- O. Functional Performance Verification - verification of the dynamic function and operation of equipment and systems using manual (direct observation) or monitoring methods. Functional verification is the dynamic verification of systems (rather than just components) under full operation (e.g., the chiller pump is verified interactively with the chiller functions to see if the pump ramps up and down to maintain the differential pressure setpoint). Systems are verified under various modes, such as during low cooling or heating loads, high loads, component failures, unoccupied, varying outside air temperatures, fire alarm, power failure, etc. The systems are run through all the control system's sequences of operation and components are verified to be responding as the sequences state. Traditional air or water verification and balancing (TAB) is not functional verification, in the commissioning sense of the word. TAB's primary work is setting up the system flows and pressures as specified, while functional verification is verifying that which has already been set up. The commissioning authority develops the functional verification procedures in a sequential written form, coordinates, oversees and documents the actual verification, which is performed by the contractor or manufacturer's representative. Functional verifications are performed after prefunctional checklists and startup is complete.
- P. Indirect Indicators - indicators of a response or condition, such as a reading from a control system screen reporting a damper to be 100% closed.
- Q. Manual Verification - using hand-held instruments, immediate control system readouts or direct observation to verify performance (contrasted to analyzing monitored data taken over time to make the "observation").
- R. Monitoring - the recording of parameters (flow, current, status, pressure, etc.) of equipment operation using the trending capabilities of control systems.
- S. Non-Compliance - see Deficiency.
- T. Non-Conformance - see Deficiency.
- U. Over-written Value - writing over a sensor value in the control system to see the response of a system (e.g., changing the outside air temperature value from 50F to 75F to verify economizer operation). See also "Simulated Signal."
- V. Owner-Contracted Verifications - verifications paid for by the Owner outside this contract. These verifications will not be repeated during functional verifications if properly documented.
- W. Phased Commissioning - commissioning that is completed in phases (by floors, for example) due to the size of the structure or other scheduling issues, in order minimize the total construction time.

- X. Prefunctional Checklist (Pc) - a list of items to inspect and elementary component verifications to conduct to verify proper installation of equipment, provided by the CxA. Prefunctional checklists are primarily static inspections and procedures to prepare the equipment or system for initial operation (e.g., belt tension, oil levels OK, labels affixed, gages in place, sensors calibrated, etc.). However, some prefunctional checklist items entail simple verification of the function of a component, a piece of equipment or system (such as measuring the voltage imbalance on a three phase pump motor of a chiller system). The word prefunctional refers to before functional verification. Prefunctional checklists augment and are combined with the manufacturer's start-up checklist. Even without a commissioning process, contractor typically perform some, if not many, of the prefunctional checklist items a commissioning authority will recommend. However, few contractor document in writing the execution of these checklist items. Therefore, for most equipment, the contractor executes the checklist on their own. The commissioning authority only requires that the procedures be documented and submitted in writing, and does not witness much of the prefunctional check listing, except for larger or more critical pieces of equipment.
- Y. Project Manager (PM) - the contracting and managing authority for the owner over the design and/or construction of the project, a staff position.
- Z. Sampling - Functional verification of only a portion of the total number of identical or near identical pieces of equipment. Refer to Section 241000, Part 3.6, F for details.
- AA. Seasonal Performance Verifications - FT that are deferred until the system(s) will experience conditions closer to their design conditions.
- BB. Simulated Condition - condition that is created for the purpose of verification the response of a system (e.g., applying a heat source to a space sensor to see the response in a VAV box).
- CC. Simulated Signal - disconnecting a sensor and using a signal generator to send an amperage, resistance or pressure to the transducer and DDC system to simulate a sensor value.
- DD. Specifications - the construction specifications of the Contract Documents.
- EE. Startup - the initial starting or activating of dynamic equipment, including executing prefunctional checklists.
- FF. Verification Procedures - the step-by-step process which must be executed to fulfill the verification requirements. The verification procedures are developed by the CxA.
- GG. Verification Requirements - requirements specifying what modes and functions, etc. shall be verified. The verification requirements are not the detailed verification procedures. The verification requirements are specified in the Contract Documents.
- HH. Trending - monitoring using the building control system.
- II. Manufacturer's representative - supplier of equipment.

- JJ. Warranty Period - warranty period for entire project, including equipment components. Warranty begins at Substantial Completion and extends for at least one year, unless specifically noted otherwise in the Contract Documents and accepted submittals.

1.08 SYSTEMS TO BE COMMISSIONED

- A. The following systems and equipment will be commissioned in this project:
 - 1. HVAC Equipment (100% Verification):
 - a. Water to Water Exchangers
 - b. Base-mounted Pumps w/VFD's
 - c. Fan Systems
 - d. Exhaust Systems
 - e. Unit Heaters
 - f. Cabinet Unit Heaters
 - g. HVAC piping
 - h. Fin Tube Radiation
 - i. Heat Recovery Units
 - j. Reheat coils
 - k. Control Valves
 - l. Air-to-Air Heat Exchangers
 - m. Variable Speed Drives
 - n. Testing, Adjusting and Balancing
 - o. Temperature Controls
 - p. Warranty Phase

PART 2 - PRODUCTS

2.01 VERIFICATION EQUIPMENT

- A. All standard verification instruments and equipment required to perform startup, initial checkout and required functional performance verification shall be provided by the Contractor. For example, the contractor shall ultimately be responsible for all standard verification equipment for the HVAC system and controls system, except for equipment specific to and used by TAB in their commissioning responsibilities. Two-way radios shall be provided by the Contractor.
- B. Special equipment, tools and instruments (particularly those only available from manufacturer's representative, specific to a piece of equipment) required for verification equipment, according to these Contract Documents shall be included in the base bid price to the Contractor and left on site.
- C. All verification equipment shall be of sufficient quality and accuracy to verify and/or measure system performance within the tolerances specified. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers used for verification purposes shall have a certified calibration within the past year to an accuracy of 0.1°F and a resolution of + or - 0.1°F. Pressure sensors shall have an accuracy of + or - 2.0% of the value range 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

3.01 MEETINGS

- A. Scoping Meeting. The CxA will schedule, plan and conduct a commissioning scoping meeting with the entire commissioning team in attendance. Meeting minutes will be distributed to all parties by the CxA. Information gathered from this meeting will allow the CxA to revise the Commissioning Plan to its “final” version, which will also be distributed to all parties.
- B. Miscellaneous Meetings. Other meetings will be planned and conducted by the CxA as construction progresses. These meetings will cover coordination, deficiency resolution and planning issues with the Contractor. The CxA will plan these meetings and will minimize unnecessary time being spent by the Contractor. The frequency of these meetings will be determined by the CxA.

3.02 REPORTING

- A. The CxA will provide regular reports to the PM with increasing frequency as construction and commissioning progresses.
- B. The CxA will regularly communicate with all members of the commissioning team, keeping them apprised of commissioning progress and scheduling changes through memos, progress reports, etc.
- C. Verification or review approvals and non-conformance and deficiency reports are made regularly with the review and verification as described in later sections.
- D. A final summary report by the CxA will be provided to the PM, focusing on evaluating commissioning process issues and identifying areas where the process could be improved. All acquired documentation, logs, minutes, reports, deficiency lists, communications, findings, unresolved issues, etc., will be compiled in appendices and provided with the summary report. Prefunctional checklists, functional verifications and monitoring reports will not be part of the final report, but will be stored in the Commissioning Record.

