SECTION 019113 – GENERAL COMMISSIONING REQUIREMENTS

PART 1 – GENERAL

1.1 SUMMARY AND CONTRACT RESPONSIBILITIES

A. The Owner will contract separately and directly for the majority of the commissioning work described in Sections 019113, 220800, 230800, 260800 and 210800. The Prime contractor, the Automatic Temperature Control/Facility Management System (ATC/FMS) subcontractor and Testing-Adjusting-Balancing (TAB) subcontractor are, however, responsible for coordinating, sequencing, cooperating, and assisting with the work of the Commissioning Authority.

1. The Prime Contractor is responsible to provide start up of all equipment with factory trained equipment manufacturer's technicians. This startup shall include providing detailed list verifying that all functions and requirements of the design and manufacturer's criteria have been met and equipment is properly installed.

2. The Prime Contractor, the ATC/FMS subcontractor and TAB subcontractor are responsible to provide and coordinate startup of all equipment with equipment manufacturer's representatives in the presence of the Commissioning Authority.

3. Work under this contract shall conform under requirements of Division 1, General Requirements, Conditions of the Contract, and Supplementary Conditions. This specification covers commissioning of the MEP systems which solely serve The New Broughal Middle School for the Bethlehem area School District

4. Furnish labor and material to accomplish and complete MEP commissioning as specified herein. Complete interim commissioning of MEP systems during initial season operation and follow-up commissioning of required MEP systems during additional season operation.

5. Failure to comply will result in withholding of payments and/or default of contract.

B. Commissioning work shall be a team effort to ensure that all MEP equipment and systems have been completely and properly installed and function together correctly to meet the design intent. System performance parameters shall be documented for fine-tuning of control sequences and operational procedures. Commissioning shall coordinate system documentation, equipment start-up, control system calibration, testing, balancing, verification and performance testing.

C. The commissioning team shall be made up of representatives from the owner, design professionals, major equipment suppliers and construction trades. The trades represented on the commissioning team shall include, but not be limited to, sheet metal, piping and fittings, Building management and controls, test and balance, and electrical. The lead person for each trade who will actually perform or supervise the work is to be designated by the contractor as the representative to the commissioning team. Responsibility for various steps of the commissioning process shall be divided among the members of the commissioning team, as described in this section.

1. The Commissioning Authority, retained by the OWNER shall have responsibility for coordinating and directing each step of the commissioning process. Horizon Engineering Associates has been retained by the Bethlehem Area School District as the Commissioning Authority for the New Broughal Middle School Project.

D. The Commissioning Authority will not be responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating or construction management.

E. MEP system installation, start-up, testing and balancing, preparation of O&M manuals, and operator training are the responsibility of the Division 21, 22, 23, and 26 MEP Contractors, with coordination, observation, verification and commissioning the responsibility of the Commissioning Authority. The commissioning process does not relieve Division 21, 22, 23, and 26 contractors from the obligations to complete all portions of work in a satisfactory and fully operational manner. Nor any obligation the trades have for operation and maintenance manuals and training.

F. Definitions

1. Commissioning: the process of ensuring that systems are designed, installed, functionally tested and capable of being operated and maintained to perform in conformity with the design intent. For this project, the commissioning includes construction, start-up, acceptance and training.

2. Commissioning Authority: The designated person or company retained by the OWNER who is charge of the commissioning process. Horizon Engineering Associates has been retained by the Bethlehem Area School District as the Commissioning Authority for the New Broughal Middle School Project.

3. Commissioning Plan: A document defining the commissioning process, which is developed by the commissioning Authority.

4. Commissioning Report: A document recording the results of the commissioning process, including the record documents, performance of the MEP system and documents all sign-offs. The report will address the following:

   a. Adequacy of equipment with respect to Contract Documents and Design Intent
   b. Equipment installation
   c. Functional performance and efficiency
   d. Equipment documentation
   e. O&M review, recommendations and training

5. Commissioning Specifications: the contract document that details the objective, scope and implementation of the construction and acceptance phases of the commissioning process as developed in the Commissioning Plan.

6. Commissioning Team: those people responsible for working together in carrying out the commissioning process.

7. Functional Performance Testing (FPT): the process of determining the ability of the Mechanical, Electrical and Plumbing systems to perform in accordance with the final design intent.

8. Owner: The Building OWNER.

9. Design Engineer of Record: The OWNER'S Architectural, Engineering and Other Consultants who prepared the Construction Documents.

