



Design Guidelines for Facilities Construction:

DESIGN GUIDELINE DG01-9 General Commissioning Requirements

Part 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements that apply to implementation of commissioning without regard to specific systems, assemblies, or components.
- B. Western Michigan University has retained the services of [**Commissioning Agent**] to serve as the project Commissioning Authority (CxA). [**Commissioning Agent**] will perform the items specified under Commissioning Authority responsibilities.
- C. Related Sections:
 - 1. Division 21 Section “Commissioning of Fire Suppression System” for commissioning process activities for Fire Suppression systems, assemblies, equipment, and components.
 - 2. Division 22 Section “Commissioning of Plumbing” for commissioning process activities for Plumbing systems, assemblies, equipment, and components.
 - 3. Division 23 Section “Commissioning of HVAC” for commissioning process activities for HVAC&R systems, assemblies, equipment, and components.
 - 4. Division 26 Section “Commissioning of Electrical” for commissioning process activities for Electrical systems, assemblies, equipment, and components.
 - 5. Division 28 Section “Commissioning of Fire Alarm” for commissioning process activities for Fire Alarm systems, assemblies, equipment, and components.

1.2 DEFINITIONS

- A. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the OPR and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

- B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.
- C. CxA: Commissioning Authority.
- D. OPR: Owner's Project Requirements. A document that details the functional requirements of a project and the expectations of how it will be used and operated. These include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.
- E. Systems, Subsystems, Equipment, and Components: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, equipment, and components.

1.3 DESCRIPTION

- A. Commissioning: Commissioning is a quality oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meet defined objective and criteria. The commissioning process includes specific tasks to be conducted during the project in order to verify that design, construction, and training meets the construction/contract documents.
- B. Commissioning shall:
 - 1. Verify that applicable equipment and systems are installed according to the Contract Documents, manufacturer's recommendations and that they receive adequate operational checkout by installing Contractors.
 - 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 operation personnel are adequately trained.
- C. The commissioning process does not take away from or reduce the responsibility of the system designers or installing Contractors to provide a finished and fully functioning product.

1.4 SUBMITTALS

- A. Submit under provisions of Division I and as supplemented in this section.
- B. Contractor commissioning submittals will be integrated into the normal submittal process and protocol of the construction team. In addition to sample material submittals, shop drawings, O&M submittals, etc., included in other sections of the contract/construction documents, the Contractor shall also provide, at minimum, the manufacturer and model number, the manufacturer's printed installation and detailed startup procedures, full sequences of operation, O&M data, performance data, performance test procedures, control drawings and details of Owner contracted tests. 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 CxA. All documentation will be included by the subcontractors in their O&M contributions.

- C. The CxA will review submittals related to the commissioned equipment for conformance to the Contract Documents as it relates to the commissioning process, to the performance of the equipment and adequacy for developing test procedures. This review is intended primarily to aid in the development of performance procedures and only secondarily to verify compliance with equipment specifications. The commissioning authority will notify the Owner/CM, PM or A/E as requested, of items missing or areas that are not in conformance with Contract Documents and which requires resubmission.
- D. Contractor shall prepare system test reports (pipe pressure tests, duct pressure/leak tests, electrical tests, etc.), submit to CxA for review, and insert in appropriate location of the Commissioning Plan.
- E. Contractor shall prepare equipment/system installation and start-up reports for each piece of equipment/system to be commissioned. Submit completed reports to CxA for review and insert reports in appropriate location of the Commissioning Plan.
- F. The contractor shall prepare and submit owner training plans.
- G. The contractor shall include in the Project Schedule the order and timing of the commissioning activities for each of the systems to be commissioned.
- H. A draft copy of the O&M manuals shall be submitted for review early in the construction phase and is available on site for use during commissioning.

1.5 QUALITY ASSURANCE

- A. ASHRARE: Follow Guidelines:
 - 1. ASHRAE Guideline 1.1-2007
 - 2. ASHRAE Guideline 0-2005
- B. Inter-National Electrical Testing Association: NETA Acceptance Testing Specifications (ATS)-1996.
- C. Instructor Qualifications: Factory authorized service representatives, experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.
- D. Test Equipment Calibration: Comply with test equipment manufacturer's calibration procedures and intervals. Recalibrate test instruments immediately whenever instruments have been repaired following damage or dropping. Affix calibration tags to test instruments or have certificates readily available. Instruments shall have been calibrated within 12 months prior to use.

