

SECTION 01 91 00.01**DVA/USACE PROJECTS GENERAL COMMISSIONING REQUIREMENTS**

SPEC WRITER NOTES:

For Projects with USACE as the Design and/or Construction agent, use this specification section 01 91 00.01 in lieu of specification section 01 91 00. Also, coordinate with the USACE PM for applicable UFGS GENERAL REQUIREMENTS sections.

PART 1 - GENERAL**1.1 COMMISSIONING DESCRIPTION**

- A. This Section 01 91 00.01 DVA/USACE PROJECTS GENERAL COMMISSIONING REQUIREMENTS shall form the basis of the construction phase commissioning process and procedures for VA projects with USACE as the Design and/or Construction agent. The Commissioning Agent (CxA) and Contractor's Commissioning Manager (CxM) shall add, modify, and refine the commissioning procedures, as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table and as approved by the Contracting Officer's Representative (COR), to suit field conditions and actual manufacturer's equipment, incorporate test data and procedure results, and provide detailed scheduling for all commissioning tasks.
- B. Various sections of the project specifications require equipment startup, testing, and adjusting services. Requirements for startup, testing, and adjusting services specified in the Division 7, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 series sections of these specifications are intended to be provided in coordination with the commissioning services and are not intended to duplicate services. The Contractor shall coordinate the work required by individual specification sections with the commissioning services requirements specified herein.
- C. Where individual testing, adjusting, or related services are required in the project specifications and not specifically required by this commissioning requirements specification, the specified services shall be provided and copies of documentation, as required by those specifications shall be submitted to the COR and the CxA to be indexed for future reference.
- D. Where training or educational services for VA are required and specified in other sections of the specifications, including but not

limited to Division 7, Division 8, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 series sections of the specification, these services are intended to be provided in addition to the training and educational services specified herein.

- E. Commissioning is a systematic process of verifying that the building systems perform interactively according to the construction documents and the VA's operational needs. The commissioning process shall encompass and coordinate the system documentation, equipment startup, control system calibration, testing and balancing, performance testing and training. Commissioning during the construction and post-occupancy phases is intended to achieve the following specific objectives according to the contract documents:
1. Verify that the applicable equipment and systems are installed in accordance with the contract documents and according to the manufacturer's recommendations.
 2. Verify and document proper integrated performance of equipment and systems.
 3. Verify that Operations & Maintenance documentation is complete.
 4. Verify that all components requiring servicing can be accessed, serviced and removed without disturbing nearby components including ducts, piping, cabling or wiring.
 5. Verify that the VA's operating personnel are adequately trained to enable them to operate, monitor, adjust, maintain, and repair building systems in an effective and energy-efficient manner.
 6. Document the successful achievement of the commissioning objectives listed above.
- F. The commissioning process does not take away from or reduce the responsibility of the Contractor to provide a finished and fully functioning product.

1.2 CONTRACTUAL RELATIONSHIPS

- A. For this construction project, the Government contracts with a Contractor to provide construction services. The contracts are administered by the Contracting Officer and the COR as the designated representative of the Contracting Officer. On this project, the authority to modify the contract in any way is strictly limited to the authority of the Contracting Officer.

- B. In this project, only two contract parties are recognized and communications on contractual issues are strictly limited to COR and the Contractor. Communications between by other parties to the contracts (Subcontractors and Vendors) must be conducted through the COR and Contractor. Communications between the Contractor and other parties of the project (Commissioning Agent and Architect/Engineer) must be conducted through the COR.
- C. Whole Building Commissioning is a process that relies upon frequent and direct communications, as well as collaboration between all parties to the construction process. By its nature, a high level of communication and cooperation between the Commissioning Agent and all other parties (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc.) is essential to the success of the Commissioning effort.
- D. With these fundamental practices in mind, the commissioning process described herein has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Agent (CxA) and Commissioning Manager (CxM) must develop effective methods to communicate with every member of the construction team involved in delivering commissioned systems while simultaneously respecting the exclusive contract authority of the Contracting Officer and COR. Thus, the procedures outlined in this specification must be executed within the following limitations:
1. No communications (verbal or written) from the CxA or CxM shall be deemed to constitute direction that modifies the terms of any contract between the Government and the Contractor.
 2. Commissioning Issues identified by the CxA and CxM will be delivered to the COR and copied to the designated Commissioning Representatives for the Contractor and subcontractors on the Commissioning Team for information only in order to expedite the communication process. These issues must be understood as the professional opinion of the CxA and CxM and as suggestions for resolution.
 3. In the event that any Commissioning Issues and suggested resolutions are deemed by the COR to require either an official interpretation of the construction documents or require a modification of the contract documents, the Contracting Officer or COR will issue an official directive to this effect.

4. All parties to the Commissioning Process shall be individually responsible for alerting the COR of any issues that they deem to constitute a potential contract change prior to acting on these issues.
5. Authority for resolution or modification of design and construction issues rests solely with the Contracting Officer or COR, with appropriate technical guidance from the Architect/Engineer, CxA and/or CxM.

Spec Writer Note: Edit the following paragraph to include only those related work sections that are included in the contract. Add related work references as necessary and delete any related work references not included in the contract.

Coordinate with USACE PM and include additional project GENERAL REQUIREMENTS specification sections as required under 1.3 RELATED WORK below.

1.3 RELATED WORK

- A. UFGS Section 01 30 00 ADMINISTRATIVE REQUIREMENTS
- B. UFGS Section 01 32 01.10 PROJECT SCHEDULE
- C. UFGS Section 01 33 00 SUBMITTAL PROCEDURES
- D. Section 01 81 13 SUSTAINABLE CONSTRUCTION REQUIREMENTS
- E. Section 07 08 00.01 DVA/USACE PROJECTS FACILITY EXTERIOR CLOSURE COMMISSIONING.
- F. Section 21 08 00 .01 DVA/USACE PROJECTS COMMISSIONING OF FIRE PROTECTION SYSTEMS.
- G. Section 22 08 00.01 DVA/USACE PROJECTS COMMISSIONING OF PLUMBING SYSTEMS.
- H. Section 23 08 00.01 DVA/USACE PROJECTS COMMISSIONING OF HVAC SYSTEMS.
- I. Section 26 08 00.01 DVA/USACE PROJECTS COMMISSIONING OF ELECTRICAL SYSTEMS.
- J. Section 27 08 00.01 DVA/USACE PROJECTS COMMISSIONING OF COMMUNICATIONS SYSTEMS.
- K. Section 28 08 00.01 DVA/USACE PROJECTS COMMISSIONING OF ELECTRONIC SAFETY AND SECURITY SYSTEMS.
- L. Section 33 08 00.01 DVA/USACE PROJECTS COMMISSIONING OF SITE UTILITIES.

1.4 SUMMARY

- A. This Section includes general requirements that apply to implementation of commissioning without regard to systems, subsystems, and equipment being commissioned.
- B. The commissioning activities have been developed to support the Government requirements to meet guidelines for Federal Leadership in Environmental, Energy, and Economic Performance.

SPEC WRITER NOTE: Paragraph C is for LEED projects. Paragraphs D is for Green Globes Projects. Retain either Paragraph C or Paragraph D as appropriate. Delete paragraph C.2 if enhanced commissioning for LEED is not included in the project. Delete paragraph C.3 if the M&V credit is not included in the project.

- C. The commissioning activities have been developed to support the United States Green Building Council's (USGBC) LEED™ rating program and to support delivery of project performance in accordance with the Government requirements developed for the project to support the following credits:
1. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" and the prerequisite of "Fundamental Building Systems Commissioning."
 2. Commissioning activities and documentation for the LEED™ section on "Energy and Atmosphere" requirements for the "Enhanced Building System Commissioning" credit.
 3. Activities and documentation for the LEED™ section on "Measurement and Verification" requirements for the Measurement and Verification credit.
- D. The commissioning activities have been developed to support the Green Buildings Initiative's Green Globes rating program and to support delivery of project performance in accordance with the Government requirements developed for the project.

1.5 ACRONYMS

List of Acronyms	
Acronym	Meaning
A/E	Architect / Engineer Design Team
AHJ	Authority Having Jurisdiction
ASHRAE	Association Society for Heating Air Condition and Refrigeration Engineers

List of Acronyms	
Acronym	Meaning
BOD	Basis of Design
BSC	Building Systems Commissioning
CD	Construction Documents
A	Approve
ASI	Architect's Supplemental Instruction
CD	Construction Documents
CMMS	Computerized Maintenance Management System
CO	Contracting Officer (USACE)
COR	Contracting Officer's Representative (USACE)
COBie	Construction Operations Building Information Exchange
CPC	Construction Phase Commissioning
Cx	Commissioning
CxA	Commissioning Agent
CxM	Commissioning Manager
CxR	Commissioning Representative
D-B	Design-Build
D-B-B	Design-Bid-Build
DD	Design Development
DID	Design Intent Document
DPC	Design Phase Commissioning
DVA	Department of Veterans Affairs
FPT	Functional Performance Test
L	Lead
GBI-GG	Green Building Initiative - Green Globes
HVAC	Heating, Ventilation, and Air Conditioning
LEED	Leadership in Energy and Environmental Design
NC	Department of Veterans Affairs National Cemetery
NCA	Department of Veterans Affairs National Cemetery Administration
NEBB	National Environmental Balancing Bureau
O	Optional
O&M	Operations & Maintenance
OPR	Owner's Project Requirements
P	Participate

List of Acronyms	
Acronym	Meaning
PFC	Pre-Functional Checklist
PFT	Pre-Functional Test
R	Review
RFI	Request For Information
RFP	Request For Proposal
RE	VA Resident Engineer
SD	Schematic Design
SO	Site Observation
TAB	Test Adjust and Balance
USACE	United States Army Corps of Engineers
VA	Department of Veterans Affairs
VAMC	VA Medical Center
VA CFM	VA Office of Construction and Facilities Management
VACO	VA Central Office
VA PM	VA Project Manager
USGBC	United States Green Building Council

1.6 DEFINITIONS

Acceptance Phase Commissioning: Commissioning tasks executed after most construction has been completed, most Site Observations and Static Tests have been completed and Pre-Functional Testing has been completed and accepted. The main commissioning activities performed during this phase are verification that the installed systems are functional by conducting Systems Functional Performance tests and Owner Training.

Accuracy: The capability of an instrument to indicate the true value of a measured quantity.

Back Check: A back check is a verification that an agreed upon solution to a design comment has been adequately addressed in a subsequent design review

Basis of Design (BOD): The Engineer's Basis of Design is comprised of two components: the Design Criteria and the Design Narrative, these documents record the concepts, calculations, decisions, and product selections used to meet the Owner's Project Requirements (OPR) and to satisfy applicable regulatory requirements, standards, and guidelines.

Benchmarks: Benchmarks are the comparison of a building's energy usage to other similar buildings and to the building itself. For example, ENERGY STAR Portfolio Manager is a frequently used and nationally recognized building energy benchmarking tool.

Building Information Modeling (BIM): Building Information Modeling is a parametric database which allows a building to be designed and constructed virtually in 3D, and provides reports both in 2D views and as schedules. This electronic information can be extracted and reused for pre-populating facility management CMMS systems. Building Systems Commissioning (BSC): NEBB acronym used to designate its commissioning program.

Calibrate: The act of comparing an instrument of unknown accuracy with a standard of known accuracy to detect, correlate, report, or eliminate by adjustment any variation in the accuracy of the tested instrument.

CCTV: Closed circuit Television. Normally used for security surveillance and alarm detections as part of a special electrical security system.

COBie: Construction Operations Building Information Exchange (COBie) is an electronic industry data format used to transfer information developed during design, construction, and commissioning into the Computer Maintenance Management Systems (CMMS) used to operate facilities. See the Whole Building Design Guide website for further information (<http://www.wbdg.org/resources/cobie.php>)

Commissionability: Defines a design component or construction process that has the necessary elements that will allow a system or component to be effectively measured, tested, operated and commissioned

Commissioning Agent (CxA): A qualified and independent Commissioning Professional with professional engineering registration (PE), active commissioning certification from a nationally recognized commissioning organization, and proven hands-on and verifiable experience in the commissioning of projects with equivalent scope. The CxA is employed by a nationally recognized, certified, and qualified commissioning firm, hired directly by government under a separate contract, who leads and administers the Cx process by managing the Cx team and overseeing the Commissioning Process, except as otherwise noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table in this document. Both the commissioning firm and the CxA are certified commissioning providers with experience and expertise in the

commissioning of facilities of comparable scope and complexity. The CxA is responsible for government oversight of the commissioning process throughout all phases of the project. Where CxA is used in this document it means the Commissioning Agent, members of his staff or appointed members of the commissioning team. The CxA is collaborated by the CxM during construction period. (Note: Commissioning certification by a nationally recognized organization is required. Certifications from AABC Commissioning Group (ACG), Building Commissioning Association (BCA), or other equivalent commissioning authority would be deemed as acceptable.)