3.03 SUBMITTALS

- A. The Eng will provide the CxA with pertinent information derived from the contractor submittal log for the type of submittal documentation the CxA requires to facilitate the commissioning work. These requests will be integrated into the normal submittal process and protocol of the construction team. At minimum, the request will include the manufacturer and model number, the manufacturer’s printed installation and detailed start-up procedures, full sequences of operation, O&M data, performance data, any performance verification procedures, control drawings and details of owner contracted verifications. In addition, the installation and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning authority. All documentation requested by the CxA will be included by the Contractor in the O&M manual contributions.
- B. The Commissioning authority will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning

process, to the functional performance of the equipment and adequacy for developing verification procedures. This review is intended primarily to aid in the development of functional verification procedures and only secondarily to verify compliance with equipment specifications. The Commissioning authority will document and provide notification of items missing or areas that are not in conformance with Contract Documents and which require resubmission.

- C. The CxA may request additional design narrative from the Eng and the Contractor, depending on the completeness of the design intent documentation and sequences provided with the Specifications.
- D. These submittals to the CxA do not constitute compliance for O&M manual documentation. The O&M manuals are the responsibility of the Contractor, though the CxA will review and provide comments.

3.04 START-UP, PREFUNCTIONAL CHECKLISTS AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment to be commissioned, according to Section 1.8, Systems to be Commissioned. Some systems that are not comprised so much of actual dynamic machinery, e.g., electrical system power quality, may have very simplified Pc's, manufacturers' start up documentation must be submitted.
- B. General. Prefunctional checklists are important to ensure that the equipment and systems are properly installed and operational. It ensures that functional performance verification (in-depth system checkout) may proceed without unnecessary delays. Each piece of equipment receives full prefunctional checkout. No sampling strategies are used. The prefunctional verification for a given system must be successfully completed by the contractor prior to formal functional performance verification of equipment or subsystems of the given system by the CxA.
- C. Start-up and Initial Checkout Plan. The primary role of the CxA in this process is to ensure that there is written documentation that each of the manufacturer-recommended procedures have been completed. Parties responsible for prefunctional checklists and startup are identified in the commissioning scoping meeting and in the checklist forms. Parties responsible for executing functional performance verifications are identified in the Contract Documents.
 - 1. These checklists are provided by the CxA to the Contractor. The Contractor holds the final responsibility to determine which trade is responsible for executing and documenting each of the line item task. Each checklist will be project specific, trade specific, & product specific.
 - 2. Develop the full start-up plan by combining (or adding to) the CxA's checklists along with the manufacturer's detailed start-up and checkout procedures from the O&M manual and the contractor standard quality control field checkout forms. The plan will include checklists and procedures with specific boxes or lines for recording and documenting the checking and inspections of each procedure and a summary statement with a signature block. The full start-up plan shall consist of:
 - a. The CxA's prefunctional checklists.
 - b. The manufacturer's standard written start-up procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.
 - c. The manufacturer's normally used field checkout sheets.

3. The Contractor submits their full startup plan to the CxA for review and approval.
 4. The CxA reviews and approves the procedures and the format for documenting them, noting any procedures that need to be added.
- D. Execution of Prefunctional Checklists and Startup.
1. Prior to startup, the Contractor and manufacturer's representatives shall schedule startup and checkout with the respective contractor and notify the CxA. The performance of the prefunctional checklists, startup and checkout are directed and executed by the contractor or manufacturer's representative. When checking off prefunctional checklists, signatures are required of the Contractor for conformation of completion of their work.
 2. The Contractor and manufacturer's representatives shall execute startup and provide the CxA with a signed and dated copy of the completed start-up and prefunctional verifications and checklists.
 3. Only individuals that have direct knowledge and witnessed that a line item task on the prefunctional checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.
- E. Deficiencies, Non-Conformance and Approval in Checklists and Startup.
1. The Contractor shall clearly list any outstanding items of the initial start-up and prefunctional procedures that were not completed successfully, at the bottom of the procedures form or on an attached sheet. The procedures form and any outstanding deficiencies are provided to the CxA.
 2. The CxA reviews the prefunctional checklist and either accepts or rejects them. The CxA shall work with the contractor and manufacturer's representatives to develop a plan to correct and re-verify deficiencies or uncompleted items. The CxA will involve the PM, the Contractor and others as necessary. The Contractor or manufacturer's representatives shall correct all areas that are deficient or incomplete in the checklists and verifications in a timely manner, and shall notify the CxA as soon as outstanding items have been corrected and resubmit an updated prefunctional checklist. When satisfactorily completed, the CxA recommends approval of the prefunctional checklists and startup of each system using a standard form.
 3. Items left incomplete, which later cause deficiencies or delays during the CxA's functional verification process may result in back charges to the responsible party. Refer to Part 3.7 herein for details.

3.05 PHASED COMMISSIONING

- A. The project may require startup and initial checkout to be executed in phases. This phasing will be planned and scheduled in a coordination meeting of the contractor, Owner, and the CxA. Results will be added to the master and commissioning schedule.

3.06 FUNCTIONAL PERFORMANCE VERIFICATION

- A. This sub-section applies to all commissioning functional verification for all divisions.
- B. The general list of equipment to be commissioned is found in this section.
- C. Objectives and Scope. The objective of functional performance verification is to demonstrate that each system is operating according to the documented design intent and

Contract Documents. Functional verification facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the verification process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.

- D. In general, each system should be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load) where there is a specified system response. Verifying each sequence in the sequences of operation is required. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be verified.
- E. Development of Verification Procedures. Before verification procedures are written, the CxA shall obtain all requested documentation and a current list of change orders affecting equipment or systems, including an updated points list, program code, control sequences and parameters. The CxA shall develop functional verification forms to verify and document proper operation of each piece of equipment and system. The Contractor shall be responsible to execute, and shall provide assistance as required, to the CxA in developing the procedures review (providing sequences as programmed, answering questions about equipment, operation, sequences, etc.). The purpose of any given specific verification is to verify and document compliance with the Contract Documents. The verification forms developed by the CxA shall include (but not be limited to) the following information:
 - 1. System and equipment or component name(s)
 - 2. Equipment location and ID number
 - 3. Unique verification ID number, and reference to unique prefunctional checklist and start-up documentation ID numbers for the piece of equipment
 - 4. Date
 - 5. Project name
 - 6. Participating parties
 - 7. A copy of the specification section describing the verification requirements
 - 8. A copy of the specific sequence of operations or other specified parameters being verified
 - 9. Required pre-verification field measurements
 - 10. Special cautions, alarm limits, etc.
 - 11. Acceptance criteria of proper performance with a Yes / No check box to allow for clearly marking whether or not proper performance of each part of the verification was achieved.
 - 12. A section for comments
 - 13. Signatures and date block for the CxA
- F. Verification Methods.
 - 1. Functional performance verification and verification may be achieved by manual verification (persons manipulate the equipment and observe performance) in addition to monitoring the performance and analyzing the results using the control system's trend log capabilities. The CxA may substitute specified methods or require an additional method to be executed, other than what was specified. The CxA will determine which method is most appropriate for verifications that do not have a method specified.
 - 2. Trending. All trending must be provided in an "X – Y" graphical format, color coded, with multiple scales to enhance resolution on the "Y" axis. Trend groups will be defined for all points, as directed by CxA. Trending will be provided for

all HVAC systems, a sampling strategy for secondary equipment will not be utilized. Trending for the previous weeks must be readily available, earlier trending will be archived on the BAS server. Each trend report should show the system that is being trended, along with the point IDs for all points being trended at 15 min. intervals. Color codes must be consistent for common point types in different trend groups. Fourteen days of consecutive days of trend data exhibiting system performance that has been verified is compliant with the control specification. After seven days of trending, capture an interim report to verify that trend data results are compliant with the Contract Documents. If the trend data results are compliant with the Contract Documents, continue trending. If there are abnormalities in the trend data reports, note the abnormalities and provide a resolution to correct the abnormalities with an anticipated resolution date and provide a report of the findings. When 14 consecutive days of trend data exhibiting system performance that the Contractor deems as compliant with the Contract Documents has been completed, submit the trend data to the CxA for review.