1.6 COORDINATION

- A. Project Commissioning Team: The members of the project commissioning team will consist of the commissioning authority and any support personnel, the Construction Manager, the Owner's facility staff or designee, the subcontractors and/or vendors as required, and the architect/engineer.

- B. Management: The CxA coordinates the commissioning activities through the CM, All members shall work together to fulfill their contracted responsibilities and meet the objectives of the Contract Documents.
- C. Scheduling: The CxA, through the Owner or CM, will provide sufficient notice to the contractor for scheduling commissioning activities with respect to the Owner's participation. The contractor will integrate all commissioning activities into the overall project schedule. All parties will address scheduling problems and make necessary notifications in a timely manner in order to expedite the commissioning process.
- D. Manufacturer's Field Services: CM and/or the contractor shall coordinate services of subcontractors and manufacturers field representatives with the commissioning team.

1.7 COMMISSIONING PLAN

- A. The CxA will develop the commissioning manual which will include the commissioning plan, installation verification checklists and functional test protocol and checklists, which will be reviewed by the commissioning team. 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 an initial commissioning meeting conducted by the CxA where the commissioning process is reviewed with the project commissioning team members.
 - 2. Additional meetings will be required throughout construction, scheduled by the CxA, through the Owner or CM, with necessary parties attending to plan, scope, coordinate, schedule future activities and resolve issues.
 - 3. Equipment documentation is submitted to the CxA, through the Owner or CM, during normal submittals, including detailed startup procedures.
 - 4. The construction checklists are to be prepared and completed by the contractor or subcontractor before and during the startup process.
 - 5. Installation verification is executed by the CxA.
 - 6. Construction checklists, installation verification checklists, TAB and startup must be completed before functional performance testing.
 - 7. Items of non-compliance in material, installation, or setup shall be corrected at no expense to the Owner.
 - 8. The contractor ensures that the subcontractors construction checklists are executed and documented and that startup and initial checkouts are performed. The CxA verifies that the TAB, construction checklists and startups were completed according to the plans. This includes the CxA reviewing TAB reports, construction checklists and startup plans/checklists. This also includes witnessing startup of selected equipment. Any testing failure is to be corrected at no additional cost to the Owner, and a re-test is to be performed, observed, and documented.
 - 9. Draft O&M's are submitted.
 - 10. Owner training plans are submitted.

11. The CxA develops and implements equipment and system functional performance test procedures. The forms and procedures are reviewed by the commissioning team.
12. The functional performance tests are executed by the contractor under the direction of the CxA with the assistance of the facility staff. All results are documented by the CxA.
13. The CxA concurrently with the design team and Owner reviews the O&M documentation for completeness.
14. Commissioning shall be completed before substantial completion with the exception of deferred testing.
15. The contractor develops procedures, reviews, coordinates, and implements the training.
16. Deferred testing is conducted as specified or required.

1.8 COMMISSIONING TEAM

A. Members Appointed by Contractor(s): Individuals, each having the authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated action. The commissioning team shall consist of, but not be limited to, representatives of each contractor, including project superintendent and subcontractors, installers, suppliers, and specialists deemed appropriate by the CxA. Required entities include but are not limited to the following:

1. Fire Suppression
2. Plumbing
3. HVAC sheet metal
4. HVAC piping
5. Test and Balance
6. DDC
7. Electrical
8. Fire Alarm
9. Refrigeration
10. Food service

B. Members Appointed by Owner:

1. Construction Manager: The designated person that plans, schedules, and coordinates the construction process.
2. CxA: The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. Owner will engage the CxA under a separate contract.
3. Representatives of the facility user and operation and maintenance personnel.
4. Architect and engineering design professionals.