Commissioning Checklists: Lists of data or inspections to be verified to ensure proper system or component installation, operation, and function. Verification checklists are developed and used during all phases of the commissioning process to verify that the Owner's Project Requirements (OPR) is being achieved.

Commissioning Design Review: The commissioning design review is a collaborative review of the design professionals design documents for items pertaining to the following: owner's project requirements; basis of design; operability and maintainability (O&M) including documentation; functionality; training; energy efficiency, control systems' sequence of operations including building automation system features; commissioning specifications and the ability to functionally test the systems.

Commissioning Issue: A condition identified by the CxA, CxM, or other member of the Commissioning Team that adversely affects the commissionability, operability, maintainability, or functionality of a system, equipment, or component. A condition that is in conflict with the Contract Documents and/or performance requirements of the installed systems and components. (See also - Commissioning Observation).

Commissioning Manager (CxM): A qualified individual with professional engineering registration (PE) and active commissioning certification from a nationally recognized commissioning organization, and proven hands-on and verifiable experience in the commissioning of projects with equivalent scope, appointed by the Construction General Contractor to manage the commissioning process on behalf of the Contractor. The CxM is employed by a nationally recognized, certified, and qualified commissioning firm, responsible for managing, scheduling, executing, and documenting commissioning activities during the construction period

as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table in this document. The CxM is regularly employed in commissioning of total building systems and is an employee of a commissioning firm hired by the construction contractor. The commissioning firm is a first-tier subcontractor to the Prime Contractor. The CxM is supported by commissioning specialists employed by the commissioning firm. (Note: Commissioning certification by a nationally recognized organization is required. Certifications from AABC Commissioning Group (ACG), Building Commissioning Association (BCA), or other equivalent commissioning authority would be deemed as acceptable).

Commissioning Observation: An issue identified by the CxA, CxM, or other member of the Commissioning Team that does not conform to the project OPR, contract documents or standard industry best practices. (See also Commissioning Issue)

Commissioning Plan: A document that outlines the commissioning process, commissioning scope and defines responsibilities, processes, schedules, and the documentation requirements of the Commissioning Process.

Commissioning Process: A quality focused process for enhancing the delivery of a project. The process focuses upon verifying and documenting that the facility and all of its systems, components, and assemblies are planned, designed, installed, tested, can be operated, and maintained to meet the Owner's Project Requirements.

Commissioning Report: The final commissioning document which presents the commissioning process results for the project. Cx reports include an executive summary, the commissioning plan, issue log, correspondence, and all appropriate check sheets and test forms.

Commissioning Representative (CxR): An individual appointed by a subcontractor to manage the commissioning process on behalf of the subcontractor.

Commissioning Specifications: The contract documents that detail the objective, scope and implementation of the commissioning process as developed in the Commissioning Plan.

Commissioning Team: Individual team members whose coordinated actions are responsible for implementing the Commissioning Process.

Construction Phase Commissioning: All commissioning efforts executed during the construction process after the design phase and prior to the Acceptance Phase Commissioning.

Contract Documents (CD): Contract documents include design and construction contracts, price agreements and procedure agreements. Contract Documents also include all final and complete drawings, specifications and all applicable contract modifications or supplements.

Construction Phase Commissioning (CPC): All commissioning efforts executed during the construction process after the design phase and prior to the Acceptance Phase Commissioning.

Coordination Drawings: Drawings showing the work of all trades that are used to illustrate that equipment can be installed in the space allocated without compromising equipment function or access for maintenance and replacement. These drawings graphically illustrate and dimension manufacturers' recommended maintenance clearances. On mechanical projects, coordination drawings include structural steel, ductwork, major piping and electrical conduit and show the elevations and locations of the above components.

Data Logging: The monitoring and recording of temperature, flow, current, status, pressure, etc. of equipment using stand-alone data recorders.

Deferred System Test: Tests that cannot be completed at the end of the acceptance phase due to ambient conditions, schedule issues or other conditions preventing testing during the normal acceptance testing period.

Deficiency: See "Commissioning Issue".

Design Criteria: A listing of the VA Design Criteria outlining the project design requirements, including its source. These are used during the design process to show the design elements meet the OPR.

Design Intent: The overall term that includes the OPR and the BOD. It is a detailed explanation of the ideas, concepts, and criteria that are defined by the owner to be important. The design intent documents are utilized to provide a written record of these ideas, concepts and criteria.

Design Narrative: A written description of the proposed design solutions that satisfy the requirements of the OPR.

Design Phase Commissioning (DPC): All commissioning tasks executed during the design phase of the project.

Environmental Systems: Systems that use a combination of mechanical equipment, airflow, water flow and electrical energy to provide

heating, ventilating, air conditioning, humidification, and dehumidification for the purpose of human comfort or process control of temperature and humidity.

Executive Summary: A section of the Commissioning report that reviews the general outcome of the project. It also includes any unresolved issues, recommendations for the resolution of unresolved issues and all deferred testing requirements.

Functionality: This defines a design component or construction process which will allow a system or component to operate or be constructed in a manner that will produce the required outcome of the OPR.

Functional Test Procedure (FTP): A written protocol that defines methods, steps, personnel, and acceptance criteria for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

Industry Accepted Best Practice: A design component or construction process that has achieved industry consensus for quality performance and functionality. Refer to the current edition of the NEBB Design Phase Commissioning Handbook for examples.

Installation Verification: Observations or inspections that confirm the system or component has been installed in accordance with the contract documents and to industry accepted best practices.

Integrated System Testing: Integrated Systems Testing procedures entail testing of multiple integrated systems performance to verify proper functional interface between systems. Typical Integrated Systems Testing includes verifying that building systems respond properly to loss of utility, transfer to emergency power sources, re-transfer from emergency power source to normal utility source; interface between HVAC controls and Fire Alarm systems for equipment shutdown, interface between Fire Alarm system and elevator control systems for elevator recall and shutdown; interface between Fire Alarm System and Security Access Control Systems to control access to spaces during fire alarm conditions; and other similar tests as determined for each specific project.

Issues Log: A formal and ongoing record of problems or concerns - and their resolution - that have been raised by members of the Commissioning Team during the course of the Commissioning Process.

LEAD: The "LEAD" Roles & Responsibilities designation represents the overall leadership and administration of the Cx process by managing the

Cx team and overseeing and managing the Commissioning Process. The LEAD party responsibilities shall also include participation and review responsibilities as applicable.

Lessons Learned Workshop: A workshop conducted to discuss and document project successes and identify opportunities for improvements for future projects.

Maintainability: A design component or construction process that will allow a system or component to be effectively maintained. This includes adequate room for access to adjust and repair the equipment. Maintainability also includes components that have readily obtainable repair parts or service.

Manual Test: Testing 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').

Owner's Project Requirements (OPR): A written document that details the project requirements and the expectations of how the building and its systems will be used and operated. These include project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

Peer Review: A formal in-depth review separate from the commissioning review processes. The level of effort and intensity is much greater than a typical commissioning facilitation or extended commissioning review. The VA usually hires an independent third-party (called the IDIQ A/E) to conduct peer reviews.

PARTICIPATE: The "PARTICIPATE" Roles & Responsibilities designation represents an active participation in the Cx process and its development by working closely and directly with the party designated as the LEAD, as well as review responsibility as applicable.

Precision: The ability of an instrument to produce repeatable readings of the same quantity under the same conditions. The precision of an instrument refers to its ability to produce a tightly grouped set of values around the mean value of the measured quantity.

Pre-Design Phase Commissioning: Commissioning tasks performed prior to the commencement of design activities that includes project programming and the development of the commissioning process for the project

Pre-Functional Checklist (PFC): A form used by the contractor to verify that appropriate components are onsite, correctly installed, set up, calibrated, functional and ready for functional testing.

Pre-Functional Test (PFT): An inspection or test that is done before functional testing. PFT's include installation verification and system and component start up tests.

Procedure or Protocol: A defined approach that outlines the execution of a sequence of work or operations. Procedures are used to produce repeatable and defined results.

Range: The upper and lower limits of an instrument's ability to measure the value of a quantity for which the instrument is calibrated.

Resolution: This word has two meanings in the Cx Process. The first refers to the smallest change in a measured variable that an instrument can detect. The second refers to the implementation of actions that correct a tested or observed deficiency.

Site Observation Visit: On-site inspections and observations made by the Commissioning Agent for the purpose of verifying component, equipment, and system installation, to observe contractor testing, equipment start-up procedures, or other purposes.

Site Observation Reports (SO): Reports of site inspections and observations made by the Commissioning Agent. Observation reports are intended to provide early indication of an installation issue which will need correction or analysis.

Special System Inspections: Inspections required by a local code authority prior to occupancy and are not normally a part of the commissioning process.

Static Tests: Tests or inspections that validate a specified static condition such as pressure testing. Static tests may be specification or code initiated.

Start Up Tests: Tests that validate the component or system is ready for automatic operation in accordance with the manufactures requirements.

Systems Manual: A system-focused composite document that includes all information required for the owners operators to operate the systems.

Test Procedure: A written protocol that defines methods, personnel, and expectations for tests conducted on components, equipment, assemblies, systems, and interfaces among systems.

Testing: The use of specialized and calibrated instruments to measure parameters such as: temperature, pressure, vapor flow, air flow, fluid flow, rotational speed, electrical characteristics, velocity, and other data in order to determine performance, operation, or function.

Testing, Adjusting, and Balancing (TAB): A systematic process or service applied to heating, ventilating and air-conditioning (HVAC) systems and other environmental systems to achieve and document air and hydronic flow rates. The standards and procedures for providing these services are referred to as "Testing, Adjusting, and Balancing" and are described in the Procedural Standards for the Testing, Adjusting and Balancing of Environmental Systems, published by NEBB or AABC.

Thermal Scans: Thermographic pictures taken with an Infrared Thermographic Camera. Thermographic pictures show the relative temperatures of objects and surfaces and are used to identify leaks, thermal bridging, thermal intrusion, electrical overload conditions, moisture containment, and insulation failure.

Training Plan: A written document that details, in outline form the expectations of the operator training. Training agendas should include instruction on how to obtain service, operate, startup, shutdown and maintain all systems and components of the project.

Trending: Monitoring over a period of time with the building automation system.

Unresolved Commissioning Issue: Any Commissioning Issue that, at the time that the Final Report or the Amended Final Report is issued that has not been either resolved by the construction team or accepted by the DVA/USACE. **Validation:** The process by which work is verified as complete and operating correctly:

1. First party validation occurs when a firm or individual verifying the task is the same firm or individual performing the task.
2. Second party validation occurs when the firm or individual verifying the task is under the control of the firm performing the task or has other possibilities of financial conflicts of interest in the resolution (Architects, Designers, General Contractors and Third Tier Subcontractors or Vendors).
3. Third party validation occurs when the firm verifying the task is not associated with or under control of the firm performing or designing the task.

Verification: The process by which specific documents, components, equipment, assemblies, systems, and interfaces among systems are confirmed to comply with the criteria described in the Owner's Project Requirements.

Warranty Phase Commissioning: Commissioning efforts executed after a project has been completed and accepted by the Owner. Warranty Phase Commissioning includes follow-up on verification of system performance, measurement and verification tasks and assistance in identifying warranty issues and enforcing warranty provisions of the construction contract.

Warranty Visit: A commissioning meeting and site review where all outstanding warranty issues and deferred testing is reviewed and discussed.

Whole Building Commissioning: Commissioning of building systems such as Building Envelope, HVAC, Electrical, Special Electrical (Fire Alarm, Security & Communications), Plumbing and Fire Protection as described in this specification.

1.7 SYSTEMS TO BE COMMISSIONED

- A. Commissioning of a system or systems specified for this project is part of the construction process. Documentation and testing of these systems, as well as training of the VA's Operation and Maintenance personnel, is required in cooperation with the VA and the Commissioning Agent.