3. Simulated Conditions. Simulating conditions (not by an overwritten value) shall be allowed, though timing the verification to experience actual conditions is encouraged wherever practical.
4. Overwritten Values. Overwriting sensor values to simulate a condition, such as overwriting the outside air temperature reading in a control system to be something other than it really is, shall be allowed as directed by CxA. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
5. Altering Setpoints. Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to verification a sequence is acceptable. For example, to see the AC compressor lockout work at an outside air temperature below 55F, when the outside air temperature is above 55F, temporarily change the lockout setpoint to be 2F above the current outside air temperature.
6. Indirect Indicators. Relying on indirect indicators for responses or performance shall be allowed only after visually and directly verifying and documenting, over the range of the verified parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification is completed during the execution of the prefunctional checklists.
7. Setup. Each function and verification shall be performed under conditions that simulate actual conditions as close as is practically possible. Executing the verification and provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc. necessary to execute the verification according to the specified conditions. At completion of the verification, return all affected building equipment and systems, due to these temporary modifications, to their pre-verification condition.
8. Sampling. Functional verification of only a portion of the total number of identical or near identical pieces of equipment. Sampling for select equipment is identified in section 1.8.

- G. Coordination and Scheduling. The Contractor shall provide sufficient notice to the CxA regarding their completion schedule for the prefunctional checklists and startup of all equipment and systems. The CxA will schedule functional verifications through the Contractor. The CxA shall direct, witness and document the functional verification of all equipment and systems. The Contractor shall execute the verifications.
 - 1. In general, functional verification is conducted after prefunctional verification and startup has been satisfactorily completed. The control system is sufficiently verified and approved by the CxA before it is used for TAB or to verify performance of other components or systems. The air balancing and water balancing is completed and debugged before functional verification of air-related or water-related equipment or systems. Verification proceeds from components to subsystems to systems. When the proper performance of all interacting individual systems has been achieved, the interface or coordinated responses between systems is checked.
- H. Verification Equipment. Refer to Section 019113, Section 2.1 for verification equipment requirements.
- I. Problem Solving. The burden of responsibility to solve and correct and problems is with the Contractor and Eng.

3.07 DOCUMENTATION, NON-CONFORMANCE AND APPROVAL OF VERIFICATIONS

- A. Documentation. The CxA shall witness and document the results of all functional performance verifications using the functional verification forms. The CxA will include the filled out forms in the commissioning record.
- B. Non-Conformance.
 - 1. The CxA will record the results of the functional verification on the procedure or verification form. All deficiencies or non-conformance issues shall be noted and reported to the PM and the Contractor.
 - 2. Corrections of minor deficiencies identified may be made during the verifications at the discretion of the CxA. In such cases the deficiency and resolution will be documented on the procedure form.
 - 3. Every effort will be made to expedite the verification process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxA will not be pressured into overlooking deficient work or loosening acceptance criteria to satisfy scheduling or cost issues.
 - 4. As verifications progress and a deficiency is identified, the CxA discusses the issue with the contractor.
 - a. When there is no dispute on the deficiency and the Contractor accepts responsibility to correct it.
 - b. If there is a dispute about a deficiency, regarding whether it is a deficiency or who is responsible the deficiency shall be documented and turned over to the PM.
 - 1) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed in accordance with the agreement.
 - 2) The CxA documents the resolution process.
 - 3) Once the interpretation and resolution have been decided, the appropriate party corrects the deficiency, the CxA reschedules

the verification and the verification is repeated until satisfactory performance is achieved.

5. Cost of Re-verification.
 - a. The cost for the Contractor to re-verify a prefunctional checklist or functional verification, if they are responsible for the deficiency, shall be theirs. If they are not responsible, any cost recovery for re-verification shall be negotiated by the PM with the Contractor.
 6. Any required re-verification by the contractor shall not be considered a justified reason for a claim of delay or for a time extension.
- C. Approval. The CxA notes each satisfactorily demonstrated function on the verification form. Formal approval of the functional verification is made later after review by the CxA. Upon a successful review, the CxA will recommend acceptance of each verification.

3.08 OPERATION AND MAINTENANCE MANUALS

- A. The commissioning process requires the following detailed O&M documentation in addition to requirements found in the “General Requirements Section”.
- B. The Contractor shall compile O&M manuals for every piece of commissioned equipment and commissioned building operating or electrical system with the following format and content.
 1. Vendor location and contact information.
 2. Submittal information.
 3. Operations and maintenance instructions for specific model (Only information for equipment actually installed shall be included).
 4. Installation and startup instructions.
 5. Parts list and special tool list.
 6. Performance data (pump, fan curves).
 7. Warranty information
 8. As-built data for control systems to document actual control schemes and sequences used.

- C. CxA Review. Prior to substantial completion, the CxA shall review the O&M manuals, documentation for systems that were commissioned and to verify compliance with the Contract Documents. The CxA will communicate deficiencies in the manuals to the PM, as requested. Upon a successful review of the corrections, the CxA recommends approval and acceptance of these sections of the O&M manuals to the PM. This work does not supersede the Eng's review of the O&M manuals according to the Eng's contract.

3.09 TRAINING OF OWNER PERSONNEL

- A. The Contractor shall be responsible for training coordination and scheduling and ultimately for ensuring that training is completed.
- B. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment.
 - 1. The CxA shall interview the facility manager and lead engineer to determine the special needs and areas where training will be most valuable. The Owner and CxA shall decide how rigorous the training should be for each piece of commissioned equipment. The CxA shall communicate the results to the contractor and manufacturer's representatives who have training responsibilities.
 - 2. In addition to these general requirements, the specific training requirements of Owner personnel by the Contractor and manufacturer's representatives is specified in the Contract Documents.
 - 3. The Contractor and manufacturer's representative responsible for training will submit a written training plan to the CxA for review and approval prior to training. The plan will cover the following elements:
 - a. Equipment (included in training)
 - b. Intended audience
 - c. Location of training
 - d. Objectives
 - e. Subjects covered (description, duration of discussion, special methods, etc.)
 - f. Duration of training on each subject
 - g. Instructor for each subject
 - h. Methods (classroom lecture, video, site walk-through, actual operational demonstrations, written handouts, etc.)
 - i. Instructor and qualifications
 - 4. For the primary HVAC equipment, the Controls representative shall provide a short discussion of the control of the equipment during the mechanical or electrical training conducted by others.
 - 5. The CxA oversees a complete training plan developed by the contractor and coordinates and schedules, with the PM and the Contractor, the overall training for the commissioned systems. The CxA recommends approval of the training to the PM.