10. Verification: that full range of checks and tests carried out to determine if all components, subsystems, systems, and interfaces between systems operate in accordance with the contract documents. In this context, "operate" includes all modes and sequences of control operation, interlocks and conditional control responses, and specified responses to abnormal or emergency conditions.

G. Commissioning is a process and its purpose is:

1. To clearly document the design intent

2. To verify that the systems installation and performance is in accordance with the plans, specifications and design intent.

3. To train the owner's operators so that they fully understand the design intent and the operation and maintenance requirements of the equipment.

1.2 SCOPE OF WORK

A. Commissioning work of Division 21, 22, 23, and 26 shall include, participation from the entire commissioning team but not be limited to:

1. Documentation of the construction process.

2. Ensuring the basis of design as well as the design intent is carried out.

3. Reporting on the project schedule to the Owner.

4. Assisting the design professional with RFI issues.

5. Preparing installation checklists.

6. Preparing functional checklists.

7. Testing and start-up of the equipment.

8. Testing, adjusting and balancing of hydronic and air systems.

9. Cooperation with the Commissioning Authority.

10. Providing qualified personnel for participation in commissioning tests, including seasonal testing required after the initial testing.

11. Providing equipment, materials, and labor as necessary to correct construction and/or equipment deficiencies found during the commissioning process.

12. Providing operation and maintenance manuals and record document drawings to the Commissioning Authority for verification.

13. Providing on site and off site training and demonstrations for the systems specified in this Division.

B. The work included in the commissioning process involves a complete and thorough evaluation of the operation and performance of all components, systems and sub-systems. The following equipment and systems shall be evaluated.

1. Heating and cooling systems

2. Air handling/air distribution systems

3. Hydronic distribution systems

4. Ventilation and exhaust systems

5. Automatic temperature controls integrated with the MEP Systems

6. Coordination and functionality with the Building Management Controls System

7. Domestic Hot Water Heaters and distribution.

8. Electrical Panels

9. Lighting & Daylighting Control systems

10. Fire Alarm and Controls

11. Generator

12. Building Envelope including windows, doors, insulation and envelope penetrations.

13. Communication & Paging system

14. Rain water harvesting system.

C. Timely and accurate documentation is essential for the commissioning process to be effective. Documentation required as part of the commissioning process shall be provided to the commissioning Authority by the RPE (Resident Project Engineer) but not be limited to:

1. Progress and status reports, including deficiencies noted.

2. Minutes from all meetings.

3. Pre-start and start-up procedures.

4. Training agenda and materials.

5. Record Documents.

6. Commissioning report.

7. Operational and Maintenance (O&M) manuals.

D. Detailed testing shall be performed on all installed equipment and systems to ensure that operation and performance conform to contract documents. All tests shall be evaluated and witnessed by the Commissioning Authority. After each grade of checklist and test are complete the system will be upgraded to the next test. Once all systems have completed each check they will be ready to be turned over. The following testing is required as part of the commissioning process:

1. Installation Checklists are comprised of a full range of checks developed that all systems were actually installed correctly. This includes piping is complete, all electric is tied in and complete and all accessories are installed.

2. Pre-functional Checklists are comprised of a full range of checks and tests to determine that all components, equipment, systems, and interfaces between systems operate in accordance with contract documents. This includes all operating modes, interlocks, control responses, and specific responses to abnormal or emergency conditions.

3. Functional Performance Tests (FPT) shall determine if the MEP system is providing the required cooling and heating services in accordance with the finalized design intent. These tests shall also determine the installed capacity of the cooling and heating plant and the individual heat transfer components.

E. Comprehensive training of O&M personnel shall be performed by the MEP Contractor, and where appropriate by other sub-contractors and vendors prior to turnover of building to the Owner. The training shall include on-site classroom instruction, along with hands-on instruction on the installed equipment and systems.