SPEC WRITER NOTE: Paragraph B should list the specific systems that will be commissioned. Edit the list as necessary for specific projects. The list below should match the list included in Sections XX 08 00 COMMISSIONING OF "XX" SYSTEMS included in the various Divisions' Technical Specifications. It is recommended that the list included in Sections XX 08 00 be developed first and then copied/pasted into the list below. Both lists should be identical to prevent confusion.

- B. The following systems will be commissioned as part of this project:

Systems To Be Commissioned	
System	Description
Building Exterior Closure	
Foundations (excluding structural)	Standard, special, slab-on-grade, vapor barriers, air barriers
Basements	Basement walls, crawl spaces, waterproofing, drainage

Systems To Be Commissioned	
System	Description
Superstructure	Floor construction, roof construction, sunshades, connections to adjacent structures
Exterior Closure	Exterior walls, exterior windows, exterior doors, louvers, grilles and sunscreens,
Roofing	Roof system (including parapet), roof openings (skylights, pipe chases, ducts, equipment curbs, etc.)
Note:	The emphasis on commissioning the above building envelope systems is on control of air flow, heat flow, noise, infrared, ultraviolet, rain penetration, moisture, durability, security, reliability, constructability, maintainability, and sustainability.
Specialties	
Patient Bed Service Walls	Medical gas certification and cross check, electrical connections
Patient Lifts	Patient lifts support, controls, certification of compliance
Equipment	
Parking Control Equipment	Barriers
Laboratory Fume Hoods	Fume Hood Certification
Biological Safety Cabinets	Cabinet Certification
Packaged Incinerators	Combustion Testing, Cycle Certification
Conveying Equipment	
Electric Dumbwaiters	Interface with other systems (Fire Alarm, etc.) [ASTM testing and certification by others]
Elevators	Interface with other systems (fire alarm, etc.) [ASTM testing and certification by others]
Escalators	Interface with other systems (fire alarm, etc.) [ASTM testing and certification by others]

Systems To Be Commissioned	
System	Description
Material Delivery Systems	Interface with other systems (fire alarm, elevators, etc.)
Pneumatic Tube Systems	Interface with other systems (fire alarm, etc.)
Fire Suppression	
Fire Pump	Fire Pump, jockey pump, fire pump controller/ATS
Fire Sprinkler Systems	Wet pipe system, dry pipe system, pre-action system, special agent systems
Plumbing	
Domestic Water Distribution	Booster pumps, backflow preventers, water softeners, potable water storage tanks
Domestic Hot Water Systems	Water heaters**, heat exchangers, circulation pumps, point-of-use water heaters*
Sewerage Pump Systems	Sewage ejectors
Wastewater Pump Systems	Sump pumps
Sanitary Waste Interceptors	Grease interceptors, acid neutralizers
General Service Air Systems	Packaged compressor systems, air dryers, filtration
Medical Air Systems	Packaged medical air compressor units. Outlet certification, cross-connection verification
Medical Vacuum Systems	Packaged medical vacuum units, outlet certification, cross-connection verification
Dental Air Systems	Packaged dental air compressor units, outlet certification, cross-connect verification
Dental Evacuation and Vacuum Systems	Packaged Dental Evacuation units, packaged dental vacuum units, outlet certification, cross-connection verification
Waste Anesthesia Gas Systems	Packaged Waste Anesthesia Gas units, outlet certification, cross-connection verification
Medical Gas Systems (other than Medical Air Systems)	Medical gas (oxygen, nitrogen, nitrous oxide, etc.) tank/manifold systems, outlet certification, cross-connection verification

Systems To Be Commissioned	
System	Description
Chemical Waste Systems	Chemical storage tanks, neutralization systems, ventilation, process control
Reverse-Osmosis Systems	Packaged Reverse-Osmosis systems
Water De-Alkalizing Systems	Package Water De-Alkalizing systems
HVAC	
Noise and Vibration Control	Noise and vibration levels for critical equipment such as Air Handlers, Chillers, Cooling Towers, Boilers, Generators, etc. will be commissioned as part of the system commissioning
Direct Digital Control System**	Operator Interface Computer, Operator Work Station (including graphics, point mapping, trends, alarms), Network Communications Modules and Wiring, Integration Panels. [DDC Control panels will be commissioned with the systems controlled by the panel]
Chilled Water System**	Chillers (centrifugal, rotary screw, air-cooled), pumps (primary, secondary, variable primary), VFDs associated with chilled water system components, DDC Control Panels (including integration with Building Control System)
Condenser Water System**	Cooling Towers, Fluid Coolers, heat exchangers/economizers, pumps, VFDs associated with condenser water system components, DDC control panels.
Steam/Heating Hot Water System**	Boilers, boiler feed water system, economizers/heat recovery equipment, condensate recovery, water treatment, boiler fuel system, controls, interface with facility DDC system.

Systems To Be Commissioned	
System	Description
HVAC Air Handling Systems**	Air handling Units, packaged rooftop AHU, Outdoor Air conditioning units, humidifiers, DDC control panels
HVAC Ventilation/Exhaust Systems	General exhaust, toilet exhaust, laboratory exhaust, isolation exhaust, room pressurization control systems
HVAC Energy Recovery Systems**	Heat Wheels, Heat Recovery Loops, AHU Integrated Heat Recovery
HVAC Terminal Unit Systems**	VAV Terminal Units, CAV terminal units, fan coil units, fin-tube radiation, unit heaters
Decentralized Unitary HVAC Systems*	Split-system HVAC systems, controls, interface with facility DDC
Unitary Heat Pump Systems**	Water-source heat pumps, controls, interface with facility DDC
Humidity Control Systems	Humidifiers, de-humidifiers, controls, interface with facility DDC
Hydronic Distribution Systems	Pumps, DDC control panels, heat exchangers,
Facility Fuel Systems	Boiler fuel system, generator fuel system
Geothermal Energy Direct Use Heating **	Geothermal well, ground heat exchanger, geothermal pumps, heat exchanger, valves, instrumentation
Solar Energy Heating Systems **	Solar collectors, heat exchangers, storage tanks, solar-boosted domestic hot water heater, pumps, valves, instrumentation
Facility Fuel Gas Systems	Witness Natural gas piping pressure testing, natural gas compressors and storage, propane storage
Smoke Evacuation System	Atrium smoke evacuation, other smoke evacuation and smoke management systems, controls, interface with other systems (fire alarm), emergency operation.
Electrical	

Systems To Be Commissioned	
System	Description
Medium-Voltage Electrical Distribution Systems	Medium-Voltage Switchgear, Medium-Voltage Switches, Underground ductbank and distribution, Pad-Mount Transformers, Medium-Voltage Load Interrupter Switches,
Grounding & Bonding Systems	Witness 3rd party testing, review reports
Electric Power Monitoring Systems	Metering, sub-metering, power monitoring systems, PLC control systems
Electrical System Protective Device Study	Review reports, verify field settings consistent with Study
Secondary Unit Substations	Medium-voltage components, transformers, low-voltage distribution, verify breaker testing results (injection current, etc)
Low-Voltage Distribution System	Normal power distribution system, Life-safety power distribution system, critical power distribution system, equipment power distribution system, switchboards, distribution panels, panelboards, verify breaker testing results (injection current, etc)
Emergency Power Generation Systems	Generators, Generator paralleling switchgear, automatic transfer switches, PLC and other control systems
Lighting & Lighting Control** Systems	Emergency lighting, occupancy sensors, lighting control systems, architectural dimming systems, theatrical dimming systems, exterior lighting and controls
Cathodic Protection Systems	Review 3rd party testing results.
Lightning Protection System	Witness 3rd party testing, review reports
Communications	

Systems To Be Commissioned	
System	Description
Grounding & Bonding System	Witness 3rd party testing, review reports
Structured Cabling System	Witness 3rd party testing, review reports
Master Antenna Television System	Witness 3rd party testing, review reports
Public Address & Mass Notification Systems	Witness 3rd party testing, review reports
Intercom & Program Systems	Witness 3rd party testing, review reports
Nurse Call & Code Blue Systems	Witness 3rd party testing, review reports
Security Emergency Call Systems	Witness 3rd party testing, review reports
Duress Alarm Systems	Witness 3rd party testing, review reports
Electronic Safety and Security	
Grounding & Bonding	Witness 3rd party testing, review reports
Physical Access Control Systems	Witness 3rd party testing, review reports
Access Control Systems	Witness 3rd party testing, review reports
Security Access Detection Systems	Witness 3rd party testing, review reports
Video Surveillance System	Witness 3rd party testing, review reports
Electronic Personal Protection System	Witness 3rd party testing, review reports
Fire Detection and Alarm System	100% device acceptance testing, battery draw-down test, verify system monitoring, verify interface with other systems.
Renewable Energy Sources	
Geothermal Energy Electrical Generation Systems **	Geothermal well, DC-AC Inverters, storage batteries, turbine generator modules, switchgear, combiner boxes, instrumentation, monitoring and control systems

Systems To Be Commissioned	
System	Description
Solar Energy Electrical Power Generation Systems **	Solar collector modules, DC-AC inverter, storage batteries, combiners, Switchgear, instrumentation, monitoring and control systems
Wind Energy Electrical Power Generation Systems **	Wind Turbines, DC-AC inverter, storage batteries, combiners, switchgear, instrumentation, monitoring and control systems
Site Utilities	
Water Utilities	City Water Service Entrance, Backflow Prevention, Pressure Control, Booster Pumps, Irrigation Systems
Sanitary Sewerage Utilities	City Sanitary Connection, Waste Treatment Systems
Storm Drainage Utilities	City Storm Water Connection, Site Storm Water Distribution
Energy Distribution Utilities	Connection to Third Party Energy (Steam, High Temp Hot Water, Chilled Water) Supply Systems, Metering, Pressure Control
Transportation	
Active Traffic Barrier Systems	Witness 3rd party testing
Integrated Systems Tests	
Loss of Power Response	Loss of power to building, loss of power to campus, restoration of power to building, restoration of power to campus.
Fire Alarm Response	Integrated System Response to Fire Alarm Condition and Return to Normal
Table Notes	
** Denotes systems that LEED requires to be commissioned to comply with the LEED Fundamental Commissioning pre-requisite.	

1.8 COMMISSIONING TEAM

- A. The commissioning team shall consist of, but not be limited to, representatives of Contractor, including Project Superintendent and subcontractors, installers, schedulers, suppliers, and specialists deemed appropriate by the Government, CxA, and CxM.
- B. Members Appointed by Contractor:
 - 1. Contractor's Commissioning Manager (CxM, See the CxM definition above): The designated person, company, or entity that plans, schedules and coordinates the commissioning activities for the construction team. See the Roles & Responsibilities table below for more detailed responsibilities.
 - 2. Contractor's Commissioning Representative(s): Individual(s), each having authority to act on behalf of the entity he or she represents, explicitly organized to implement the commissioning process through coordinated actions.
- C. Members Appointed by the Government:
 - 1. Commissioning Agent (CxA, See the CxA definition above): The designated person, company, or entity that plans, schedules, and coordinates the commissioning team to implement the commissioning process. The Government will engage the CxA under a separate contract.
 - 2. User: Representatives of the facility user and operation and maintenance personnel. See the Roles & Responsibilities table below for more detailed responsibilities.
 - 3. A/E: Representative of the Architect and engineering design professionals.

1.9 GOVERNMENT'S COMMISSIONING RESPONSIBILITIES

- A. Appoint an individual, company or firm to act as the Commissioning Agent. See the Roles & Responsibilities table for details.
- B. Assign operation and maintenance personnel and schedule them to participate in commissioning team activities including, but not limited to, the following:
 - 1. Coordination meetings.
 - 2. Training in operation and maintenance of systems, subsystems, and equipment.
 - 3. Testing meetings.
 - 4. Witness and assist in Systems Functional Performance Testing.
 - 5. Demonstration of operation of systems, subsystems, and equipment.

SPEC WRITER NOTE: For Design
Build projects revise paragraph
C as appropriate.

- C. Provide the Construction Documents, prepared by Architect and approved by the Government, to the CxA and CxM, and for use in managing the commissioning process, developing the commissioning plan, systems manuals, and reviewing the operation and maintenance training plan.