3.10 DEFERRED VERIFICATION

- A. Unforeseen Deferred Verifications. If any check or verification cannot be completed due to the building structure, required occupancy condition or other deficiency, execution of checklists and functional verification may be delayed upon approval of the PM. These verifications will be conducted in the same manner as the seasonal verifications (6-10 months after functional verification) as soon as possible. Services of necessary parties will be negotiated.
- B. Seasonal Verification. During the warranty period (6-10 months after functional verification), seasonal verification (verifications delayed until weather conditions are closer to the system's design) shall be completed as part of this contract. The CxA shall coordinate this activity. Verifications will be executed, documented and deficiencies corrected by the Contractor, with facilities staff and the CxA witnessing. Any final adjustments to the O&M manuals and as-builds due to the verification will be made.

END OF SECTION

SECTION 019114

SYSTEMS COMMISSIONING REQUIREMENTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General Conditions and Division 019113, apply to this Section.

1.02 DESCRIPTION

- A. The purpose of this section is to specify the responsibilities in the commissioning process which are being directed by the CxA. Other systems verification is still required as part of the contract.
- B. The systems to be commissioned are listed in Section 019113, 1.8.
- C. Commissioning requires the participation of the Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Division 1. The Contractor shall be familiar with all parts of Division 1 and the commissioning plan issued by the CxA and shall execute all commissioning responsibilities assigned to them in the Contract Documents.

1.03 RESPONSIBILITIES

- A. The commissioning responsibilities applicable to the Contractor are as follows (all references apply to commissioned equipment only):
 - 1. Construction and Acceptance Phases
 - a. Include and itemize the cost of commissioning in the Schedule of Values (Include these line items in the project CPM schedule)
 - 1) O & M manual turnover
 - 2) Prefunctional Checklist turnover
 - 3) Functional Hardware Verification
 - 4) Operational Sequence Verification
 - 5) Trend Log Verification
 - 6) Owner Training
 - b. In each purchase order or subcontract written, include requirements for submittal data, commissioning documentation, O&M data and training.
 - c. Attend commissioning scoping meeting and other meetings necessary to facilitate the Cx process.
 - d. The Contractor shall provide the CxA with standard manufacturers submittal cut sheets and shop drawing submittals of commissioned equipment.
 - e. Provide additional requested documentation, prior to normal O&M manual submittals, to the CxA for development of start-up and functional verification procedures.
 - 1) Typically this will include detailed manufacturer installation and start-up, operating, troubleshooting and maintenance procedures, full details of any

owner-contracted verifications, fan and pump curves, full factory testing reports, if any, and full warranty information, including all responsibilities of the Owner to keep the warranty in force clearly identified. In addition, the installation, start-up and checkout materials that are actually shipped inside the equipment and the actual field checkout sheet forms to be used by the factory or field technicians shall be submitted to the Commissioning Authority.

- 2) The Commissioning Authority may request further documentation necessary for the commissioning process.
 - f. This data request may be made prior to normal submittals.
 - g. Provide a copy of the O&M manuals and submittals of commissioned equipment, through normal channels, to the CxA for review and comments. The CxA's primary focus in reviewing the submittals will be directed towards insuring the commissionability of the equipment and interoperability of the equipment into functioning systems as per the Contract Documents.
 - h. The Contractor shall assist (along with the design engineers) in clarifying the operation and control of commissioned equipment in areas where the specifications, control drawings or equipment documentation is not sufficient for writing detailed verification procedures.
 - i. Provide assistance to the CxA in preparing the specific functional performance verification procedures. The Contractor shall review verification procedures to ensure feasibility, safety and equipment protection and provide necessary written alarm limits to be used during the verifications.
 - j. Develop a full start-up and initial checkout plan using manufacturer's start-up procedures and the prefunctional checklists from the CxA for all commissioned equipment. Submit to CxA for review and approval prior to startup. Refer to specifications for further details on start-up plan preparation (0119113).
 - k. During the startup and initial checkout process, execute the mechanical-related portions of the prefunctional checklists for all commissioned equipment.
 - l. Perform and clearly document all completed startup and system operational checkout procedures, providing a copy to the CxA.
 - m. Address current A/E punch list items before functional verification. Air and water TAB shall be completed with discrepancies and problems remedied before functional verification of the respective air- or water-related systems.
 - n. Provide skilled technicians to execute starting of equipment and to execute the functional performance verifications. Ensure that they are available and present during the agreed upon schedules and for sufficient duration to complete the necessary verifications, adjustments and problem-solving.
 - o. Provide skilled technicians to perform functional performance verifications under the direction of the CxA. Assist the CxA in interpreting the monitoring data, as necessary.
 - p. Correct deficiencies (differences between specified and observed performance) as interpreted by the CxA and A/E and re-verification the equipment.
 - q. Prepare O&M manuals according to the Contract Documents, including clarifying and updating the original sequences of operation to as-built conditions.
 - r. During construction, maintain as-built red-line drawings for all drawings and specifications.
 - s. Provide training of the Owner's operating staff using expert qualified personnel.
 - t. Coordinate with equipment manufacturers to determine specific requirements to maintain the validity of the warranty.

2. Warranty Period
 - a. Execute seasonal or deferred functional performance verifications, witnessed by the CxA, according to the specifications.
 - b. Correct deficiencies and make necessary adjustments to O&M manuals and as-built drawings for applicable issues identified in any seasonal verification.
3. Additional Requirements
 - a. The responsibilities of the Contractor, during construction and acceptance phases in addition to those listed in (A) are:
 - 1) Provide startup for all HVAC equipment.
 - 2) Assist and cooperate with the TAB and CxA by:
 - a) Putting all HVAC equipment and systems into operation and continuing the operation during each working day of TAB and commissioning, as required.
 - b) Including cost of sheaves and belts that may be required by TAB.
 - c) Providing verification ports in ducts and plenums where directed by TAB to allow air measurements and air balancing. Provide an approved plug when complete.
 - d) Providing temperature and pressure taps according to the Construction Documents for TAB and commissioning verification.
 - 3) Install a P/T plug at each water sensor which is an input point to the control system.
 - 4) List and clearly identify on the as-built drawings the locations of all air-flow stations.
 - 5) Prepare a preliminary schedule for the pipe and duct system verification, flushing and cleaning, equipment start-up and TAB start and completion for use by the CxA. Update the schedule as appropriate.
 - 6) Notify the CxA, Eng and Owner, depending on protocol, when pipe and duct system testing, flushing, cleaning, startup of each piece of equipment and TAB will occur. Be responsible to notify the Owner or CxA, ahead of time, when commissioning activities not yet performed or not yet scheduled will delay construction. Be proactive in seeing that pre-functional commissioning processes are executed and that the CxA has the scheduling information needed to efficiently execute the commissioning process.