1.9 OWNER'S RESPONSIBILITIES

A. Provide the OPR documentation to the CxA and each Contractor for information and use.

- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities.
- C. Provide the BoD documentation, prepared by Architect and approved by Owner, to the CxA and each Contractor for use in developing the commissioning plan, systems manual, and operation and maintenance training plan.

1.10 CONTRACTOR'S RESPONSIBILITIES

- A. Contractor shall assign representatives with expertise and authority to act on its behalf and shall schedule them to participate in and perform commissioning process activities including, but not limited to, the following:
 - 1. Evaluate performance deficiencies identified in test reports and, in collaboration with entity responsible for system and equipment installation, recommend corrective action.
 - 2. Cooperate with the CxA for resolution of issues recorded in the Issues Log.
 - 3. Attend commissioning team meetings held on a monthly basis or as scheduled by the CxA.
 - 4. Integrate and coordinate commissioning process activities with construction schedule.
 - 5. Review and accept construction checklists provided by the CxA.
 - 6. Complete paper and/or electronic construction checklists as Work is completed and provide to the Commissioning Authority on a monthly basis.
 - 7. Review and accept commissioning process test procedures provided by the Commissioning Authority.
 - 8. Complete commissioning process test procedures.

1.11 CxA's RESPONSIBILITIES

- A. Organize and lead the commissioning team.
- B. Provide commissioning plan.
- C. Convene commissioning team meetings.
- D. Prepare project-specific construction checklists and commissioning process test procedures.
- E. Verify the execution of commissioning process activities using random sampling. The sampling rate may vary from 1 to 100 percent. Verification will include, but is not limited to, equipment submittals, construction checklists, training, operating and maintenance data, tests, and test reports to verify compliance with the OPR. When a random sample does not meet the requirement, the CxA will report the failure in the Issues Log.
- F. Prepare and maintain the Issues Log.
- G. Prepare and maintain completed construction checklist log.
- H. Witness systems, assemblies, equipment, and component startup.
- I. Compile test data, inspection reports, and certificates; include them in the systems manual and commissioning process report.

1.12 EQUIPMENT/SYSTEMS TO BE COMMISSIONED

A. Mechanical

1. Air Handling Systems
2. HVAC Zone Control
3. Kitchen exhaust system (hoods, ducts, fans, and controls)
4. Food service (pulper, dish machine and conveyor system)
5. Cooling System Components
6. Steam and Condensate
7. Heating Hot Water
8. Domestic Hot Water
9. Snowmelt system
10. Elevator sump pumps
11. Fire alarms, dampers, and suppression
12. Temperature Controls
13. Test and Balance
14. Labeling of equipment, piping, and components
15. Refrigeration systems (coolers, freezers, evaporators, condensers, piping, and controls)
16. Fire pump

B. Electrical Systems

1. Power distribution, lighting and occupancy sensors
2. Distribution panels
3. Emergency generator system
4. Emergency lights
5. Lighting controls
6. Exterior lighting
7. Variable frequency drives

Part 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. All standard testing equipment required to perform startup and initial checkout and required performance testing shall be provided by the contractor for the equipment being tested. This includes but is not limited to two-way radios, meters, and data recorders.
- B. Special equipment, tools, and instruments required for testing equipment according to these Contract Documents shall be included in the Contractor's base bid price and shall be turned over to the Owner at Project closeout.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance within the tolerances specified in the specifications. If not otherwise noted, the following minimum requirements apply: temperature sensors and digital thermometers shall have a certified calibration to NIST traceable standards to an accuracy of 0.5 deg F and a resolution of plus or minus

0.1 deg F. Pressure sensors shall have an accuracy of plus or minus 2.0% of the value range being measured (not full range of the meter).