1.10 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- A. The Contractor shall assign a qualified Commissioning Manager (CxM, See the CxM definition above) to manage commissioning activities of the team, Contractor, and subcontractors, as indicated in the Roles & Responsibilities table.
- B. The Contractor shall ensure that the commissioning responsibilities outlined in these specifications are included in all subcontracts and that subcontractors comply with the requirements of these specifications.
- C. The Contractor shall ensure that each installing subcontractor shall assign representatives with expertise and authority to act on behalf of the subcontractor and schedule them to participate in and perform commissioning team activities including, but not limited to, the following:
 - 1. Participate in commissioning coordination meetings.
 - 2. Conduct operation and maintenance training sessions in accordance with approved training plans.
 - 3. Verify that Work is complete and systems are operational according to the Contract Documents, including calibration of instrumentation and controls.
 - 4. Evaluate commissioning issues and commissioning observations identified in the Commissioning Issues Log, field reports, test reports or other commissioning documents. In collaboration with entity responsible for system and equipment installation, recommend corrective action.
 - 5. Review and comment on commissioning documentation.
 - 6. Participate in meetings to coordinate Systems Functional Performance Testing.

7. Provide schedule for operation and maintenance data submittals, equipment startup, and testing to Commissioning Agent for incorporation into the commissioning plan.
8. Provide information to the CxA and CxM for developing commissioning plan.
9. Participate in training sessions for VA's operation and maintenance personnel.
10. Provide technicians who are familiar with the construction and operation of installed systems and who shall develop specific test procedures to conduct Systems Functional Performance Testing of installed systems.

1.11 COMMISSIONING AGENT'S (CXA) RESPONSIBILITIES

- A. Organize and lead the commissioning team. See the Roles & Responsibilities table below for more detailed responsibilities.
- B. Prepare the commissioning plan. See Paragraph 1.11-A of this specification Section for further information.
- C. Review and comment on selected submittals from the Contractor for general conformance with the Construction Documents. Review and comment on the ability to test and operate the system and/or equipment, including providing gages, controls and other components required to operate, maintain, and test the system. Review and comment on performance expectations of systems and equipment and interfaces between systems relating to the Construction Documents.
- D. At the beginning of the construction phase, coordinate with CxM for and participate in an initial construction phase coordination meeting for the purpose of reviewing the commissioning activities and establishing tentative schedules for operation and maintenance submittals; operation and maintenance training sessions; TAB Work; Pre-Functional Checklists, Systems Functional Performance Testing; and project completion.
- E. Refer to the Roles & Responsibilities table for meetings that are expected to be coordinated and led by the CxA throughout the entire project. For meetings that CxA is not indicated to be the Lead, the CxA shall proactively and collaboratively participate and support the Lead individual, including but not limited to, coordination with CxM in preparation of and careful review of the meeting agenda and minutes prior to distribution. For meetings that CxA is identified as the Lead, the CxA shall convene commissioning team meetings for the purpose of coordination, communication, and conflict resolution; discuss status of

the commissioning processes. Responsibilities include arranging for facilities, preparing agenda and attendance lists, and notifying participants. The Commissioning Agent shall prepare and distribute minutes to commissioning team members and attendees within five workdays of the commissioning meeting.

- F. Observe construction and report progress, observations and issues to the CxM for distribution. This is not intended to substitute the CxM's own construction observation and progress reporting. Observe systems and equipment installation for adequate accessibility for maintenance and component replacement or repair, and for general conformance with the Construction Documents.
- G. Coordinate with the CxM in preparation of the Project specific Pre-Functional Checklists and Systems Functional Performance Test procedures.
- H. Collaborate with the CxM for the coordination of the Systems Functional Performance Testing schedule with the Contractor.
- I. Witness selected systems startups.
- J. Verify selected Pre-Functional Checklists completed and submitted by the Contractor.
- K. Witness Systems Functional Performance Testing and ensure it is properly documented.
- L. Coordinate with and support the CxM to ensure test data, inspection reports, and certificates are properly compiled and are included in the systems manual and commissioning report.

Spec Writer's Note: Coordinate the specification reference in Para M below with the specific project spec section dealing with O&M Data requirements. Also, coordinate with USACE PM for O&M Data requirements.

- M. Review and comment on operation and maintenance (O&M) documentation and systems manual outline for commissioning impact and compliance with the Contract Documents.
- N. Review operation and maintenance training program developed by the Contractor. Verify training plans provide qualified instructors to conduct operation and maintenance training.
- O. Coordinate with and support the CxM to ensure commissioning Field Observation Reports are prepared and documented.

- P. Coordinate with and support the CxM in preparation of the Final Commissioning Report.
- Q. Return to the site at 10 months into the 12 month warranty period and review with the CxM and facility staff the current building operation and the condition of outstanding issues related to the original and seasonal Systems Functional Performance Testing. Also join the CxM in 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. Collaborate with the CxM and assist facility staff in developing reports, documents and requests for services to remedy outstanding problems.
- R. Coordinate with and support the CxM in assembling the final commissioning documentation, including the Final Commissioning Report and Addendum to the Final Commissioning Report.

1.12 COMMISSIONING DOCUMENTATION

- A. Commissioning Plan: A document, prepared by the CxA during the pre-design and design phases, and tailored for the project and finalized by the CxM during the construction phase with close collaboration with and agreement by the CxA (Note: The changes to the plan by the CxM shall be considered to be minor and limited to ONLY those necessary for fine tuning the document to better align with the contractor activities such as coordination with the subcontractors and vendors), that outlines the preliminary schedule, allocation of resources, and documentation requirements of the commissioning process, and shall include, but is not limited, to the following:
 - 1. Plan for delivery and review of submittals, systems manuals, and other documents and reports. Identification of the relationship of these documents to other functions and a detailed description of submittals that are required to support the commissioning processes. Submittal dates shall include the latest date approved submittals must be received without adversely affecting commissioning plan.
 - 2. Description of the organization, layout, and content of commissioning documentation (including systems manual) and a detailed description of documents to be provided along with identification of responsible parties.
 - 3. Identification of systems and equipment to be commissioned.

4. Schedule of Commissioning Coordination meetings.
 5. Identification of items that must be completed before the next operation can proceed.
 6. Description of responsibilities of commissioning team members.
 7. Description of observations to be made.
 8. Description of requirements for operation and maintenance training.
 9. Schedule for commissioning activities with dates coordinated with overall construction schedule.
 10. Process and schedule for documenting changes on a continuous basis to appear in Project Record Documents.
 11. Process and schedule for completing prestart and startup checklists for systems, subsystems, and equipment to be verified and tested.
 12. Preliminary Systems Functional Performance Test procedures.
- B. Systems Functional Performance Test Procedures: The CxA will develop Systems Functional Performance Test Procedures for each system to be commissioned, including subsystems, or equipment and interfaces or interlocks with other systems. Systems Functional Performance Test Procedures will include a separate entry, with space for comments, for each item to be tested. Preliminary Systems Functional Performance Test Procedures will be provided to the COR, CxM, Architect/Engineer, and Contractor for review and comment. During the construction phase and with close collaboration with the CxA, the CxM will finalize the Systems Functional Performance Test Procedures. The Systems Performance Test Procedure will include test procedures for each mode of operation and provide space to indicate whether the mode under test responded as required. Each System Functional Performance Test procedure, regardless of system, subsystem, or equipment being tested, shall include, but not be limited to, the following:
1. Name and identification code of tested system.
 2. Test number.
 3. Time and date of test.
 4. Indication of whether the record is for a first test or retest following correction of a problem or issue.
 5. Dated signatures of the person performing test and of the witness, if applicable.
 6. Individuals present for test.
 7. Observations and Issues.
 8. Issue number, if any, generated as the result of test.

- C. Pre-Functional Checklists: The CxA will prepare Pre-Functional Checklists. Pre-Functional Checklists shall be finalized by the CxM during the construction phase and completed and signed by the Contractor, verifying that systems, subsystems, equipment, and associated controls are ready for testing. The CxA and CxM will spot check Pre-Functional Checklists to verify accuracy and readiness for testing. Inaccurate or incomplete Pre-Functional Checklists shall be returned to the Contractor for correction and resubmission.
- D. Test and Inspection Reports: The CxM will record test data, observations, and measurements on Systems Functional Performance Test Procedure, while the CxA will participate and assist the CxM in the entire effort. The report will also include recommendation for system acceptance or non-acceptance. Photographs, forms, and other means appropriate for the application shall be included with data. The CxM will compile test and inspection reports and test and inspection certificates and include them in systems manual and commissioning report.

Spec Writer Note: Modify Para E below to include a reference to other paragraph(s) that may be included to require that the Contractor is liable for any costs incurred by the Government for retesting. These costs may include additional fees to the CxA and/or A/E.

- E. Corrective Action Documents: The CxM will document corrective action taken for systems and equipment that fail tests. The documentation will include any recommended and/or completed corrective actions to systems and equipment and/or revisions to test procedures, if any. The CxA will witness and collaborate with the CxM to ensure that any retesting of systems and/or equipment requiring corrective action, as well as the retest results are properly documented.
- F. Commissioning Issues Log: The CxM will prepare and maintain Commissioning Issues Log that describes Commissioning Issues and Commissioning Observations that are identified during the Commissioning process. The CxA will participate by reviewing the Commissioning Issues Log to ensure it is up to date and accurate. These observations and issues include, but are not limited to, those that are at variance with the Contract Documents. The Commissioning Issues Log will identify and track issues as they are encountered, the party

responsible for resolution, progress toward resolution, and document how the issue was resolved. The Master Commissioning Issues Log will also track the status of unresolved issues.

1. Creating a Commissioning Issues Log Entry:

- a. Identify the issue with unique numeric or alphanumeric identifier by which the issue may be tracked.
- b. Assign a descriptive title for the issue.
- c. Identify date and time of the issue.
- d. Identify test number of test being performed at the time of the observation, if applicable, for cross reference.
- e. Identify system, subsystem, and equipment to which the issue applies.
- f. Identify location of system, subsystem, and equipment.
- g. Include information that may be helpful in diagnosing or evaluating the issue.
- h. Note recommended corrective action.
- i. Identify commissioning team member responsible for corrective action.
- j. Identify expected date of correction.
- k. Identify person that identified the issue.

2. Documenting Issue Resolution:

- a. Log date correction is completed or the issue is resolved.
- b. Describe corrective action or resolution taken. Include description of diagnostic steps taken to determine root cause of the issue, if any.
- c. Identify changes to the Contract Documents that may require action.
- d. State that correction was completed and system, subsystem, and equipment are ready for retest, if applicable.
- e. Identify person(s) who corrected or resolved the issue.
- f. Identify person(s) verifying the issue resolution.

G. Final Commissioning Report: The CxM will document results of the commissioning process, including unresolved issues, and performance of systems, subsystems, and equipment. The CxA will participate and assist the CxM in the entire effort. The Commissioning Report will indicate whether systems, subsystems, and equipment have been properly installed and are performing according to the Contract Documents. This report will be used by the Government when determining that systems

will be accepted. This report will be used to evaluate systems, subsystems, and equipment and will serve as a future reference document during VA occupancy and operation. It shall describe components and performance that exceed requirements of the Contract Documents and those that do not meet requirements of the Contract Documents. The commissioning report will include, but is not limited to, the following:

1. Lists and explanations of substitutions, compromises, variances with the Contract Documents, record of conditions; and, if appropriate, recommendations for resolution. Design Narrative documentation maintained by the AE, with input from the CxA and CxM.
 2. Commissioning plan.
 3. Pre-Functional Checklists completed by the Contractor, with annotation of the CxA and CxM review and spot check.
 4. Systems Functional Performance Test Procedures, with annotation of test results and test completion.
 5. Commissioning Issues Log.
 6. Listing of deferred and off season test(s) not performed, including the schedule for their completion.
- H. Addendum to Final Commissioning Report: The CxM will prepare an Addendum to the Final Commissioning Report near the end of the Warranty Period. The CxA will participate and assist the CxM in the entire effort. The Addendum will indicate whether systems, subsystems, and equipment are complete and continue to perform according to the Contract Documents. The Addendum to the Final Commissioning Report shall include, but is not limited to, the following:
1. Documentation of deferred and off season test(s) results.
 2. Completed Systems Functional Performance Test Procedures for off season test(s).
 3. Documentation that unresolved system performance issues have been resolved.
 4. Updated Commissioning Issues Log, including status of unresolved issues.
 5. Identification of potential Warranty Claims to be corrected by the Contractor.
- I. Systems Manual: The CxM will gather required information and compile the Systems Manual. The CxA will participate by reviewing the content

and completeness. The Systems Manual will include, but is not limited to, the following:

1. Design Narrative, including system narratives, schematics, single-line diagrams, flow diagrams, equipment schedules, and changes made throughout the Project.
2. Reference to Final Commissioning Plan.
3. Reference to Final Commissioning Report.
4. Approved Operation and Maintenance Data as submitted by the Contractor.