1.3 QUALITY ASSURANCE

a. The following reference is a guideline to the commissioning process and should be applied as appropriate.

b. Reference:

1. ASHRAE Guideline 1-1996: The MEP Commissioning Process

2. ASHRAE Application Handbook – 1995: Chapter 39 – Building Commissioning.

3. ASHRAE Guideline 4-1993: Preparation of Operating and Maintenance Documentation for Building Systems.

1.4 ROLES AND RESPONSIBILITIES

A. Owner

1. Owner will advise Commissioning Authority regarding changes in building occupancy and/or usage.

2. Owner will witness and attend any and all commissioning meetings and testing.

3. Assign maintenance personnel and schedule them to participate in meetings and training sessions as follows:

a. Construction Phase coordination meeting.

b. Initial owner training session at initial placement of major equipment.

c. Maintenance orientation and inspection.

d. Piping and ductwork test and flushing verification meetings.

e. Procedures meeting for Testing, Adjusting and Balancing.

f. Owners training session.

g. Final review at acceptance meeting.

h. Provide qualified personnel for on-site classroom training

B. Commissioning Authority

1. Review and approve the Basis of Design, Design Intent and Sequence of operations. The CA shall review contractor submittals, verify the system installation, and perform functional tests with the assistance of the installing contractors. The Commissioning Authority will also assemble written verification that training was conducted in a satisfactory manner.

2. Provide the OWNER with a Commissioning Report that will address the adequacy of the installed systems and equipment with respect to Contract Documents and the Design Intent. In addition, any outstanding commissioning and warranty issues will be identified in the report.

3. Review the shop drawings and submittals to ensure the system are being installed with the design intent and basis of design. In addition review of the shop drawings will also include assisting in coordination and the proper installation of equipment to support operation and maintenance in the future.

4. Prepare the commissioning program required as part of the commissioning specification. Include lists of all contractors for commissioning events by name, firm and trade specialty.

5. Develop detailed pre-test and final test report forms, specifically developed, for each system and piece of equipment installed on the project.

6. Oversee the air quality and air pressurization testing as required in the contract documents.

7. Oversee the development and compiling of the O&M documents.

8. Be available for one year after significant acceptance to monitor warranty period.

9. Develop and begin the continuous commissioning program

C. Architect

1. Provide support to the Design Professional who must provide a service as a part of the commissioning process. This shall include providing adequate space for equipment installation and maintenance.

2. Provide data on structure, building materials, interior finishes, and furnishings for their effect on indoor air quality.

D. Design Professionals

1. The Design Professional retains responsibility for the system evaluation, adequacy of the system to meet design intent, capacity of the system, quality check or any of the other elements of the system design.

2. Participate in field observations at the final construction stage.

3. Review verification and functional performance testing procedures submitted by the Commissioning Authority, for conformance with Construction Documents.

4. Review testing and balancing report and verification data sheets for system conformance to contract documents. Issue a report noting deficiencies requiring correction to the Commissioning Authority.

5. Review functional performance testing report for deficiencies in meeting the finalized design intent.

6. Review record documents as required by contract documents and turn them over to the Commissioning Authority for inclusion in final project documentation.

7. Review and comment on the final commissioning report.

8. Conduct periodic field observations of work in progress to ensure that all systems and equipment are installed according to specifications.

9. Provide documentation or design narratives for electrical services for specific MEP equipment requirements.

10. Provide electrical system information confirming compatibility with electrical service requirements specified by the mechanical design professional for all MEP equipment and systems. Provide information necessary for the basis of design.

11. Prepare contract documents that coordinate interfaces between life safety systems, MEP and BMCS systems. including commissioning specifications.

12. Attend construction phase commissioning meetings scheduled by the Commissioning Authority.

13. Participate in the commissioning of MEP equipment and systems.

14. Participate in review of shop drawings for MEP equipment.

15. Prepare electrical contract documents indicating power source connections to MEP equipment and systems and interrelationships between life safety systems and MEP systems and equipment, including a review of the automatic control and/or building automation system.

16. Verify that any space requirements for electrical equipment are in accordance with relevant code requirements.

E. Resident Project Engineer (RPE)

1. RPE shall coordinate construction progress with the commissioning schedule to assure that the building envelope and systems that affect operation of the systems being tested are complete prior to testing.

2. Include commissioning requirements in the mechanical, electrical and Building Management System as well as all other sub-contractors, to ensure cooperation of all parties in the commissioning program.

3. Ensure acceptable representation, with the means and authority to prepare and coordinate execution of the commissioning program as described in the contract documents.

4. Ensure acceptable representation at all commissioning meetings for this project.

5. Issue a statement that testing and balancing work has been completed, and submit the final testing and balancing reports for review.

6. Issue a statement that control systems have been calibrated.

7. Respond to deficiencies identified in verification tests within five (5) business days of notification. The Commissioning Authority can issue an extension upon written notification and approval.