Part 3 - EXECUTION

3.1 MEETINGS

- A. Initial Meeting: The CxA, through the Owner/CM will schedule, plan, and conduct an initial commissioning meeting. The Contractor and Contractor's responsible parties are required to attend.
- B. Training: Before operation and maintenance training, the Contractor shall prepare and submit training plans for all systems to be commissioned. In addition to requirements specified in Division 01 Section "Demonstration and Training" the training plans shall also include the following:
 - 1. Review the OPR and BoD.
 - 2. Review installed systems, subsystems, and equipment.
 - 3. Instructor qualifications.
 - 4. Instructional methods and procedures.
 - 5. Training module outlines and contents.
 - 6. Course materials (including operation and maintenance manuals).
 - 7. Locations and other facilities required for instruction.
 - 8. Training schedule and verify availability of educational materials, instructors, audiovisual equipment, and facilities needed to avoid delays.
 - 9. For instruction that must occur outside, review weather and forecasted weather conditions and procedures to follow if conditions are unfavorable.
- C. Commissioning Meetings: Meetings will be planned and conducted by the CxA as construction progresses. These meetings will be held as required depending on construction progress and as required for the system being commissioned.

3.2 STARTUP, CONSTRUCTION CHECKLISTS, AND INITIAL CHECKOUT

- A. The following procedures apply to all equipment/systems to be commissioned, according to Article “Equipment/Systems to be Commissioned.”
- B. General: Construction checklists are important to verify that the equipment and systems are fully connected and operational. It ensures that functional performance testing (in-depth system checkout) may proceed without unnecessary delays. The construction checklists for a given system must be successfully completed prior to startup and formal functional performance testing of equipment or subsystems of the given system.
- C. Startup and Checkout Plan: This process is to ensure that there is written documentation that each of the manufacturer recommended procedures has been completed.
 - 1. The construction checklists are provided by the CxA. These checklists indicate required procedures to be executed as part of startup and initial checkout of the systems and the party responsible for their execution.
 - 2. The Contractor shall determine which trade is responsible for executing and documenting each of the line item tasks and transmit the checklists to the responsible subcontractors. Each form may have more than one trade responsible for its execution.
 - 3. The Contractor/Subcontractor responsible for the purchase of the equipment shall develop the full startup plan by combining the manufacturer’s detailed startup and checkout procedures and the construction checklists.
 - 4. The Contractor/Subcontractor shall submit the completed startup to CxA or review.
- D. Sensor and Actuator Calibration: All field installed temperature, relative humidity, CO2, pressure, occupancy, flow sensors and gauges, and all actuators (dampers and valves) on all equipment shall be calibrated. Verify that all locations are appropriate and away from causes of erratic operation. Submit to the CxA through the CM the calibration methods and results. All test instruments shall have had a certified calibration within the last 12 months to NIST traceable standard, and comply with all local, state and/or federal requirements/certifications, as required. Sensors installed in the unit at the factory with calibration certification provided need not be field calibrated. Provide bench testing as required at the direction of the CxA.
 - 1. Sensor calibration methods:
 - a. 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 deg F of each other for temperature and within a tolerance equal to 2 percent of the reading, of each other, for pressure. Tolerances for critical applications may be tighter.
 - b. Sensors Without Transmitters: Standard Application. Make a reading with a calibrated test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gauge or BAS) is within

the tolerances in the table below of the instrument measured value. If not, calibrate or replace sensor.

- c. 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 test instrument within 6 inches of the site sensor. Verify that the sensor reading (via the permanent thermostat, gauge, or BAS) is within the tolerances in the table below of the instrument measured value. If not, replace sensor and repeat. For pressure sensor, perform a similar process with a suitable signal generator.
- d. Tolerances: Standard Applications.

1) Heat Pump loop temperature	+/- 0.4 F
2) AHU wet bulb or dew point	+/- 2.0 F
3) Heating hot water temperature	+/- 1.5 F
4) OA, space, duct temperature	+/- 0.4 F
5) Pressure: air, water, and gas	3% of design
6) Flow rates: air	10% of design
7) Flow rates: water	5% of design
8) Relative Humidity	4% of design
9) CO2 monitor	0.1 % pts
- e. Valve and Damper Stroke Setup and Check EMS Readout: For all valve and damper actuator positions checked, verify the actual position against the BAS readout. Set pumps or fans to normal operation mode. Command valve or damper closed, visually verify that valve or damper is closed and adjust output zero signal as required. 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, replace actuator or add pilot positioner (for pneumatics).
- f. Closure for Heating Coil Valves (NO): Set heating setpoint 20 deg F above room temperature. Observe valve open. Remove control air or power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set heating setpoint to 20 deg F below room temperature, Observe the valve close. For pneumatics, by override in the BAS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.
- g. Closure for Cooling Coil Valves (NC): Set cooling setpoint 20 deg F above room temperature. Observe the valve close. Remove control air or

power from the valve and verify that the valve stem and actuator position do not change. Restore to normal. Set cooling setpoint to 20 deg F below room temperature. Observe valve open. For pneumatics, by override in the BAS, increase pressure to valve by 3 psi (do not exceed actuator pressure rating) and verify valve stem and actuator position does not change. Restore to normal.