1.13 SUBMITTALS

- A. Preliminary Commissioning Plan Submittal: The CxA has prepared a Preliminary Commissioning Plan based on the final Construction Documents. The Preliminary Commissioning Plan is included as an Appendix to this specification section. The Preliminary Commissioning Plan is provided for information only. It contains preliminary information about the following commissioning activities:
 1. The Commissioning Team: A list of commissioning team members by organization.
 2. Systems to be commissioned. A detailed list of systems to be commissioned for the project. This list also provides preliminary information on systems/equipment submittals to be reviewed by the Commissioning Agent; preliminary information on Pre-Functional Checklists that are to be completed; preliminary information on Systems Performance Testing, including information on testing sample size (where authorized by the Government).
 3. Commissioning Team Roles and Responsibilities: Preliminary roles and responsibilities for each Commissioning Team member.
 4. Commissioning Documents: A preliminary list of commissioning-related documents, include identification of the parties responsible for preparation, review, approval, and action on each document.
 5. Commissioning Activities Schedule: Identification of Commissioning Activities, including but not limited to the following:
 - a. Submission and approval of the Commissioning Firm and Commissioning Specialists such as CxM and CxR.
 - b. Submission and approval of the Testing, Adjusting, and Balancing (TAB) Firm and TAB Specialist.
 - c. Submission of the Design Review Reports.

- d. Submission and approval of the Construction Phase Commissioning Plan.
- e. Installation of permanent utilities (gas, water, electric, etc.).
- f. Building Envelope Construction.
- g. Submission and approval of the Building Envelope Inspection Checklists.
- h. Air Barrier Pressure Tests.
- i. Drainage and Vent, Building Sewers, Water Supply Systems and Backflow Prevention Assembly Tests.
- j. Factory Acceptance Testing for each of the systems to be commissioned as required.
- k. Manufacturer's Equipment Start-Up for each of the systems to be commissioned.
- l. Potable Water System Flushing.
- m. Operational Tests of the plumbing system.
- n. Potable Water System Disinfection.
- o. Submission and approval of the TAB Schematic Drawings, Report Forms, and Procedures.
- p. Submission and approval of Duct Air Leakage Test Procedures.
- q. Duct Air Leakage Test Execution.
- r. Submission and approval of the Final Duct Air Leakage Test Report.
- s. Testing, Adjusting, and Balancing (TAB) Field Work.
- t. Submission and approval of the TAB Report.
- u. TAB Field Acceptance Testing.
- v. Submission and approval of the Start-Up Testing Report for HVAC Controls and Instrumentation.
- w. Submission and approval of the Performance Verification Test Procedures for HVAC Controls and Instrumentation.
- x. Performance Verification Tests for HVAC Controls and Instrumentation.
- y. Performance Verification Test Report for HVAC Controls and Instrumentation.
- z. Pre-Functional Checklist Submittal.
- aa. Functional Performance Testing for each system to be commissioned, the expected duration and predecessors for the activity.
- bb. Integrated Systems Tests.

- cc. Post-Test Deficiency Correction for each system to be commissioned.
 - dd. Re-Testing.
 - ee. Endurance Tests.
 - ff. Training for each of the systems to be commissioned.
 - gg. [Systems Manual][Computerized Maintenance Management System Manual], Maintenance Plan, and Service Life Plan submission and approval.
 - hh. Seasonal Testing.
 - ii. Phasing.
6. Pre-Functional Checklists: Preliminary Pre-Functional Checklists for equipment, components, subsystems, and systems to be commissioned provide guidance on the level of detailed information the Contractor shall include on the final submission.
7. Systems Functional Performance Test Procedures: Preliminary step-by-step System Functional Performance Test Procedures to be used during Systems Functional Performance Testing. These Preliminary Systems Functional Performance procedures provide information on the level of testing rigor, and the level of Contractor support required during performance of system's testing.
- B. Commissioning and Final Commissioning Plans Submittals: Based on the Final Construction Documents, the CxA will prepare the Commissioning Plan as described in this section. The CxA will submit four hard copies and four sets of electronic files of the Commissioning Plan. During the construction phase, the CxM shall review and finalize the Commissioning Plan. The changes to the plan shall be minimal in nature as needed to tailor the plan for better alignment with the Contractor activities. All changes made to the Commissioning Plan by the CxM shall be reviewed by the CxA and approved by the COR. The CxM will submit three hard copies and three sets of electronic files of the Final Commissioning Plan.
- C. Systems Functional Performance Test Procedure: The CxA will submit preliminary Systems Functional Performance Test Procedures to the CxM, and the COR for review and comment. The CxM shall return review comments to the COR and the CxA. The COR will also return review comments to the CxA. The CxA will incorporate review comments and re-issue the revised preliminary Systems Functional Performance Test

Procedures. Based on the revised preliminary Systems Functional Performance Test Procedures, the CxM in close collaboration with the CxA will prepare and issue the Final Systems Functional Test Procedures to be used in Systems Functional Performance Testing. This document shall be reviewed by all parties as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table, and approved by COR.

- D. Pre-Functional Checklists: Similarly, the CxA will submit preliminary Pre-Functional Checklists to be reviewed and finalized by the CxM, after collection and incorporation of the review comments from all parties as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table and with approval from COR.
- E. Test and Inspection Reports: The CxM will submit test and inspection reports to the DVA/USACE with copies to the CxA and other parties as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table.
- F. Corrective Action Documents: The CxM will submit corrective action documents to the COR with copies to the CxA and other parties as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table.
- G. Preliminary Commissioning Report Submittal: The CxM will submit four electronic copies of the preliminary commissioning report. One electronic copy and four hard copies, with consolidated review comments, will be prepared by the CxM for redistribution amongst the parties, and preparation of the final submittal.
- H. Final Commissioning Report Submittal: The CxM will submit four sets of electronically formatted information of the final commissioning report to the COR. The final submittal will incorporate comments as directed by the COR.
- I. Data for Commissioning:
 - 1. The CxA, through coordination with COR and CxM, will request in writing from the Contractor specific information needed about each piece of commissioned equipment or system to fulfill requirements of the Commissioning Plan.
 - 2. The CxA, through coordination with COR and CxM, shall request further documentation as is necessary for the commissioning process or to support other Government data collection requirements, including Construction Operations Building Information Exchange (COBIE), Building Information Modeling (BIM), etc.

1.14 COMMISSIONING PROCESS

- A. During the Pre-Design and Design Phases, the CxA will be responsible for the overall management of the commissioning process as well as coordinating scheduling of commissioning tasks with the Government and the other parties outside of this contract as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table. During the Construction and Warranty Phases, the CxM, in close coordination and collaboration with CxA, has the overall management of the commissioning process as well as coordinating and scheduling of commissioning tasks with the Government and the other parties outside of this contract as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table. The CxA is responsible for government oversight of the commissioning process throughout all phases of the project. As directed by the COR, the Contractor shall incorporate Commissioning tasks, including, but not limited to, Systems Functional Performance Testing (including predecessors) with the Master Construction Schedule.

Spec writer's note: Coordinate the number of days listed in the following paragraphs with the COR.

- B. Within //XX// days of contract award, the Contractor shall provide a certified commissioning professional through an independent commissioning firm, see the CxM definition above, to act as the Commissioning Manager (CxM) to manage and lead the commissioning effort on behalf of the Contractor. The Commissioning Manager shall be the single point of contact and communications for all commissioning related services by the Contractor. The credentials of the commissioning firm and CxM shall be reviewed and approved by the COR.
- C. Within //XX// days of contract award, the Contractor shall ensure that each subcontractor designates specific individuals as Commissioning Representatives (CXR) to be responsible for commissioning related tasks. The Contractor shall ensure the designated Commissioning Representatives participate in the commissioning process as team members providing commissioning testing services, equipment operation, adjustments, and corrections if necessary. The Contractor shall ensure that all Commissioning Representatives shall have sufficient authority to direct their respective staff to provide the services required, and to speak on behalf of their organizations in all commissioning related contractual matters.

1.15 QUALITY ASSURANCE

- A. Instructor Qualifications: Factory authorized service representatives shall be experienced in training, operation, and maintenance procedures for installed systems, subsystems, and equipment.

- B. Test Equipment Calibration: The Contractor shall 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. Instruments shall have been calibrated within six months prior to use.

1.16 COORDINATION

- A. Management: The CxM will coordinate the commissioning activities with the COR, CxA and Contractor. The CxM will submit commissioning documents and information to the COR, CxA and other parties as noted in COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table. All commissioning team members shall work together to fulfill their contracted responsibilities and meet the objectives of the contract documents.
- B. Scheduling: The Contractor shall work with the CxM, CxA and COR to incorporate the commissioning activities into the construction schedule. The CxM, with close coordination with CxA, will provide sufficient information (including, but not limited to, tasks, durations and predecessors) on commissioning activities to allow the Contractor to schedule commissioning activities. All parties shall address scheduling issues and make necessary notifications in a timely manner in order to expedite the project and the commissioning process. The Contractor shall update the Master Construction Schedule as directed by the COR.
- C. Initial Schedule of Commissioning Events: The CxA will provide the initial schedule of primary commissioning events in the Preliminary Commissioning Plan. The Commissioning Plan will provide a format for this schedule. As construction progresses, more detailed schedules will be developed by the Contractor with information from the CxM and other parties.
- D. Commissioning Coordinating Meetings: The CxM will conduct periodic Commissioning Coordination Meetings of the commissioning team to review status of commissioning activities, to discuss scheduling conflicts, and to discuss upcoming commissioning process activities.
- E. Pretesting Meetings: The CxM will conduct pretest meetings of the commissioning team to review startup reports, Pre-Functional Checklist results, Systems Functional Performance Testing procedures, testing personnel and instrumentation requirements.

- F. Systems Functional Performance Testing Coordination: The Contractor shall coordinate testing activities to accommodate required quality assurance and control services with a minimum of delay and to avoid necessity of removing and replacing construction to accommodate testing and inspecting. The Contractor shall coordinate the schedule times for tests, inspections, obtaining samples, and similar activities.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. The Contractor shall provide all standard and specialized testing equipment required to perform Systems Functional Performance Testing. Test equipment required for Systems Functional Performance Testing will be identified in the detailed System Functional Performance Test Procedure prepared by the CxM.
- B. Data logging equipment and software required to test equipment shall be provided by the Contractor.
- C. All testing equipment shall be of sufficient quality and accuracy to test and/or measure system performance with the tolerances specified in the Specifications. If not otherwise noted, the following minimum requirements apply: Temperature sensors and digital thermometers shall have a certified calibration within the past year to an accuracy of 0.5 °C (1.0 °F) and a resolution of + or - 0.1 °C (0.2 °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 following any repairs to the equipment. Calibration tags shall be affixed or certificates readily available.

PART 3 - EXECUTION**3.1 COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES**

A. The following table outlines the roles and responsibilities for the Commissioning Team members during the Pre-Design Phase (D-B-B) and RFP Development Phase (D-B):

Spec Writer's Notes: Edit the following tables to describe the roles and responsibilities for each commissioning team member for each of the commissioning tasks as appropriate for the project.