- B. Controls. The commissioning responsibilities associated with the controls, during construction and acceptance phases in addition to those listed in (A) are:
1. Sequences of Operation Submittals. The Contractor's submittals of control drawings shall include complete detailed sequences of operation for each piece of equipment, regardless of the completeness and clarity of the sequences in the specifications. They shall include:
 - a. An overview narrative of the system (1 or 2 paragraphs) generally describing its purpose, components and function.
 - b. All interactions and interlocks with other systems.
 - c. Detailed delineation of control between any packaged controls and the building automation system, listing what points the BAS monitors only and what BAS points are control points and are adjustable.
 - d. Written sequences of control for packaged controlled equipment. (Equipment manufacturers' stock sequences may be included, but will generally require additional narrative).
 - e. Start-up sequences.
 - f. Warm-up mode sequences.
 - g. Normal operating mode sequences.
 - h. Shutdown sequences.
 - i. Capacity control sequences and equipment staging.
 - j. Temperature and pressure control: setbacks, setups, resets, etc.
 - k. Detailed sequences for all control strategies, e.g., economizer control, optimum start/stop, staging, optimization, demand limiting, etc.
 - l. Effects of power or equipment failure with all standby component functions.
 - m. Sequences for all alarms and emergency shut downs.
 - n. Seasonal operational differences and recommendations.
 - o. Initial and recommended values for all adjustable settings, setpoints and parameters that are typically set or adjusted by operating staff; and any other control settings or fixed values, delays, etc. that will be useful during verification and operating the equipment.
 - p. Schedules, if known.
 - q. To facilitate referencing in verification procedures, all sequences shall be written in small statements, each with a number for reference. For a given system, numbers will not repeat for different sequence sections, unless the sections are numbered.
 2. Control Drawings Submittal
 - a. The control drawings shall have a key to all abbreviations.
 - b. The control drawings shall contain graphic schematic depictions of the systems and each component.
 - c. The schematics will include the system and component layout of any equipment that the control system monitors, enables or controls, even if the equipment is primarily controlled by packaged or integral controls.
 - d. Provide a full points list with at least the following included for each point:
 - 1) Controlled system
 - 2) Point abbreviation
 - 3) Point description
 - 4) Display unit
 - 5) Control point or setpoint (Yes / No)
 - 6) Monitoring point (Yes / No)

- 7) Intermediate point (Yes / No)
 - 8) Calculated point (Yes / No)
 - a) Key:
 - b) Point Description: DB temp, airflow, etc.
 - c) Control or Setpoint: Point that controls equipment and can have its setpoint changed (OSA, SAT, etc.)
 - d) Intermediate Point: Point whose value is used to make a calculation which then controls equipment (space temperatures that are averaged to a virtual point to control reset).
 - e) Monitoring Point: Point that does not control or contribute to the control of equipment, but is used for operation, maintenance, or performance verification.
 - f) Calculated Point: "Virtual" point generated from calculations of other point values.
 - 9) The Contractor shall keep the CxA informed of all changes to this list during programming and setup.
3. Sensor and Actuator Calibration.
- a. All field-installed temperature, relative humidity, CO, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described below. Alternate methods may be used, if approved before-hand. All verification instruments shall have had a certified calibration within the last 12 months. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated.
 - b. All procedures used shall be fully documented on the prefunctional checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.
 - c. Sensor Calibration Methods
 - 1) All Sensors. Verify that all sensor locations are appropriate and away from causes of erratic operation. Verify that sensors with shielded cable are grounded only at one end. For sensor pairs that are used to determine a temperature or pressure difference, make sure they are reading within 0.2°F of each other for temperature and within a tolerance equal to 2% of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
 - 2) Sensors Without Transmitters--Standard Application. Make a reading with a calibrated verification instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or BAS is within the tolerances in the table below of the instrument-measured value. If not, install offset in BAS, calibrate or replace sensor.

- 3) **Sensors With Transmitters--Standard Application.** Disconnect sensor. Connect a signal generator in place of sensor. Connect ammeter in series between transmitter and BAS control panel. Using manufacturer's resistance-temperature data, simulate minimum desired temperature. Adjust transmitter potentiometer zero until 4 mA is read by the ammeter. Repeat for the maximum temperature matching 20 mA to the potentiometer span or maximum and verify at the BAS. Record all values and recalibrate controller as necessary to conform with specified control ramps, reset schedules, proportional relationship, reset relationship and P/I reaction. Reconnect sensor. Make a reading with a calibrated verification instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gage or building automation system (BAS)) is within the tolerances in the table below of the instrument-measured value. If not, replace sensor and repeat. For pressure sensors, perform a similar process with a suitable signal generator.
4. **Critical Applications.** For critical applications (process, manufacturing, etc.) more rigorous calibration techniques may be required for selected sensors. Describe any such methods used on an attached sheet.
5. **Tolerances, Standard Applications**

<u>Sensor</u>	<u>Required Tolerance (+/-)</u>	<u>Sensor</u>	<u>Required Tolerance (+/-)</u>
Cooling coil, chilled and condenser water temps	0.5F	Flow rates, water	4% of design
		Relative humidity	4% of design
AHU wet bulb or dew point	2.0F	Combustion flue temps	5.0F
Hot water coil and boiler water temp	1.5F	Oxygen or CO2 monitor	0.4% pts
Outside air, space air, duct air temps	0.4F	CO monitor	1% of design
Flow rates, air	10% of design	Natural gas flow rate	1% of design
Pressures, air, water and gas	3% of design	Barometric pressure	0.1 in. of Hg

6. **Valve and Damper Stroke Setup and Check**
- a. **BAS Readout.** For all valve and damper actuator positions checked, verify the actual position against the BAS readout. Set pumps or fans to normal operating mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. Adjust "pre-load" on actuators to insure tight shutoff when commanded closed or on a loss of power. Command valve or damper open, verify position is full open and adjust output signal as required. Command valve or damper to a few intermediate positions. If actual valve or damper position doesn't reasonably correspond, scale output as required to achieve commanded response, replace actuator.

7. During construction, maintain as-built red-line drawings for all drawings. An updated as-built version of the control drawings and an updated as-built version of the sequences of operation shall be included in the final controls O&M manual submittal.
8. Assist and cooperate with the TAB in the following manner:
 - a. Meet with the TAB prior to beginning TAB and review the TAB plan to determine the capabilities of the control system toward completing TAB. Provide the TAB any needed unique instruments, hardware and or software, for setting terminal unit boxes and instruct TAB in their use (handheld control system interface for use around the building during TAB, etc.).
 - b. For a given area, have all required prefunctional checklists, calibrations, startup and selected functional verifications of the system completed and approved by the CxA prior to TAB.
 - c. Provide a qualified technician to operate the controls to assist the TAB contractor in performing TAB, or provide sufficient training for TAB to operate the system without assistance.
9. Assist and cooperate with the CxA in the following manner:
 - a. Using a skilled technician who is familiar with this building, execute the functional verification of the controls system as specified for the controls Representative. Assist in the functional verification of all equipment.
 - b. Execute all control system trend logs (reference section 019113).
10. The Contractor shall prepare a written plan indicating in a step-by-step manner, the procedures that will be followed to verification, checkout and adjust the control system prior to functional performance verification, according to the process in Section 019113. At minimum, the plan shall include for each type of equipment controlled by the automatic controls:
 - a. System name.
 - b. List of devices.
 - c. Step-by-step procedures for verification each controller after installation, including:
 - 1) Process of verifying proper hardware and wiring installation.
 - 2) Process of downloading programs to local controllers and verifying that they are addressed correctly.
 - 3) Process of performing operational checks of each controlled component.
 - 4) Plan and process for calibrating valve and damper actuators and all sensors.
 - 5) A description of the expected field adjustments for transmitters, controllers and control actuators should control responses fall outside of expected values.
 - d. A copy of the log and field checkout sheets that will document the process. This log must include a place for initial and final read values during calibration of each point and clearly indicate when a sensor or controller has “passed” and is operating within the contract parameters.
 - e. A description of the instrumentation required for verification.
 - f. Indicate what verifications on what systems should be completed prior to TAB using the control system for TAB work. Coordinate with the CxA and TAB Representative for this determination.

11. Provide a signed and dated certification to the CxA upon completion of the checkout of each controlled device, equipment and system prior to functional verification for each piece of equipment or system, that all system programming is complete as to all respects of the Contract Documents, except functional verification requirements.
12. Beyond the control points necessary to execute all documented control sequences, provide monitoring, control and virtual points as specified in Contract Documents.
13. List and clearly identify on the as-built duct and piping drawings as well as the control drawing schematics as-built locations of the locations of all static and differential pressure sensors (air, water and building pressure).
14. Utilizing the CxA approved TC as built drawing schematics and as built sequences, demonstrate to the CxA the validity of these documents.