E. Execution of Construction Checklists and Startup:

1. The execution and acceptance of the construction checklists, startup, and checkout shall be directed and performed by the Contractor, subcontractor or vendor. Signatures are required of the applicable subcontractors for verification of completion of their work.
2. The subcontractors and vendors shall execute startup and provide the CxA and A/E, through the Owner/CM, with a signed and dated copy of the completed startup and construction checklists.
3. Only individuals of the Contractor (technicians, engineers, tradesmen, vendors, etc.) who have direct knowledge and witnessed that a line item task on the construction checklist was actually performed shall check off that item.

F. Deficiencies, Non-Conformance, and Acceptance in Checklists and Startup (Master Issues Log):

1. The Contractor shall ensure that the subcontractors clearly list any outstanding items of the initial startup and construction checklist procedures that were not completed successfully, on an attached sheet. The form and any outstanding deficiencies shall be provided, through the Owner/CM, to the CxA.
2. The CxA will review the report and add any issues to the issues log. The installing subcontractors or vendors shall correct all areas that are deficient or incomplete in the checklists and tests in a timely manner, shall notify the Owner/CM as soon as outstanding items have been corrected, and resubmit an updated startup report with a Statement of Correction on the original non-compliance report. When satisfactorily completed, the CxA will update issues log and close the items.
3. Items left incomplete, which later cause deficiencies or delays during performance testing may result in back-charges to the Contractor.

3.3 INSTALLATION VERIFICATION CHECKLISTS AND VERIFICATION

- A. Requirements: Installation checklists will verify that equipment and systems are mounted, installed and fully connected in accordance with the contract documents and manufacturer recommendations.
- B. Development of Installation Verification Checklists: CxA will develop the installation verification checklists based on the latest construction documents and manufacturer installation data. CxA will submit checklist to commissioning team for review and will update based on review comments.
- C. Coordination and Scheduling: The Contractor shall provide notice to CM when installation is complete. CM will notify CxA that the installation is complete and ready for verification. CxA will perform installation verification.

- D. Documentation: CxA will complete the installation verification checklists and document any deficiencies in the issue tracking log. Issue tracking log will be submitted to Owner/CM for resolution. After deficiencies have been addressed, CxA will re-verify and close the item.

3.4 FUNCTIONAL PERFORMANCE TESTING

- A. Requirements: The functional performance testing shall demonstrate that each system is operating according to the documented design intent and Contract Documents. Performance testing facilitates bringing the systems from a state of individual substantial completion to full dynamic operation. Additionally, during the testing process, areas of deficient performance are identified and corrected, improving the operation and functioning of the systems.
- B. Coordination and Scheduling: The Contractor shall provide sufficient notice, regarding their completion schedule for the construction checklists and startup of all equipment and systems to allow the functional performance testing to be scheduled. The commissioning team shall oversee, witness, and document the functional performance of all equipment and systems. The Contractor/subcontractors shall execute the test, the CxA and Owner will witness and direct the tests. Performance testing shall be conducted after the construction checklists, and startup has been satisfactorily completed. The control system shall be sufficiently tested prior to use, to verify performance of other components or systems. The air balancing and water balancing shall be completed before functional testing of air or water related equipment or systems, Testing proceeds from components to sub-systems to systems. When the proper performance of all interacting individual systems has been achieved, the interface of coordinated responses between systems shall be checked.
- C. Development of Test Procedures: Before test procedures are finalized, the Contractor shall provide the A/E and the CxA with all requested documentation and a current list of changes affecting equipment or systems, including an updated points list, program code, control sequences, and testing parameters. Using the testing parameters and requirements in the technical Specifications, the CxA shall update/develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Each Contractor/subcontractor or vendor, as appropriate, shall provide assistance to the CxA in developing the final procedures. Prior to finalizing, the A/E shall review and concur with the test procedure.
- D. Test Methods:
 - 1. Functional performance testing and verification may be achieved by manually adjusting system setpoints and by monitoring the performance and analyzing the results using the control system's trend log capabilities.
 - 2. Simulated Conditions: Simulating conditions shall be allowed, through timing the testing to experience actual condition is encouraged wherever practical.