Pre-Design Phase (D-B-B)/RFP Development Phase (D-B)		Commissioning Roles & Responsibilities					Notes
Commissioning Roles & Responsibilities		CxA = Commissioning Agent COR = Contracting Off. Rep A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Category	Task Description	CxA	COR	A/E	CxM	O&M	Notes
Meetings	Pre-Design Kick-Off Meeting	P	P	L	N/A	P	
	Owner's Project Requirements (OPR) Meeting	P	P	L	N/A	P	
	Commissioning Planning Meetings	L	P	P	N/A	O	
Coordination	Coordinate with [A/E, COR, AHJ, Vendors, etc.] to ensure that Cx is incorporated into project planning and documents.	L	P	P	N/A	O	
Cx Plan & Spec	Draft Commissioning Plan	L	A	R	N/A	R	
Schedules	Preliminary Commissioning Schedule	L	A	R	N/A	N/A	

Pre-Design Phase (D-B-B)/RFP Development Phase (D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	COR	A/E	CxM	O&M	Notes
OPR and BOD	Prepare OPR	P	A	L	N/A	P	
	Prepare BOD	P	A	L	N/A	R	
Commissioning Documents	Identify systems to be commissioned.	L	P	P	N/A	R	
	Preliminary Acceptance Criteria	L	P	P	N/A	R	
	Commissioning Documents Preliminary Templates	L	P	P	N/A	R	

B. The following table outlines the roles and responsibilities for the Commissioning Team members during the Bid Phase (D-B):

Bid Phase (D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	COR	A/E	CxM	O&M	Notes
Pre-Bid Meeting	Organize, schedule and conduct meeting	P	L	P	N/A	O	

C. The following table outlines the roles and responsibilities for the Commissioning Team members during the Design Phase (D-B-B):

Design Phase (D-B-B)		CxA = Commissioning Agent COR = Contracting Off. Rep A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	COR	A/E	CxM	O&M	Notes
Meetings	Design Review Meetings	P	P	L	N/A	P	
	Controls Meeting	L	P	P	N/A	P	
Coordination	Coordinate with [A/E, COR, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support the OPR and BOD	L	P	P	N/A	O	
Cx Plan & Spec	Commissioning Plan	L	A	R	N/A	R	
	Cx Specifications	L	A	R	N/A	R	
Schedules	Design Phase Preliminary Commissioning schedule	L	A	R	N/A	N/A	
OPR and BOD	Maintain OPR on behalf of Owner	P	A	L	N/A	P	
	Review BOD vs. OPR	L	A	P	N/A	P	
	Maintain BOD on behalf of Owner	P	A	L	N/A	R	
Reviews	Focused Schematic (Concept) Designs (SDs)	P	L	P	N/A	P	
	Focused Schematic (Concept) Designs (SDs) Comments Resolution	P	L	P	N/A	P	

Design Phase (D-B-B)		CxA = Commissioning Agent COR = Contracting Off. Rep A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	COR	A/E	CxM	O&M	Notes
	Focused Design Developments (DDs)	P	L	P	N/A	P	
	Focused Design Developments (DDs) Comments Resolution	P	L	P	N/A	P	
	Focused Construction Documents (CDs)	P	L	P	N/A	P	
	Focused Construction Documents (CDs) Comments Resolution	P	L	P	N/A	P	
	Focused Pre-Final Construction Document	P	L	P	N/A	P	
	Focused Pre-Final Construction Document Comments Resolution	P	L	P	N/A	P	
	Focused Final Construction Document	P	L	P	N/A	P	
	Final Construction Document Comments Backcheck	P	L	P	N/A	P	
Functional Test Protocols	Draft Pre-Functional Checklists (PFCs)	L	A	R	N/A	R	
	Draft System Functional Performance Tests (FPTs)	L	A	R	N/A	R	

D. The following table outlines the roles and responsibilities for the Commissioning Team members during the Design Phase (D-B):

Design Phase (D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	COR	A/E	CxM	O&M	Notes
Meetings	Design Review Meetings	P	P	L	p	P	
	Controls Meeting	L	P	P	p	P	
Coordination	Coordinate with [Contractor, A/E, COR, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support the OPR and BOD	L	P	P	p	O	
Cx Plan & Spec	Commissioning Plan	L	A	R	R	R	
	Cx Specifications	L	A	R	R	R	
Schedules	Design Phase Preliminary Commissioning Schedule	L	A	R	R	N/A	
OPR and BOD	Maintain OPR on behalf of Owner	P	A	L	P	P	
	Review BOD vs. OPR	L	A	P	P	P	
	Maintain BOD on behalf of Owner	P	A	L	P	R	
Reviews	Focused Schematic (Concept) Designs (SDs)	P	L	P	P	P	
	Focused Schematic(Concept) Designs (SDs) Comments	P	L	P	P	P	
	Focused Design Developments (DDs)	P	L	P	P	P	
	Focused Design Developments (DDs) Comments	P	L	P	P	P	
	Focused Construction Documents (CDs)	P	L	P	P	P	
	Focused Construction Documents (CDs) Comments	P	L	P	P	P	

Design Phase (D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities							
Category	Task Description	CxA	COR	A/E	CxM	O&M	Notes
	Focused Pre-Final Construction Document	P	L	P	P	P	
	Focused Pre-Final Construction Document Comments	P	L	P	P	P	
	Focused Final Construction Document	P	L	P	P	P	
	Final Construction Document Comments Backcheck	P	L	P	P	P	
Functional Test Protocols	Draft Pre-Functional Checklists (PFCs)	L	A	R	R	R	
	Draft System Functional Performance Tests (FPTs)	L	A	R	R	R	

E. The following table outlines the roles and responsibilities for the Commissioning Team members during the Bid and Pre-Construction Phase (D-B-B):

Bid and Pre-Construction Phase (D-B-B)		CxA = Commissioning Agent COR = Contracting Off. Rep RE = VA Resident Engineer A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M					L = Lead P = Participate A = Approve R = Review O = Optional	
Commissioning Roles & Responsibilities								
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
Pre-Bid Meeting	Organize, schedule and conduct meeting	P	L	P	P	P	O	

Bid and Pre-Construction Phase (D-B-B)		CxA = Commissioning Agent COR = Contracting Off. Rep RE = VA Resident Engineer A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M						L = Lead P = Participate A = Approve R = Review O = Optional
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
Commissioning Roles & Responsibilities								
Pre-Construction Meeting	Organize, schedule and conduct meeting	P	L	P	P	P	O	

F. The following table outlines the roles and responsibilities for the Commissioning Team members during the Construction Phase:

Construction Phase (D-B-B & D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep RE = VA Resident Engineer A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M						L = Lead P = Participate A = Approve R = Review O = Optional
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
Commissioning Roles & Responsibilities								
Meetings	Construction Commissioning Kick Off meeting	p	p	P	L	P	P	
	Commissioning Meetings	P	P	P	L	P	O	
	Project Progress Meetings	P	P	P	L	P	O	
	Controls Meeting	P	P	P	L	P	P	

Construction Phase (D-B-B & D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep RE = VA Resident Engineer A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M						L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities								
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
Coordination	Coordinate with [Contractor, A/E, COR, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support the OPR and BOD	P	P	P	L	P	P	
Cx Plan	Final Commissioning Plan	P	A	R	L	R	R	See Note 1
Schedules	Duration Schedule for Commissioning Activities	P	A	R	L	R	N/A	
OPR and BOD	Maintain OPR on behalf of Owner	L	A	R	R	R	O	
	Maintain BOD/DID on behalf of Owner	P	A	L	P	R	O	
Document Reviews	TAB Plan Review	P	A	R	L	R	O	
	Submittal and Shop Drawing Review	P	A	R	L	R	O	
	Review Contractor Equipment Startup Checklists	P	A	O	L	R	O	
	Review Change Orders, ASIs, and RFIs	P	A	R	L	R	O	
	Witness Factory Testing	P	A	O	L	O	O	

Construction Phase (D-B-B & D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep RE = VA Resident Engineer A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M						L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities								
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
Site Observations	Construction Observation Site Visits	P	A	O	L	P	P	
Functional Test Protocols	Finalize Pre-Functional Checklists	P	A	R	L	R	O	
	Finalize Functional Performance Test Protocols	P	A	R	L	R	O	
Technical Activities	Issues Resolution Meetings	P	A	P	L	P	O	
Reports and Logs	Status Reports	P	A	R	L	R	O	
	Maintain Commissioning Issues Log	P	A	R	L	R	O	

Notes:

1. Finalizing the project Cx Plan which was developed during the design phase by the CxA, shall be limited to minor tailoring for better alignment with the construction activities such as testing and scheduling. Any modification to the Cx Plan shall be in close coordination with and oversight by the CxA.
- G. The following table outlines the roles and responsibilities for the Commissioning Team members during the Acceptance Phase:

Acceptance Phase (D-B-B & D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep RE = VA Resident Engineer A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M						L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities								
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
Meetings	Commissioning Meetings	P	P	P	L	P	P	
	Project Progress Meetings	P	P	P	L	P	P	
	Pre-Test Coordination Meeting	P	P	P	L	P	P	
	Lessons Learned and Commissioning Report Review Meetings	P	P	P	L	P	P	
Coordination	Coordinate with [Contractor, A/E, COR, AHJ, Vendors, etc.] to ensure that Cx interacts properly with other systems as needed to support OPR and BOD	P	P	P	L	P	P	
Cx Plan	Maintain/Update Commissioning Plan	P	A	R	L	R	R	
Schedules	Prepare Functional Test Schedule	P	A	R	L	R	N/A	
OPR and BOD	Maintain OPR on behalf of Owner	L	A	R	R	R	O	
	Maintain BOD/DID on behalf of Owner	P	A	L	P	R	O	
Document Reviews	Review Completed Pre-Functional Checklists	P	A	R	L	R	O	
	Pre-Functional Checklist Verification	P	A	R	L	R	O	

Acceptance Phase (D-B-B & D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep RE = VA Resident Engineer A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M						L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities								
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
	Review Operations & Maintenance Systems Manuals	P	A	R	L	R	P	
	Training Plan Review	P	A	R	L	R	P	
	Warranty Review	R	P	R	L	R	P	
	Review TAB Report	R	A	R	L	R	P	
Site Observations	Construction Observation Site Visits	P	P	P	L	P	P	
	Witness Selected Equipment Startup	P	P	P	L	P	P	
Functional Test Protocols	TAB Verification	P	A	R	L	R	O	
	Systems Functional Performance Testing	P	A	P	L	P	P	
	Retesting	P	A	P	L	P	P	
Technical Activities	Issues Resolution Meetings	P	P	P	L	P	P	
	Systems Training	P	A	R	L	R	P	
Reports and Logs	Status Reports	R	A	R	L	R	O	
	Maintain Commissioning Issues Log	P	A	R	L	R	O	
	Final Commissioning Report	P	A	R	L	R	R	
	Prepare Systems Manuals	P	A	R	L	R	R	

Acceptance Phase (D-B-B & D-B)		CxA = Commissioning Agent					L = Lead	
Commissioning Roles & Responsibilities		COR = Contracting Off. Rep					P = Participate	
		RE = VA Resident Engineer					A = Approve	
		A/E = Design Arch/Engineer					R = Review	
		CxM = Commissioning Manager					O = Optional	
		O&M = VA Facility O&M						
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes

H. The following table outlines the roles and responsibilities for the Commissioning Team members during the Warranty Phase:

Warranty Phase (D-B-B & D-B)		CxA = Commissioning Agent					L = Lead	
Commissioning Roles & Responsibilities		COR = Contracting Off. Rep					P = Participate	
		RE = VA Resident Engineer					A = Approve	
		A/E = Design Arch/Engineer					R = Review	
		CxM = Commissioning Manager					O = Optional	
		O&M = VA Facility O&M						
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
Meetings	Post-Occupancy User Review Meeting	P	P	O	L	P	P	
Document Reviews	Systems Monitoring Trended Data	P	A	O	L	R	P	
	Systems Manual Update	P	A	O	L	R	R	

Warranty Phase (D-B-B & D-B)		CxA = Commissioning Agent COR = Contracting Off. Rep RE = VA Resident Engineer A/E = Design Arch/Engineer CxM = Commissioning Manager O&M = VA Facility O&M						L = Lead P = Participate A = Approve R = Review O = Optional
Commissioning Roles & Responsibilities								
Category	Task Description	CxA	COR	A/E	CxM	RE	O&M	Notes
Site Observations	Periodic Warranty Site Visits (4 & 9 Month)	P	P	O	L	P	P	
Functional Test Protocols	Deferred and/or seasonal Testing	P	P	O	L	P	P	
Technical Activities	Commissioning/Issues Resolution/Lessons Learned Meetings	P	P	O	L	P	P	
	Post-Occupancy Warranty Checkup and review of Significant Outstanding Issues	P	P	O	L	P	P	
Reports and Logs	Final Commissioning Report Amendment	P	A	R	L	R	R	
	Status Reports	R	A	R	L	R	O	
	Issues Logs Closure Report	P	A	R	L	R	O	

3.2 STARTUP, INITIAL CHECKOUT, AND PRE-FUNCTIONAL CHECKLISTS

A. The following procedures shall apply to all equipment and systems to be commissioned, according to Part 1, Systems to Be Commissioned.