8. Evaluate any performance deficiencies identified in the Functional Performance Testing report for non-performance with contract documents.

9. The equipment supplier shall document the performance of his equipment.

F. HVAC, Electrical, Plumbing, and Fire Protection Contractors

1. Include requirements for submittal data, operation and maintenance data, and training in each purchase order or sub-contract written.

2. Ensure cooperation and participation of specialty sub-contractors such as sheet metal, piping, refrigeration, water treatment, and testing and balancing.

3. Ensure participation of major equipment manufacturers in appropriate training and testing activities.

4. Attend construction phase commissioning meetings scheduled by the Commissioning Authority. These meetings will typically take place immediately after construction phase contractor meetings.

5. Ensure proper representation at all commissioning meetings.

6. Assist the Commissioning Authority in all verification and functional performances by completing all required checklists.

7. Prepare preliminary schedule for Mechanical, Electrical Plumbing system orientations and inspections, operation and maintenance manual submissions, training sessions, pipe and duct system testing, flushing and cleaning, equipment start-up, testing and balancing and task completion for owner by Commissioning Authority.

8. Update schedule as required throughout the construction period.

9. Attend initial training session.

10. Conduct MEP system orientation and inspection at the equipment placement completion stage.

11. Update drawings to the record condition to date and review with the Commissioning Authority for approval no more than 45 days after all material is installed and in place.

12. Gather operation and maintenance data on all equipment, and assemble in binders as required by the Commissioning Specification. Submit to Commissioning Authority 45 days after full submittal acceptance.

13. Coordinate with the Commissioning Authority to provide 48-hour advance notice so that the witnessing of equipment and system start-up and testing can begin.

14. Notify the Commissioning Authority a minimum of two weeks in advance of the time for start of the testing and balancing work. Attend the initial testing and balancing meeting for review of the official testing and balancing procedures.

15. Participate in, and schedule vendors and contractors to participate in the training sessions.

16. Provide written notification to the General Contractor and Commissioning Authority that the following work has been completed in accordance with the contract documents, and that the equipment, systems, and sub-system are operating as required.

a. MEP equipment including all fans, air handling units, ductwork, dampers, terminals, and all other equipment furnished under this Division.

b. Heating and refrigeration equipment, pumping systems, heat exchange and heat rejection equipment.

c. Fire stopping in the fire rated construction, including fire and smoke damper installation, caulking, gasketing and sealing of smoke barriers.

d. Fire detection and smoke detection devices furnished under other divisions of this specification as they affect the operations of the smoke control systems.

17. The equipment supplier shall document the performance of his equipment.

18. Provide a complete set of as-built records to the Commissioning Authority.

G. Test, Adjust and Balance Contractor

1. Attend initial commissioning coordination meeting scheduled by the Commissioning Authority.

2. Submit the site specific testing and balancing procedures and testing and balancing plan to the Commissioning Authority and Design Professional for review and acceptance.

3. Attend the testing and balancing review meeting scheduled by the Commissioning Authority. Be prepared to discuss the procedures that shall be followed in testing, adjusting, and balancing the MEP system.

4. At the completion of the testing and balancing work, and the submittal of the final testing and balancing report, notify the MEP contractor and the General Contractor.

5. Participate in training sessions as scheduled by the Commissioning Authority.

6. At the completion of testing and balancing work, and the submittal of the final testing and balancing report, notify the MEP Contractor and the General Contractor.

7. Participate in verification of the testing and balancing report, which will consist of repeating any selected measurement contained in the testing and balancing where required by the Commissioning Authority for verification or diagnostic purposes.

8. The equipment supplier shall document the performance of his equipment. The Commissioning Authority shall witness performance testing.

1.5 DOCUMENTATION

A. The Commissioning Authority shall oversee and maintain the development of commissioning documentation. The commissioning documentation shall be kept in three ring binders, and organized by system and sub-system when practical. All pages shall be numbered, and a table of contents page(s) shall be provided. The commissioning documentation shall include, but not be limited to, the following:

1. Approved final test and balance report for the building being commissioned.

2. All accepted shop drawings of systems equipment. Shop drawings shall be full size sheets folded as required to fit in binders.

3. All pre-functional performance test checklists, signed by personnel performing and/or witnessing test, organized by system and sub-system.