3. Overridden Values: Overriding sensor values to simulate a condition, such as overriding the outside air temperature reading in a control system to be something other than it really is, is acceptable.
4. Altering Setpoints: Rather than overriding sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable.
5. Setup: Each performance test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor/subcontractor(s) assisting the CxA in executing the test shall provide all necessary materials, system modifications, etc., to produce the necessary flows, pressures, temperature, etc., necessary to execute the test according to the specified condition. At completion of the test, the Contractor/subcontractor(s) shall return all affected equipment and systems to their normal operating settings.

E. Test Equipment: Refer to Part 2 for test equipment requirements.

3.5 DOCUMENTATION, NON-CONFORMANCE, AND ACCEPTANCE OF TESTS

A. Documentation: The CxA shall witness and document the results of all performance tests. The CxA shall complete all documentation for performance testing.

B. Non-Conformance:

1. Corrections of minor deficiencies identified may be made during the tests at the discretion of the CxA. In such cases the deficiency and resolutions will be documented on the functional test checklist or on the issues tracking sheet.
2. As tests progress and a deficiency is identified, the CxA shall discuss the issue with the commissioning team, and the Contractor.
 - a. When there is no dispute concerning the deficiency and the Contractor accepts responsibility to correct it:
 - 1) The CxA will document the deficiency and the Contractor's response and intentions. After the day's work, the CxA will submit the non-compliance reports to the CM. The Contractor corrects the deficiency, and informs the commissioning team that the equipment is ready to be retested.
 - 2) The Contractor shall reschedule the test; and the test is repeated.
 - b. If there is a dispute about a deficiency, regarding whether or not it is a deficiency:
 - 1) The dispute shall be documented on the issues tracking list.
 - 2) Resolutions are made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive authority is with the A/E. Final acceptance authority is with the A/E. Final acceptance authority is with the CM.
 - 3) The CxA documents the resolution.

- 4) Once the interpretation and resolution has been decided, the Contractor corrects the deficiency. The Contractor shall reschedule the test and the test shall be repeated until satisfactory performance is achieved.
3. Cost of repeating a performance test is the Contractor's.
4. The Contractor shall submit in writing to the CM at least as often as commissioning meetings are being scheduled, the status of each outstanding discrepancy identified during commissioning. Discussion shall cover explanations of any disagreement and proposals for their resolutions.
 - a. The CxA retains the issues tracking log until the end of the project.
 - b. Retesting shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- C. Failure Due to Manufacturer Defect: If 10 percent (or three, whichever is greater) of identical pieces of equipment fail to perform to the Contract Documents (mechanically or substantively) due to a manufacturing defect, not allowing it to meet its submitted performance specification, all identical units may be considered unacceptable by the A/E or CxA. In such case, the Contractor shall provide the Owner with the following:
 1. Within one week of notification from the Owner/CM, the Contractor or manufacturer's representative shall examine all other identical units making a record of the findings. The findings shall be provided to the CM within two weeks of the original notice.
 2. Within two weeks of the original notification, the Contractor or manufacturer shall provide a signed and dated, written explanation of the problem, cause of failures, etc., and all proposed solutions. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
 3. The A/E will determine whether a replacement of all identical units or a repair is acceptable.
 4. Two examples, where applicable, of the proposed solution shall be installed by the Contractor and the A/E shall be allowed to test the installations for up to one week, upon which the A/E will decide whether to accept the solution.
 5. Upon acceptance, the Contractor and/or manufacturer shall replace or repair all identical items, at their expense. The replacement/repair work shall proceed with reasonable speed beginning within one week from the time parts can be obtained.
- D. Acceptance: The CxA notes each satisfactorily demonstrated function on the test form. Final acceptance of the performance test by the Owner is made after review by the CxA and CM, following recommendations by the A/E.