1. Pre-Functional Checklists are important to ensure that the equipment and systems are hooked up and operational. These ensure that Systems Functional Performance Testing may proceed without unnecessary delays. Each system to be commissioned shall have a full Pre-Functional Checklist completed by the Contractor prior to Systems Functional Performance Testing. No sampling strategies are used.

a. The Pre-Functional Checklist will identify the trades responsible for completing the checklist. The Contractor shall ensure the appropriate trades complete the checklists.

b. The CxM will review completed Pre-Functional Checklists and field-verify the accuracy of the completed checklist using sampling techniques. The CxA and other parties as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table will also review the completed Pre-Functional Checklists for accuracy.

2. Startup and Initial Checkout Plan: The Contractor shall develop detailed startup plans for all equipment. The primary role of the Contractor in this process is to ensure that there is written documentation that each of the manufacturer recommended procedures have been completed. Parties responsible for startup shall be identified in the Startup Plan and in the checklist forms.

a. The Contractor shall develop the full startup plan by combining (or adding to) the checklists with the manufacturer's detailed startup and checkout procedures from the O&M manual data and the field checkout sheets normally used by the Contractor. The plan shall 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 at the end of the plan.

b. The full startup plan shall at a minimum consist of the following items:

1) The Pre-Functional Checklists.

2) The manufacturer's standard written startup procedures copied from the installation manuals with check boxes by each procedure and a signature block added by hand at the end.

3) The manufacturer's normally used field checkout sheets.

- c. The CxM will submit the full startup plan to the COR, CxA, Contractor, and other parties as noted in the COMMISSIONING PROCESS ROLES AND RESPONSIBILITIES table for review. Final approval will be by the DVA/USACE.
 - d. The Contractor shall review and evaluate the procedures and the format for documenting them, noting any procedures that need to be revised or added.
3. Sensor and Actuator Calibration
- a. All field installed temperature, relative humidity, CO2 and pressure sensors and gages, and all actuators (dampers and valves) on all equipment shall be calibrated using the methods described in Division 21, Division 22, Division 23, Division 26, Division 27, and Division 28 specifications.
 - b. All procedures used shall be fully documented on the Pre-Functional Checklists or other suitable forms, clearly referencing the procedures followed and written documentation of initial, intermediate and final results.

4. Execution of Equipment Startup

Spec Writer Note: Coordinate the number of week's lead-time with the COR.

- a. //Four// //insert number// weeks prior to equipment startup, the Contractor shall schedule startup and checkout with the COR and Commissioning Agent. The performance of the startup and checkout shall be directed and executed by the Contractor.
- b. The CxM will observe the startup procedures for selected pieces of primary equipment. The CxA and other Government representative(s) may choose to participate in some or all of the startup procedures as observers.
- c. The Contractor shall execute startup and provide the COR, CxM and CxA with a signed and dated copy of the completed startup checklists, and contractor tests.
- d. Only individuals that have direct knowledge and witnessed that a line item task on the Startup Checklist was actually performed shall initial or check that item off. It is not acceptable for witnessing supervisors to fill out these forms.

3.3 DEFICIENCIES, NONCONFORMANCE, AND APPROVAL IN CHECKLISTS AND STARTUP

- A. The Contractor shall clearly list any outstanding items of the initial startup and Pre-Functional Checklist 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 shall be provided to the CxM, CxA and Government within two days of completion.
- B. The CxM and CxA will review the report and submit comments to the COR. The CxM will work with the Contractor to correct and verify deficiencies or uncompleted items. The CxM will involve the CxA, COR and others as necessary. The Contractor shall correct all areas that are noncompliant or incomplete in the checklists in a timely manner, and shall notify the COR, CxM and CxA as soon as outstanding items have been corrected. The Contractor shall submit an updated startup report and a Statement of Correction on the original noncompliance report. When satisfactorily completed, the CxM in collaboration with CxA will recommend approval of the checklists and startup of each system to the COR.
- C. The Contractor shall be responsible for resolution of deficiencies as directed the COR.

Spec Writer Note: The following paragraph on Phased Commissioning is for projects with phased delivery of buildings or parts of buildings. It is intended to notify the Contractor that some Commissioning Activities, such as startup, functional testing, etc. will be conducted as the various phases of the project near completion and will require multiple mobilizations of the startup and functional testing teams to support the phased commissioning. Delete the following paragraph when phased delivery is not part of the project.

3.4 PHASED COMMISSIONING

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

3.5 DDC SYSTEM TRENDING FOR COMMISSIONING

- A. Trending is a method of testing as a standalone method or to augment manual testing. The Contractor shall trend any and all points of the system or systems at intervals specified below.
- B. Alarms are a means to notify the system operator that abnormal conditions are present in the system. Alarms shall be structured into three tiers - Critical, Priority, and Maintenance.

1. Critical alarms are intended to be alarms that require the immediate attention of and action by the Operator. These alarms shall be displayed on the Operator Workstation in a popup style window that is graphically linked to the associated unit's graphical display. The popup style window shall be displayed on top of any active window within the screen, including non DDC system software.
 2. Priority level alarms are to be printed to a printer which is connected to the Operator's Work Station located within the engineer's office. Additionally, Priority level alarms shall be able to be monitored and viewed through an active alarm application. Priority level alarms are alarms which shall require reaction from the operator or maintenance personnel within a normal work shift, and not immediate action.
 3. Maintenance alarms are intended to be minor issues which would require examination by maintenance personnel within the following shift. These alarms shall be generated in a scheduled report automatically by the DDC system at the start of each shift. The generated maintenance report will be printed to a printer located within the engineer's office.
- C. The Contractor shall provide a wireless internet network in the building for use during controls programming, checkout, and commissioning. This network will allow project team members to more effectively program, view, manipulate and test control devices while being in the same room as the controlled device.
- D. The Contractor shall provide graphical trending through the DDC control system of systems being commissioned. Trending requirements are indicated below and included with the Systems Functional Performance Test Procedures. Trending shall occur before, during and after Systems Functional Performance Testing. The Contractor shall be responsible for producing graphical representations of the trended DDC points that show each system operating properly during steady state conditions as well as during the System Functional Testing. These graphical reports shall be submitted to the COR, CxM and CxA for review and analysis before, during dynamic operation, and after Systems Functional Performance Testing. The Contractor shall provide, but not limited to, the following trend requirements and trend submissions:
1. Pre-testing, Testing, and Post-testing - Trend reports of trend logs and graphical trend plots are required as defined by the CxA and

CxM. The trend log points, sampling rate, graphical plot configuration, and duration will be dictated by the CxA and CxM. At any time during the Commissioning Process the CxA and CxM may recommend changes to aspects of trending as deemed necessary for proper system analysis. The Contractor shall implement any changes as directed by the COR. Any pre-test trend analysis comments generated by the Commissioning Team should be addressed and resolved by the Contractor, as directed by the COR, prior to the execution of Systems Functional Performance Testing.

2. Dynamic plotting - The Contractor shall also provide dynamic plotting during Systems Functional Performance testing at frequent intervals for points determined by the Systems Functional Performance Test Procedure. The graphical plots will be formatted and plotted at durations listed in the Systems Functional Performance Test Procedure.
3. Graphical plotting - The graphical plots shall be provided with a dual y-axis allowing 15 or more trend points (series) plotted simultaneously on the graph with each series in distinct color. The plots will further require title, axis naming, legend etc. all described by the Systems Functional Performance Test Procedure. If this cannot be sufficiently accomplished directly in the Direct Digital Control System then it is the responsibility of the Contractor to plot these trend logs in Microsoft Excel.
4. The following tables indicate the points to be trended and alarmed by system. The Operational Trend Duration column indicates the trend duration for normal operations. The Testing Trend Duration column indicates the trend duration prior to Systems Functional Performance Testing and again after Systems Functional Performance Testing. The Type column indicates point type: AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, Calc = Calculated Point. In the Trend Interval Column, COV = Change of Value. The Alarm Type indicates the alarm priority; C = Critical, P = Priority, and M = Maintenance. The Alarm Range column indicates when the point is considered in the alarm state. The Alarm Delay column indicates the length of time the point must remain in an alarm state before the alarm is recorded in the DDC. The intent is to allow minor, short-duration events to be corrected by the DDC system prior to recording an alarm.

Spec Writer Note: The following tables provide guidelines for system trends and alarms. Coordinate the types of systems and point names with the construction documents. Verify alarm priorities, ranges and delay. The Design Engineer may elect to include trending and alarm information on the DDC Control Schematics and Sequences of Operations in the Construction Drawing set or in the DDC Control Specifications. Verify the control drawings and/or DDC specifications have included reference to this section of 01 91 00. If adequately included in the drawings or specifications, the following tables should be deleted to prevent duplication and possible conflicts.

Dual-Path Air Handling Unit Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
OA Temperature	AI	15 Min	24 hours	3 days	N/A		
RA Temperature	AI	15 Min	24 hours	3 days	N/A		
RA Humidity	AI	15 Min	24 hours	3 days	P	>60% RH	10 min
Mixed Air Temp	AI	None	None	None	N/A		
SA Temp	AI	15 Min	24 hours	3 days	C	±5°F from SP	10 min
Supply Fan Speed	AI	15 Min	24 hours	3 days	N/A		
Return Fan Speed	AI	15 Min	24 hours	3 days	N/A		
RA Pre-Filter Status	AI	None	None	None	N/A		
OA Pre-Filter Status	AI	None	None	None	N/A		
After Filter Status	AI	None	None	None	N/A		
SA Flow	AI	15 Min	24 hours	3 days	C	±10% from SP	10 min
OA Supply Temp	AI	15 Min	24 hours	3 days	P	±5°F from SP	10 min
RA Supply Temp	AI	15 Min	24 hours	3 days	N/A		
RA CHW Valve Position	AI	15 Min	24 hours	3 days	N/A		

Dual-Path Air Handling Unit Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
OA CHW Valve Position	AI	15 Min	24 hours	3 days	N/A		
OA HW Valve Position	AI	15 Min	24 hours	3 days	N/A		
OA Flow	AI	15 Min	24 hours	3 days	P	±10% from SP	5 min
RA Flow	AI	15 Min	24 hours	3 days	P	±10% from SP	5 min
Initial UVC Intensity (%)	AI	None	None	None	N/A		
Duct Pressure	AI	15 Min	24 hours	3 days	C	±25% from SP	6 min
CO2 Level	AI	15 Min	24 hours	3 days	P	±10% from SP	10 min
Supply Fan Status	DI	COV	24 hours	3 days	C	Status <> Command	10 min
Return Fan Status	DI	COV	24 hours	3 days	C	Status <> Command	10 Min
High Static Status	DI	COV	24 hours	3 days	P	True	1 min
Fire Alarm Status	DI	COV	24 hours	3 days	C	True	5 min
Freeze Stat Level 1	DI	COV	24 hours	3 days	C	True	10 min
Freeze Stat Level 2	DI	COV	24 hours	3 days	C	True	5 min
Freeze Stat Level 3	DI	COV	24 hours	3 days	P	True	1 min
Fire/Smoke Damper Status	DI	COV	24 hours	3 days	P	Close d	1 min
Emergency AHU Shutdown	DI	COV	24 hours	3 days	P	True	1 min
Exhaust Fan #1 Status	DI	COV	24 hours	3 days	C	Status <> Command	10 min
Exhaust Fan #2 Status	DI	COV	24 hours	3 days	C	Status <> Command	10 min

Dual-Path Air Handling Unit Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Exhaust Fan #3 Status	DI	COV	24 hours	3 days	C	Status <> Command	10 min
OA Alarm	DI	COV	24 hours	3 days	C	True	10 min
High Static Alarm	DI	COV	24 hours	3 days	C	True	10 min
UVC Emitter Alarm	DI	COV	24 hours	3 days	P	True	10 min
CO2 Alarm	DI	COV	24 hours	3 days	P	True	10 min
Power Failure	DI	COV	24 hours	3 days	P	True	1 min
Supply Fan Speed	AO	15 Min	24 hours	3 days	N/A		
Return Fan Speed	AO	15 Min	24 hours	3 days	N/A		
RA CHW Valve Position	AO	15 Min	24 hours	3 days	N/A		
OA CHW Valve Position	AO	15 Min	24 hours	3 days	N/A		
OA HW Valve Position	AO	15 Min	24 hours	3 days	N/A		
Supply Fan S/S	DO	COV	24 hours	3 days	N/A		
Return Fan S/S	DO	COV	24 hours	3 days	N/A		
Fire/Smoke Dampers	DO	COV	24 hours	3 days	N/A		
Exhaust Fan S/S	DO	COV	24 hours	3 days	N/A		
Exhaust Fan S/S	DO	COV	24 hours	3 days	N/A		
Exhaust Fan S/S	DO	COV	24 hours	3 days	N/A		
AHU Energy	Calc	1 Hour	30 days	N/A	N/A		