4. All verification and functional performance test checklists/results, signed by personnel performing and/or witnessing test, organized by system and sub-system. This information may be used for calibrating the original energy simulation model. The revised model will be used to create the baseline for energy use in the building.

5. Three copies of the operation and maintenance (O&M) manuals specified in the Construction Documents shall be included with the commissioning documentation. The manuals shall be incorporated in the commissioning documentation prior to commencement of Operation & Maintenance training required in this and other sections of the specification. Preparation of Operation & Maintenance manuals shall be as specified in the Contract Documents.

PART 2 – PRODUCTS

2.1 TEST EQUIPMENT

A. The appropriate Contractor(s) shall furnish all special tools and equipment required during the commissioning process as defined by the Construction Documents. The Owner shall furnish necessary utilities for the commissioning process.

2.2 TEST EQUIPMENT – PRIOPRIETARY

A. Proprietary test equipment and software required by any equipment manufacturer for programming and/or start-up, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist in the commissioning process as needed. Proprietary test equipment (and software) shall become the property of the Owner upon completion of the commissioning process.

PART 3 – EXECUTION

3.1 GENERAL

A. A pre-construction meeting of all commissioning team members shall be held at a time and place designated by the Owner. The purpose shall be to familiarize all parties with the commissioning process, and to ensure that the responsibilities of each party are clearly understood.

B. During the construction process commissioning meetings will take place that will include attendance for all necessary trades or a company representative that are involve in the commissioning process. During the beginning of construction they will take place on an as-needed basis and increase in frequency as the project progresses up to a weekly meeting during the primary testing and performance verification phases.

C. The contractor shall complete all phases of work so the systems can be started, tested, balanced, and acceptance procedures undertaken. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc. per the Construction Documents and related directives, clarifications, and change orders.

D. The Commissioning Authority shall develop a Commissioning Plan. The Contractor shall assist the Commissioning Authority in preparing the Commissioning Plan by providing all necessary information pertaining to the actual equipment and installation. If contractor initiated system changes have been made that alter the commissioning process; the Commissioning Authority shall notify the Owner. The Commissioning Plan can be modified based on the construction schedule and can be done so after consultation with the OWNER at the discretion of the Commissioning Authority.

E. Acceptance procedures are normally intended to begin prior to completion of a system and/or sub-systems, and shall be coordinated with the Division, 21, 22, 23, and 26 contractors. Start of acceptance procedures before system completion does not relieve the contractor from completing those systems as per the schedule.

F. The Commissioning Authority shall develop a detailed schedule for acceptance procedures and training. The Commissioning Authority shall work in a cooperative manner with the Contractor to assure that the commissioning process does not interfere with the completion of work in accordance with the overall construction schedule.

3.2 PARTICIPATION IN ACCEPTANCE PROCEDURES

A. The Contractor shall provide skilled technicians to start-up and debug all systems. The Contractor shall also assist the Commissioning Authority in the completion of the installation and pre-functional checklists. Work schedules, time required for testing, etc. shall be requested by the Commissioning Authority and coordinated by the contractor. Contractor shall ensure that the qualified technician(s) are available and present during the agreed upon schedules and of sufficient duration to complete the necessary tests, adjustments, and/or problem resolutions.

B. System performance problems and discrepancies may require additional technician time, Commissioning Authority time, reconstruction of systems, and/or replacement of system

components. The additional technician time shall be made available for subsequent commissioning periods until the required system performance is obtained.

C. Qualifications of technicians shall include expert knowledge relative to the specific equipment involved and a willingness to work with the Commissioning Authority. Contractor shall provide adequate documentation and tools to start-up and test the equipment, system, and/or sub-system.

3.3 DEFICIENCY RESOLUTION

A. In some systems, improper adjustments, misapplied equipment, and/or deficient performance under varying loads may result in additional work being required to commission the systems. This work shall be completed under the direction of the Owner, with input form the contractor, engineer, equipment supplier, and Commissioning Authority. Whereas all members shall have input and the opportunity to discuss, debate, and work out problems, the Design Professional shall have final jurisdiction over any additional work done to achieve performance.

B. Corrective work shall be completed in a timely fashion to permit the completion of the commissioning process. If construction operation does not permit accurate demonstration of the testing procedure then seasonal testing or other methods of testing can be implemented. The Commissioning Authority will approve all tests. Experimentation to demonstrate system performance may be permitted. If the Commissioning Authority deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Authority shall notify the Owner, indicating the nature of the problem, expected steps to be taken, and suggested deadline(s) for completion of activities. If the deadline(s) pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner shall be the contractor’s responsibility.