3.6 DEFERRED TESTING

- A. Unforeseen Deferred Tests: If any check or test cannot be completed due to the project completion level, required occupancy condition or other deficiency, execution of checklists and performance testing may be delayed upon acceptance of the CxA and CM. These tests will be conducted in the same manner as the seasonal tests as soon as possible.

- B. Seasonal Testing: During the warranty period, seasonal testing (tests 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 through the Owner/CM. Tests will be performed by the Contractor, CxA will witness, direct and document the test, and deficiencies shall be corrected by the appropriate Contractor/subcontractor with the CxA witnessing. Any final adjustments to the O&M manuals and as-built drawings due to the testing shall be made by the Contractor.

3.7 TRAINING OF OWNER PERSONNEL

- A. The Contractor shall provide training coordination, scheduling of subcontractors, and ensure training is completed. All training shall be coordinated, through the CM, with the CxA.
- B. The Contractor shall ensure that each subcontractor and vendor (mechanical, plumbing, fire, electrical, specialty, etc.) shall have the following responsibilities:
 - 1. Provide, to the CxA through the CM, a training plan 60 days before the planned training covering the following elements:
 - a. Equipment
 - 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 of each subject
 - h. Methods (classroom lecture, manufacturer's quality video, site walk through, actual operational demonstrations, written handouts, etc.)
 - 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 equipment that makes up the system.
 - 3. Training shall normally start with classroom sessions followed by hands-on demonstration/training on each piece of equipment.
 - 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 shall be repaired or adjusted as necessary and the demonstration repeated at another scheduled time, if necessary.
 - 5. The appropriate trade or manufacturer's representative shall provide the instructions on each major piece of equipment. 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 subcontractor shall attend sessions other than the controls training 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 printed installation, operation and maintenance instruction material included in the O&M manuals.
 - b. Systems manual
 - c. 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 startup, operation in all modes possible, shutdown, seasonal changeover and any emergency procedures.
 - d. Discussions of relevant health and safety issues and concerns.
 - e. Discussion of warranties and guarantees.
 - f. Common trouble shooting problems and solutions.
 - g. Explanatory information included in the O&M manuals.
 - h. Discussion of any peculiarities of equipment installation or operation.
 - i. Classroom sessions shall include the use of overhead projections, slides, video/audio-taped material as might be appropriate.
 - j. Hands on training shall include startup, operation in all modes possible, including manual, shut down, alarms, power failure and any emergency procedures, and preventative maintenance for all pieces of equipment.
 9. The Contractor shall fully explain and demonstrate the operation, function and overrides of any local packaged controls not controlled by the central control system.
- C. At the discretion of the CxA, training may occur before functional testing is complete if required by the facility operators to assist the CxA in the functional testing.

3.8 OPERATION AND MAINTENANCE MANUALS/DATA

- A. The commissioning process requires detailed O&M documentation as identified in this Section and technical Specifications.
- B. Contractor shall submit two draft copies of the complete operating and maintenance manual and systems manual to the CM for review by the Architect/Engineer and CxA within 60 calendar days after review of equipment shop drawings. One copy will be returned to the Contractor within 30 days after receipt by the A/E.
- C. Contractor shall submit corrected final reviewed manuals prior to substantial completion. Prior to final submittal, the CxA shall review the O&M manuals and systems manual (in addition to the initial draft O&M manual), and documentation, with redline as-built drawings, for systems that were commissioned to verify compliance with the specifications. The CxA will communicate, through the CM, deficiencies in the manuals to the Contractor or A/E, as requested. Upon a successful review of the corrections, the CxA will

recommend acceptance of these sections of the O&M manuals to the CM. The CxA will also review each equipment warranty and verify that all requirements to keep the warranty valid are clearly stated. This work does not supersede the A/E's review of the O&M manuals according to the A/E's Contract.

END OF SECTION 01 9113