C. TAB. The duties associated with the TAB, in addition to those listed in (A) are:

1. Submit the outline of the TAB plan and approach for each system and component to the CxA, A/E and the controls Representative six weeks prior to starting the TAB. This plan will be developed after the TAB has some familiarity with the control system.
2. The submitted documentation will include:
 - a. Procedure Submittal: The procedures for a project are detailed by the balance report layout. Only the items described on that set-up of the report will be submitted. It is generally recognized that the standards of the industry for instrumentation and proper application for each type of system will be supervised by the TAB Company and detailed descriptions of how verifications will be performed is not necessary.
 - b. TAB Plan: The TAB plan will define the responsibilities of the other contractor, designers, and owners. The plan will state what is expected from each of these parties for access, control, information, documentation, and the required completeness of the systems for TAB to be accomplished. The plan will list the pre-requisites as far as system complete for each phase of testing.
 - c. TAB Agenda: The agenda is the summary of how the testing is expected to proceed, and is usually only required if some testing will begin before all the construction is complete. The agenda for a small project that has all the systems complete and ready for testing is simply that supply is tested, then exhaust, then return for air balance and water systems are balanced from the primary equipment out to the secondary equipment and terminals. On a phased project the agenda would list systems to be tested in each phase. The agenda will also give more detail on the necessary support of other parties for each phase.
3. A running log of events and issues shall be kept by the TAB field technicians. Submit hand-written reports of discrepancies, deficient or uncompleted work by others, contract interpretation requests and lists of completed verifications to the CxA and GC at least twice a week.
4. Communicate in writing to the controls representative all setpoint and parameter changes made or problems and discrepancies identified during TAB which affect the control system setup and operation.
5. Provide a draft TAB report within two weeks of completion. A copy will be provided to the CxA. The report will contain a full explanation of the methodology, assumptions and the results in a clear format with designations of all uncommon abbreviations and column headings. The report should follow the testing and most rigorous reporting recommendations by AABC, NEBB or ASHRAE Standards.
6. Provide the CxA with any requested data, gathered, but not shown on the draft reports.
7. Provide a final TAB report for the CxA with details, as in the draft.

8. Conduct functional performance verifications and checks on the original TAB as specified.

PART 2 - PRODUCTS

2.01 VERIFICATION EQUIPMENT

- A. The Contractor shall provide all verification equipment necessary to fulfill the verification requirements of this Division.

PART 3 - EXECUTION

3.01 SUBMITTALS

- A. The Contractor shall provide submittal documentation relative to commissioning as required in this Section Part 1 and Section 019113.

3.02 STARTUP

- A. The Contractor shall follow the start-up and initial checkout procedures listed in the Responsibilities list in this section and in 019113. The Contractor has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The commissioning procedures and functional verification do not relieve or lessen this responsibility or shift that responsibility partially to the commissioning Authority or Owner.
- B. Functional verification is intended to begin upon completion of a system. Functional verification may proceed prior to the completion of systems or sub-systems at the discretion of the CxA. Beginning system verification before full completion does not relieve the Contractor from fully completing the system, including all prefunctional checklists as soon as possible.

3.03 TAB

- A. Refer to the TAB responsibilities above.

3.04 FUNCTIONAL PERFORMANCE VERIFICATIONS

- A. Refer to Section 019113 Part 1.8 for a list of systems to be commissioned and to Part 3.6 for a description of the process and the Contract Documents for specific details on the required functional performance verifications.

3.05 VERIFYING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

- A. Refer to Section 019113 Part 3.7 for specific details on non-conformance issues relating to prefunctional checklists and verifications.
- B. Refer to Section 019113 Part 3.6 for issues relating to functional performance verifications.

3.06 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The following O&M manual requirements do not replace O&M manual documentation requirements elsewhere in these specifications.
- B. The Contractor shall compile and prepare documentation for all equipment and systems covered in the Contract Documents for inclusion in the O&M manuals, according to this section, prior to the training of owner personnel.
- C. The CxA shall receive a copy of the O&M manuals for review.
- D. Special Control System O&M Manual Requirements. In addition to documentation that may be specified elsewhere, the controls Representative shall compile and organize at minimum the following data on the control system:
 - 1. Controls training manuals.
 - 2. Operation and Maintenance Manuals containing:
 - a. Specific instructions on how to perform and apply all functions, features, modes, etc. mentioned in the controls training sections of this specification and other features of this system. These instructions shall be step-by-step. Indexes and clear tables of contents shall be included. The detailed technical manual for programming and customizing control loops and algorithms shall be included.
 - b. Full as-built set of control drawings (refer to Submittal section above for details).
 - c. Full as-built sequence of operations for each piece of equipment.
 - d. Full points list. In addition to the updated points list required in the original submittals, a listing of all rooms shall be provided with the following information for each room:
 - 1) Floor
 - 2) Room number
 - 3) Room name
 - 4) Air handler unit ID
 - 5) Reference drawing number
 - 6) Air terminal unit tag ID
 - 7) Heating and/or cooling valve tag ID
 - 8) Minimum cfm
 - 9) Maximum cfm
 - e. Full print out of all schedules and set points after verification and acceptance of the system.
 - f. Electronic copy on disk of the entire program for this facility.
 - g. Marking of all concealed/hidden system sensors and devices on the as-built floor plan and mechanical drawings with their control system designations.
 - h. Maintenance instructions, including sensor calibration requirements and methods by sensor type, etc.
 - i. Control equipment component submittals, parts lists, etc.

- j. Warranty requirements.
 - k. Copies of all checkout verifications and calibrations performed by the Contractor.
 - 3. The manual shall be organized and subdivided with permanently labeled tabs including but not limited to the following items:
 - a. Sequences of operation
 - b. Control drawings
 - c. Points lists
 - d. Controller / module data
 - e. Thermostats and timers
 - f. Sensors and DP switches
 - g. Valves and valve actuators
 - h. Dampers and damper actuators
 - 4. Field checkout sheets and trend logs should be provided to the CxA for inclusion in the Commissioning Record Book.
- E. Special TAB Documentation Requirements. The TAB will compile and submit the following with other documentation that may be specified elsewhere in the Specifications.
- 1. Final report containing an explanation of the methodology, assumptions, verification conditions and the results in a clear format with designations of all uncommon abbreviations and column headings.
 - 2. The TAB shall mark on the drawings where all traverse and other critical measurements were taken and cross reference the location in the TAB report.
- F. Review and Approvals. Review of the commissioning related sections of the O&M manuals shall be made by the A/E and by the CxA. Refer to Section 241000 for additional details.

3.07 TRAINING OF OWNER PERSONNEL

- A. The CxA shall be responsible for overseeing and approving the content and adequacy of the training of Owner personnel for commissioned equipment. Refer to Section 241000 for additional details.
- B. The Contractor shall have the following training responsibilities:
 - 1. Provide approved O & M manuals prior to submitting the training plan. Provide the CxA with a training plan at least two weeks before the planned training. Training schedule must be approved by the CxA & Owner prior to approval of the training schedule.