C. Deficiencies shall be assigned by trade by both the Resident Project Engineer and the Commissioning Authority.

D. The Commissioning Authority will have jurisdiction of all matters that pertain to the commissioning process and will report directly to the OWNER on all matters including dispute resolution.

3.4 ADDITIONAL COMMISSIONING

A. Additional commissioning activities may be required after system adjustments, replacements, etc., are completed. The contractor(s), suppliers and Commissioning Authority shall complete this work as part of their contractual obligations. Seasonal commissioning will be scheduled for pieces of equipment that only operate during specific seasons.

3.5 SEASONAL COMMISSIONING

A. Seasonal commissioning pertains to testing under full load conditions during peak heating or cooling seasons, as well as part load conditions in the spring and fall. Simulations of peak load conditions shall be implemented wherever possible to allow for complete commissioning of the work.

B. Seasonal commissioning of heating and cooling systems will be performed by the contractor with the guidance and supervision of the Commissioning Authority. The Owner will be responsible for any other seasonal commissioning during part load conditions. The contractors will be responsible for any deficiencies that are discovered from the seasonal testing.

3.6 ACCEPTANCE PROCEDURES

A. Verification Tests

1. Scope of verification tests

Only after the satisfactory completion of the installation checklist, pre-functional checklist and functional performance checklist will the system be ready for acceptance. At no time will acceptance be made for pieces of equipment. Final acceptance will only be for systems that will operate as intended in the basis of design and the design intent.

a. Operating tests and checks to verify that all components, equipment, systems, sub-systems, and interfaces between systems, operate in accordance with contract documents. These tests are to include all operating modes, interlocks, specified control responses, specific responses to abnormal or emergency conditions and verifications of the proper response of the building automation system controllers and sensors.

b. Verify the validity of the TAB report.

2. Participants in verification tests

a. The Commissioning Authority shall be responsible for preparing the scope of these tests. The Commissioning Authority shall schedule the tests and assemble the commissioning team members who shall be responsible for the tests. Participating contractors, manufacturers, suppliers, etc. shall include all costs to do the work involved in these tests in their proposals.

b. MEP contractor – provide the services of a technician (s) who is (are) familiar with the construction and operation of this system. Provide access to the contract plans, shop drawings, and equipment cut sheets of all installed equipment.

c. HTC/FMS sub-contractor – provide the services of a controls technician who is familiar with the details of the project. Provide details of the control system, schematics, and a narrative description of control sequences of operation.

d. Electrical contractor – provide a foreman electrician or office personnel familiar with the electrical interlocks, interfaces with emergency power supply, and interfaces with alarm and life-safety systems. Provide access to the contract plans and all as-built schematics of sub-systems, interfaces and interlocks.

3. Documentation and Reporting Requirements.

a. Provide checklists for each component, piece of equipment, system, and sub-system, including all interfaces, interlocks, etc. Each item to be tested

shall have a different entry line with space provided for comments. Separate checklists shall be prepared for each mode of operation. Provide space to indicate whether the mode under test responded as required or not. Also, provide space for all necessary parties to sign off on each checklist.

b. Data sheets used in verification of the proper operation of the control system shall include each controller to be verified and its location. For each controller, provide space for recording the readout of the controller, the reading at the controller's sensor (s), and any comments. Also, provide space for all necessary parties to sign off on each checklist.

c. All test procedures and data sheets shall be submitted to the design professional for review and acceptance.

4. Instrumentation

a. The Commissioning Authority shall furnish all measurement instrumentation for the verification tests. All instruments shall have been calibrated within the one year period prior to these tests.

5. Verification Procedures

a. The Commissioning Authority shall direct and witness the verification operating tests and checks for all equipment and systems.

1. Set the system equipment (i.e., chiller, boiler, pumps, fans, etc.) into the operating mode to be tested, i.e. normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, alarm conditions and combustion if so required.

2. The Commissioning Authority shall inspect and verify the position of each device and interlock identified on the checklist. Each item shall be signed off as acceptable (yes), or failed (no).

3. This test shall be repeated for each operating cycle that applies to the MEP system being tested performance under normal and full operating conditions.