2. Provide designated Owner personnel with comprehensive orientation and training in the understanding of the systems and the operation and maintenance of each piece of HVAC equipment including, but not limited to, pumps, boilers, furnaces, chillers, heat rejection equipment, air conditioning units, air handling units, fans, terminal units, controls and water treatment systems, etc.
3. Training shall normally start with classroom sessions followed by hands-on training on each piece of equipment, which shall illustrate the various modes of operation, including startup, shutdown, fire/smoke alarm, power failure, etc.
4. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. This person may be the start-up technician for the piece of equipment, the contractor or manufacturer's representative. Practical building operating expertise as well as in-depth knowledge of all modes of operation of the specific piece of equipment is required. More than one party may be required to execute the training.
6. The controls Representative shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
7. The training sessions shall follow the outline in the Table of Contents of the operation and maintenance manual and illustrate whenever possible the use of the O&M manuals for reference.
8. Training shall include:
 - a. Use of the printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. A review of the written O&M instructions emphasizing safe and proper operating requirements, preventative maintenance, special tools needed and spare parts inventory suggestions. The training shall include start-up, operation in all modes possible, shut-down, seasonal changeover and any emergency procedures.
 - c. Discussion of relevant health and safety issues and concerns.
 - d. Discussion of warranties and guarantees.
 - e. Common troubleshooting problems and solutions.
 - f. Explanatory information included in the O&M manuals and the location of all plans and manuals in the facility.
 - g. Discussion of any peculiarities of equipment installation or operation.
9. Hands-on training shall include start-up, operation in all modes possible, including manual, shut-down and any emergency procedures and preventative maintenance for all pieces of equipment.
10. The Contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls, not controlled by the central control system.
11. Training shall occur after functional verification is complete, unless approved otherwise by the Project Manager.
12. Duration of Training. The Contractor shall provide training on each piece of equipment included in the applicable portion of 019113 – 1.8. The duration of training shall be as included in the project specifications; or minimally 4 hours for each type of central plant equipment and 2 hours for each type of terminal or distributed equipment.

- C. Controls. The Contractor shall have the following training responsibilities:
1. Provide approved O & M manuals, including as built drawings and as built sequences of operations four weeks prior to submitting the training plan. Provide the CxA with a training plan four weeks before the planned training according to the outline described in Section 019113 Part 3.9.
 2. The Contractor shall provide designated Owner personnel training on the control system in this facility. The intent is to clearly and completely instruct the Owner on all the capabilities of the control system.
 3. Training manuals. The standard operating manual for the system and any special training manuals will be provided for each trainee, with three extra copies left for the O&M manuals. In addition, copies of the system technical manual will be demonstrated during training and three copies submitted with the O&M manuals. Manuals shall include detailed description of the subject matter for each session. The manuals will cover all control sequences and have a definitions section that fully describes all relevant words used in the manuals and in all software displays. Manuals will be approved by the CxA. Copies of audiovisuals shall be delivered to the Owner.
 4. Multiple training sessions will be provided. The training will be tailored to the needs and skill-level of the trainees.
 5. The trainers will be knowledgeable on the system and its use in buildings. For the on-site sessions, the most qualified trainer(s) will be used. The Owner shall approve the instructor prior to scheduling the training.
 6. During any demonstration, should the system fail to perform in accordance with the requirements of the O&M manual or sequence of operations, the system will be repaired or adjusted as necessary and the demonstration repeated.
 7. The controls Representative shall attend sessions other than the controls training, as requested, to discuss the interaction of the controls system as it relates to the equipment being discussed.
 8. There shall be a minimum of six, four hour training sessions, reference section 230900. At a minimum the training sessions shall include:
 - a. Control System. This training may be held on-site or in the supplier's facility. If held off-site, the training may occur prior to final completion of the system installation.
 - b. Building Systems. The second session shall consist of actual hands-on training after the completion of system commissioning. The session shall include instruction on:
 - 1) Specific hardware configuration of installed systems in this building and specific instruction for operating the installed system, including HVAC systems, lighting controls and any interface with security and communication systems.
 - 2) Security levels, alarms, system start-up, shut-down, power outage and restart routines, changing setpoints and alarms and other typical changed parameters, overrides, freeze protection, manual operation of equipment, optional control strategies that can be considered, energy savings strategies and set points that if changed will adversely affect energy consumption, energy accounting, procedures for obtaining vendor assistance, etc.
 - 3) All trending and monitoring features (values, change of state, totalization, etc.), including setting up, executing, downloading, viewing both tabular and graphically and printing trends. Trainees will actually set-up trends in the presence of the trainer.
 - 4) Every screen shall be completely discussed, allowing time for questions.
 - 5) Use of keypad or plug-in laptop computer at the zone level.
 - 6) Use of remote access to the system via internet, phone lines or networks.

- 7) Setting up and changing an air terminal unit controller.
 - 8) Graphics generation
 - 9) Point database entry and modifications
 - 10) Understanding DDC field panel operating programming (when applicable)
- c. Additional session will be structured to address specific topics that trainees need to discuss and to answer questions concerning operation of the system during the warranty period.
- D. TAB: The Contractor shall have the following training responsibilities:
1. TAB shall meet with facility staff after completion of TAB and instruct them on the following:
 - a. Go over the final TAB report, explaining the layout and meanings of each data type.
 - b. Discuss any outstanding deficient items in control, ducting or design that may affect the proper delivery of air or water.
 - c. Identify and discuss any terminal units, duct runs, diffusers, coils, fans and pumps that are close to or are not meeting their design capacity.
 - d. Discuss any temporary settings and steps to finalize them for any areas that are not finished.
 - e. Other salient information that may be useful for facility operations, relative to TAB.

3.08 DEFERRED VERIFYING

- A. Refer to Section 019113, Part 3.10 for requirements of deferred verifications.

3.09 WRITTEN WORK PRODUCTS

- A. Written work products of the Contractor will consist of the start-up and initial checkout plan described in Section 019113 and the filled out start-up, initial checkout and prefunctional checklists.

END OF SECTION

CONSULTANT



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WARNING:
THE ALTERATION OF THIS MATERIAL IN ANY WAY, UNLESS DONE UNDER THE DIRECTION OF A COMPARABLE PROFESSIONAL, I.E. ARCHITECT FOR AN ARCHITECT, ENGINEER FOR AN ENGINEER OR LANDSCAPE ARCHITECT FOR A LANDSCAPE ARCHITECT, IS A VIOLATION OF THE NEW YORK STATE EDUCATION LAW AND/OR REGULATIONS AND IS A CLASS 'A' MISDEMEANOR.



CONTRACT:

TITLE:
INSTALL ENERGY MANAGEMENT SYSTEM

LOCATION:
BARE HILL CORRECTIONAL FACILITY
181 BRAND ROAD
MALONE, NY 12953

CLIENT:
DEPARTMENT OF CORRECTIONS
AND COMMUNITY SUPERVISION

12/09/2015	ADDENDUM 3	
07/15/2015	BID DOCUMENTS	
MARK	DATE	DESCRIPTION
PROJECT NUMBER:	44983-H	
DESIGNED BY:	CS/PN	
DRAWN BY:	JWD	
FIELD CHECK:		
APPROVED:		

SHEET TITLE:

VALVE SCHEDULE

DRAWING NUMBER:

M-06

SHEET 6 OF 50

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1	HV-1	Small Engine Building	MER - 204	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1 1/2"
CV-2	HV-2	Maintenance	MER - 204	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1 1/4"
CV-3	HV-3	Janitorial	MER - 203	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1 1/4"
CV-4	HV-4	Masonry	MER - 202	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1 1/2"
CV-5	HV-5	Welding Shop	MER - 202	3-Way	Modulating	N.O. (full flow to coil)		3-5#	2"
CV-6	HV-6	Drafting	MER - 205	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1"
CV-7	HV-7	Pre-vocational	MER - 205	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1 1/2"
CV-8	HV-8	Flooring	MER - 206	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1"
CV-9	HV-9	General Business	MER - 201	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1 1/4"
CV-10	HV-10	Electrical	MER - 201	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1 1/4"
CV-11	Clsm Fin Loop	Classroom Wing	MER-4	3-Way	Modulating	N.O. (full flow to coil)		3-5#	1 1/2"
CV-12	Clsm North Fin	Clsm North	Clsm North	3-Way	Open / Close	N.O. (full flow to coil)		<1	1"
CV-13	Clsm North Fin	Clsm North	Clsm North	3-Way	Open / Close	N.O. (full flow to coil)		<1	1"
CV-14	Clsm North Fin	Clsm North	Clsm North	3-Way	Open / Close	N.O. (full flow to coil)		<1	1"

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1,2	Heat Exchanger	MER-10	MER - 10	2-Way	Modulating	N.O. (full flow to Hx)	42.0	3-5#	2"

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1	Fin Radiation	North Wing East	Cell 24 Fin Radiation	3-Way	Open / Close	N.O. (full flow to coil)	4	<1	1"
CV-2	Fin Radiation	North Wing West	Cell 13 Fin Radiation	3-Way	Open / Close	N.O. (full flow to coil)	4	<1	1"
CV-3	Fin Radiation	South Wing East	Recreation 49 Fin Radiation	3-Way	Open / Close	N.O. (full flow to coil)	3.5	<1	1"
CV-4	Fin Radiation	South Wing West	Recreation 48 Fin Radiation	3-Way	Open / Close	N.O. (full flow to coil)	3.5	<1	1"
CV-5	Fin Radiation	East Wing North	Cell 25 Fin Radiation	3-Way	Open / Close	N.O. (full flow to coil)	3.5	<1	1"
CV-6	Fin Radiation	East Wing South	Cell 32 Fin Radiation	3-Way	Open / Close	N.O. (full flow to coil)	3.5	<1	1"
CV-7	Fin Radiation	West Wing North	Cell 1 Fin Radiation	3-Way	Open / Close	N.O. (full flow to coil)	4	<1	1"
CV-8	Fin Radiation	West Wing South	Cell 12 Fin Radiation	3-Way	Open / Close	N.O. (full flow to coil)	4	<1	1"

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1	HV-1	Gym East	Gym East	3-Way	Modulating	N.O. (full flow to coil)	31.0	3-5#	2"
CV-2	HV-2	Gym West	Gym West	3-Way	Modulating	N.O. (full flow to coil)	31.0	3-5#	2"
CV-3	HV-3	East MER	East MER	3-Way	Modulating	N.O. (full flow to coil)	11.0	3-5#	1 1/4"
CV-4	HV-4	East MER	East MER	3-Way	Modulating	N.O. (full flow to coil)	11.0	3-5#	1 1/4"
CV-5	UV-1	Room 21	Room 21	3-Way	Modulating	N.O. (full flow to coil)	4.0	3-5#	1"
CV-6	UV-2	Room 13	Room 13	3-Way	Modulating	N.O. (full flow to coil)	3.0	3-5#	1"
CV-7	UV-3	Room 12	Room 12	3-Way	Modulating	N.O. (full flow to coil)	4.0	3-5#	1"
CV-8	UV-4	Room 1	Room 1	3-Way	Modulating	N.O. (full flow to coil)	3.0	3-5#	1"
CV-9	UV-5	Room 1	Room 1	3-Way	Modulating	N.O. (full flow to coil)	3.0	3-5#	1"
CV-10	UV-6	Room 19	Room 19	3-Way	Modulating	N.O. (full flow to coil)	3.0	3-5#	1"
CV-11	UV-7	Room 19	Room 19	3-Way	Modulating	N.O. (full flow to coil)	3.0	3-5#	1"
CV-12	UV-10	Room 31	Room 31	3-Way	Modulating	N.O. (full flow to coil)	3.0	3-5#	1"
CV-13	UV-11	Room 14	Room 14	3-Way	Modulating	N.O. (full flow to coil)	3.0	3-5#	1"
CV-14	FTR-1	Room 4	Room 4	3-Way	Open / Close	N.O. (full flow to coil)	3.0	<1#	1 1/2"
CV-15	FTR-2	Room 7	Room 7	3-Way	Open / Close	N.O. (full flow to coil)	1.0	<1#	1 1/2"
CV-16	FTR-3	Room 6	Room 6	3-Way	Open / Close	N.O. (full flow to coil)	1.0	<1#	1 1/2"
CV-17	FTR-4	Room 5	Room 5	3-Way	Open / Close	N.O. (full flow to coil)	1.0	<1#	1 1/2"
CV-18	FTR-5	Room 2	Room 2	3-Way	Open / Close	N.O. (full flow to coil)	1.0	<1#	1 1/4"
CV-19	FTR-6	Room 28 (Gym)	Room 28 (Gym)	3-Way	Open / Close	N.O. (full flow to coil)	5.0	<1#	1"
CV-20	FTR-7	Room 42	Room 42	3-Way	Open / Close	N.O. (full flow to coil)	1.0	<1#	1 1/4"
CV-21	FTR-8	Room 20	Room 20	3-Way	Open / Close	N.O. (full flow to coil)	1.0	<1#	1 1/4"
CV-22	FTR-9	Room 36	Room 36	3-Way	Open / Close	N.O. (full flow to coil)	3.0	<1#	1 1/4"
CV-23	FTR-10	Room 32	Room 32	3-Way	Open / Close	N.O. (full flow to coil)	1.0	<1#	1 1/4"

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1	FTR Main Bldg	MER-4	MER-4	2-Way	Open / Close	N.O. (full flow to coil)	6.0	<1	1"

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1	HRU-1	HRU-1 North	Gym East	3-Way	Modulating	N.O. (full flow to coil)	31.0	3-5#	2"
CV-2	HRU-2	HRU-1 South	Gym West	3-Way	Modulating	N.O. (full flow to coil)	31.0	3-5#	2"
CV-3	North FTR	North Cafe	North Cafe	3-Way	Open / Close	N.O. (full flow to coil)	11.0	<1	1 1/4"
CV-4	South FTR	South Cafe	South Cafe	3-Way	Open / Close	N.O. (full flow to coil)	11.0	<1	1 1/4"

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1	H & V-1	MER	MER	3-Way	Modulating	N.O. (full flow to coil)	46.0	3-5#	2"
CV-2-5	Fin Radiation	Dorm Areas	Ceilings	3-Way	Open / Close	N.O. (full flow to coil)	20.0	<1	1 1/2"

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1	H & V-1	MER	MER	3-Way	Modulating	N.O. (full flow to coil)	46.0	3-5#	2"
CV-2-5	Fin Radiation	Dorm Areas	Ceilings	3-Way	Open / Close	N.O. (full flow to coil)	20.0	<1	1.5

Item #	Service	Equipment Location	Valve Location	Body Type	Control Type	Fail Position (Spring Return)	GPM	Design Pressure Drop	Pipe size
CV-1	H & V-1	MER	MER	3-Way	Modulating	N.O. (full flow to coil)	46.0	3-5#	2"
CV-2-5	Fin Radiation	Dorm Areas	Ceilings	3-Way	Open / Close	N.O. (full flow to coil)	20.0	<1	2"