4. Operating checks shall include all safety cutouts, alarms and interlocks with smoke control and life safety systems during all modes of operation of the MEP system.

5. If during a test an operating deficiency is observed, appropriate comments shall be added to the checklist data sheet.

6. Verification of the interface of the monitoring and control system, and the TAB criteria shall be included.

7. Verification of the proper responses of monitoring and control system controllers and sensors shall be included:

b. The Commissioning Authority shall direct and witness the field verification of the final TAB report.

1. The Commissioning Authority shall verify 10 percent of the report data.

2. The TAB contractor shall be given sufficient advance notice of the date of field verification. However, they shall not be informed in advance of the data points to be verified. The TAB contractor must use the same instruments (by model and serial number) that were used when the original data were collected.

3. Failure of an item is defined as:

a. For all readings other than sound, a deviation of more than 10 percent.

b. For sound pressure readings, a deviation of 3 decibels. (Note: variations in background noise must be considered).

4. A failure of more than 10 percent of the selected items shall result in the rejections of the final TAB report.

5. If there are deficiencies identified during verification, the owner and the Resident Project Engineer must be notified, and action taken to remedy the deficiency. The Design Professional and the Commissioning Authority, to determine if verification is complete, and the operating system is functioning in accordance with the contract documents, shall review the final tabulated checklist data sheets.

B. Functional Performance Testing

1. Scope of Functional Performance Testing

a. Functional performance tests shall determine if the MEP system is providing the required cooling and heating services in accordance with the final design intent. They shall also determine the installed capacity of the cooling and heating plant, and heat transfer components. Following is a list of test examples:

1. Determine capability of chilled water system to deliver chilled water at the design supply temperature, and required rate of flow.

2. Determine capacity of electric heating system to deliver heating at the design temperature.

3. Determine the ability of the Mechanical unit to deliver the cooling and/or heating services to the distribution system, at the design supply air temperature, required static pressure, and proper outside air ventilation rate.

2. Participants in Functional Performance Tests

a. Participants in the functional performance tests shall be the same as those listed in the verification tests.

3. Instrumentation

a. In addition to the instrumentation requirements detailed under verification, the Commissioning Authority may need to provide data acquisition equipment to record data for the complete range of testing.

4. Functional Performance Test Procedures

a. The Commissioning Authority shall supervise and direct all functional performance tests.

b. For each test, the Commissioning Authority shall install the measuring instruments and logging devices to record test data for the required test period. The instrumentation shall monitor and record all operating conditions to allow for complete evaluation of the test results.

5. Documentation and Reporting Requirements

a. All measured data, data sheets; and a comprehensive summary, describing the operation of the MEP system at the time of testing shall be submitted to the Commissioning Authority.

b. A preliminary functional performance test report shall be prepared by the Commissioning Authority and submitted to the Design Professional or review. Any identified deficiencies need to be evaluated by the Design Professional and Resident Project Engineer to determine if they are part of the contractor's contractual obligations. The responsible contractor (s) and the specific functional performance test repeated shall correct construction deficiencies.

c. If it is determined that the MEP system is constructed in accordance with the contract documents, and the performance deficiencies are not part of the contract documents, the Owner must decide whether any required modifications needed to bring the performance of the MEP system up to the finalized design intent shall be implemented, or if the test shall be accepted as submitted. If corrective work is performed, the Design Professional shall determine if a portion or all required functional performance tests should be repeated, and a revised report submitted.

3.7 OPERATING AND MAINTENANCE MANUAL

A. The operating and maintenance manual shall consist of a sturdy 3-Ring binder with 8-1/2" X 11" sheets in accordance with the Contract Documents as stated in Division 01.

3.8 OPERATING AND MAINTENANCE TRAINING

A. The MEP Contractor, and appropriate sub-contractors, shall provide comprehensive operating and maintenance instruction on building systems in accordance with the Contract Documents prior to delivery. The instruction shall include classroom instruction delivered by competent instructors based upon the contents of the operating manual.

B. Each on-site classroom-training period shall be followed by an inspection, explanation and demonstration of the system concerned by the instructors. All specified equipment should be started up and shut down, with the exception of sprinkler system.

C. The contractor shall be responsible for organizing, arranging, and delivering material on a schedule agreeable to the Owner.

D. The contractor shall provide, at or before substantial completion, a proposed agenda and schedule of the above training for approval by the Commissioning Authority and the Owner.

END OF SECTION 019113