Terminal Unit (VAV, CAV, etc.) Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Space Temperature	AI	15 Min	12 hours	3 days	P	±5°F from SP	10 min
Air Flow	AI	15 Min	12 hours	3 days	P	±5°F from SP	10 min
SA Temperature	AI	15 Min	12 hours	3 days	P	±5°F from SP	10 min
Local Setpoint	AI	15 Min	12 hours	3 days	M	±10°F from SP	60 min
Space Humidity	AI	15 Min	12 hours	3 days	P	> 60% RH	5 min
Unoccupied Override	DI	COV	12 hours	3 days	M	N/A	12 Hours
Refrigerator Alarm	DI	COV	12 hours	3 days	C	N/A	10 min
Damper Position	AO	15 Minutes	12 hours	3 days	N/A		
Heating coil Valve Position	AO	15 Minutes	12 hours	3 days	N/A		

4-Pipe Fan Coil Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Space Temperature	AI	15 Minutes	12 hours	3 days	P	±5°F from SP	10 min
SA Temperature	AI	15 Minutes	12 hours	3 days	P	±5°F from SP	10 min
Pre-Filter Status	AI	None	None	None	M	> SP	1 hour
Water Sensor	DI	COV	12 hours	3 days	M	N/A	30 Min
Cooling Coil Valve Position	AO	15 Minutes	12 hours	3 days	N/A		

4-Pipe Fan Coil Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Heating coil Valve Position	AO	15 Minutes	12 hours	3 days	N/A		
Fan Coil ON/OFF	DO	COV	12 hours	3 days	M	Status <> Command	30 min

2-Pipe Fan Coil Unit Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Space Temperature	AI	15 Minutes	12 hours	3 days	P	±5°F from SP	10 min
SA Temperature	AI	15 Minutes	12 hours	3 days	P	±5°F from SP	10 min
Pre-Filter Status	AI	None	None	None	M	> SP	1 hour
Water Sensor	DI	COV	12 hours	3 days	M	N/A	30 Min
Cooling Coil Valve Position	AO	15 Minutes	12 hours	3 days	N/A		
Fan Coil ON/OFF	DO	COV	12 hours	3 days	M	Status <> Command	30 min

Unit Heater Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Space Temperature	AI	15 Minutes	12 hours	3 days	P	±5°F from SP	10 min
Heating Valve Position	AO	15 Minutes	12 hours	3 days	N/A		
Unit Heater ON/OFF	DO	COV	12 hours	3 days	M	Status <> Command	30 min

Steam and Condensate Pumps Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Steam Flow (LB/HR)	AI	15 Minutes	12 hours	3 days	N/A		
Condensate Pump Run Hours	AI	15 Minutes	12 hours	3 days	N/A		
Water Meter (GPM)	AI	15 Minutes	12 hours	3 days	N/A		
Electric Meter (KW/H)	AI	15 Minutes	12 hours	3 days	N/A		
Irrigation Meter (GPM)	AI	15 Minutes	12 hours	3 days	N/A		
Chilled Water Flow (TONS)	AI	15 Minutes	12 hours	3 days	N/A		
Condensate Flow (GPM)	AI	15 Minutes	12 hours	3 days	N/A		
High Water Level Alarm	DI	COV	12 hours	3 days	C	True	5 Min
Condensate Pump Start/Stop	DO	COV	12 hours	3 days	P	Status <> Command	10 min

Domestic Hot Water Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Domestic HW Setpoint WH-1	AI	15 Minute	12 Hours	3 days	N/A		
Domestic HW Setpoint WH-2	AI	15 Minute	12 Hours	3 days	N/A		
Domestic HW Temperature	AI	15 Minute	12 Hours	3 days	C	> 135 oF	10 Min
Domestic HW Temperature	AI	15 Minute	12 Hours	3 days	P	±5°F from SP	10 Min
Dom. Circ. Pump #1 Status	DI	COV	12 Hours	3 days	M	Status <> Command	30 min
Dom. Circ. Pump #2 Status	DI	COV	12 Hours	3 days	M	Status <> Command	30 min
Dom. Circ. Pump #1 Start/Stop	DO	COV	12 Hours	3 days	N/A		
Dom. Circ. Pump #2 Start/Stop	DO	COV	12 Hours	3 days	N/A		
Domestic HW Start/Stop	DO	COV	12 Hours	3 days	N/A		

Hydronic Hot Water Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
System HWS Temperature	AI	15 min	12 hours	3 days	C	±5°F from SP	10 Min
System HWR Temperature	AI	15 min	12 hours	3 days	M	±15°F from SP	300 Min
HX-1 Entering Temperature	AI	15 min	12 hours	3 days	P	±5°F from SP	10 Min
HX-2 Entering Temperature	AI	15 min	12 hours	3 days	P	±5°F from SP	10 Min

Hydronic Hot Water Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
HX-2 Leaving Temperature	AI	15 min	12 hours	3 days	P	±5°F from SP	10 Min
System Flow (GPM)	AI	15 min	12 hours	3 days	N/A		
System Differential Pressure	AI	15 min	12 hours	3 days	P	±10% from SP	8 Min
				3 days			
HW Pump 1 Status	DI	COV	12 Hours	3 days	C	Status <> Command	30 min
HW Pump 2 Status	DI	COV	12 Hours	3 days	C	Status <> Command	30 min
HW Pump 1 VFD Speed	AO	15 Min	12 Hours	3 days	N/A		
HW Pump 2 VFD Speed	AO	15 Min	12 Hours	3 days	N/A		
Steam Station #1 1/3 Control Valve Position	AO	15 Min	12 Hours	3 days	N/A		
Steam Station #1 2/3 Control Valve Position	AO	15 Min	12 Hours	3 days	N/A		
Steam Station #2 1/3 Control Valve Position	AO	15 Min	12 Hours	3 days	N/A		
Steam Station #2 2/3 Control Valve Position	AO	15 Min	12 Hours	3 days	N/A		
Steam Station Bypass Valve Position	AO	15 Min	12 Hours	3 days	N/A		

Hydronic Hot Water Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
HW Pump 1 Start/Stop	DO	COV	12 Hours	3 days	N/A		
HW Pump 2 Start/Stop	DO	COV	12 Hours	3 days	N/A		
HWR #1 Valve	DO	COV	12 Hours	3 days	N/A		
HWR #2 Valve	DO	COV	12 Hours	3 days	N/A		

Chilled Water System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Chiller 1 Entering Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 1 Leaving Temperature	AI	15 Minutes	12 Hours	3 days	P	±5°F from SP	10 Min
Chiller 1 Flow	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 1 Percent Load	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 1 KW Consumption	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 1 Tonnage	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 2 Entering Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 2 Leaving Temperature	AI	15 Minutes	12 Hours	3 days	P	±5°F from SP	10 Min
Chiller 2 Flow	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 2 Percent Load	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 2 KW Consumption	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 2 Tonnage	AI	15 Minutes	12 Hours	3 days	N/A		
Primary Loop Decoupler Flow	AI	15 Minutes	12 Hours	3 days	N/A		
Primary Loop Flow	AI	15 Minutes	12 Hours	3 days	N/A		

Chilled Water System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Primary Loop Supply Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Secondary Loop Differential Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Secondary Loop Flow	AI	15 Minutes	12 Hours	3 days	N/A		
Secondary Loop Supply Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Secondary Loop Return Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Secondary Loop Tonnage	AI	15 Minutes	12 Hours	3 days	N/A		
Primary Loop Pump 1 Status	DI	COV	12 Hours	3 days	C	Status <> Command	30 min
Primary Loop Pump 2 Status	DI	COV	12 Hours	3 days	C	Status <> Command	30 min
Secondary Loop Pump 1 Status	DI	COV	12 Hours	3 days	C	Status <> Command	30 min
Secondary Loop Pump 2 Status	DI	COV	12 Hours	3 days	C	Status <> Command	30 min
Chiller 1 Status	DI	COV	12 Hours	3 days	C	Status <> Command	30 min
Chiller 1 Evaporator Iso-Valve	DI	COV	12 Hours	3 days	N/A		
Chiller 1 Evaporator Flow Switch	DI	COV	12 Hours	3 days	N/A		
Chiller 1 Unit Alarm	DI	COV	12 Hours	3 days	C	True	10 Min
Chiller 2 Status	DI	COV	12 Hours	3 days	C	Status <> Command	30 min

Chilled Water System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Chiller 2 Evaporator Iso-Valve	DI	COV	12 Hours	3 days	N/A		
Chiller 2 Evaporator Flow Switch	DI	COV	12 Hours	3 days	N/A		
Chiller 2 Unit Alarm	DI	COV	12 Hours	3 days	C	True	10 Min
Refrigerant Detector	DI	COV	12 Hours	3 days	C	True	10 Min
Refrigerant Exhaust Fan Status	DI	COV	12 Hours	3 days	M	Status <> Command	30 min
Emergency Shutdown	DI	COV	12 Hours	3 days	P	True	1 Min
Primary Loop Pump 1 VFD Speed	AO	15 Minutes	12 Hours	3 days	N/A		
Primary Loop Pump 2 VFD Speed	AO	15 Minutes	12 Hours	3 days	N/A		
Secondary Loop Pump 1 VFD Speed	AO	15 Minutes	12 Hours	3 days	N/A		
Secondary Loop Pump 2 VFD Speed	AO	15 Minutes	12 Hours	3 days	N/A		
Primary Pump 1 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Primary Pump 2 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Secondary Pump 1 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Secondary Pump 2 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Chiller 1 Enable	DO	COV	12 Hours	3 days	N/A		
Chiller 1 Iso-Valve Command	DO	COV	12 Hours	3 days	N/A		
Chiller 2 Enable	DO	COV	12 Hours	3 days	N/A		

Chilled Water System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Chiller 2 Iso-Valve Command	DO	COV	12 Hours	3 days	N/A		
Refrigerant Exhaust Fan Start / Stop	DO	COV	12 Hours	3 days	N/A		

Condenser Water System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Chiller 1 Condenser Entering Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 1 Condenser Leaving Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 2 Condenser Entering Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Chiller 2 Condenser Leaving Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 Supply Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 Return Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 Basin Temp	AI	15 Minutes	12 Hours	3 days	P	< 45 oF	10 Min
Cooling Tower 2 Supply Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 2 Return Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 2 Basin Temp	AI	15 Minutes	12 Hours	3 days	P	< 45 oF	10 Min
Condenser Water Supply Temp	AI	15 Minutes	12 Hours	3 days	N/A		

Condenser Water System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Condenser Water Return Temp	AI	15 Minutes	12 Hours	3 days	N/A		
Outdoor Air Wet Bulb	AI	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 Fan Status	DI	COV	12 Hours	3 days	P	Status <> Command	1 min
Cooling Tower 1 Basin Heat	DI	COV	12 Hours	3 days	N/A		
Cooling Tower 1 Heat Trace	DI	COV	12 Hours	3 days	N/A		
Cooling Tower 2 Fan Status	DI	COV	12 Hours	3 days	P	Status <> Command	1 min
Cooling Tower 2 Basin Heat	DI	COV	12 Hours	3 days	N/A		
Cooling Tower 2 Heat Trace	DI	COV	12 Hours	3 days	N/A		
Chiller 1 Isolation Valve	DI	COV	12 Hours	3 days	P	Status <> Command	1 min
Chiller 2 Isolation Valve	DI	COV	12 Hours	3 days	P	Status <> Command	1 min
Condenser Water Pump 1 Status	DI	COV	12 Hours	3 days	P	Status <> Command	1 min
Condenser Water Pump 2 Status	DI	COV	12 Hours	3 days	P	Status <> Command	1 min
Chiller 1 Condenser Bypass Valve	AO	15 Minutes	12 Hours	3 days	N/A		

Condenser Water System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Chiller 2 Condenser By-Pass Valve	AO	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 Bypass Valve	AO	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 Fan Speed	AO	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 2 Bypass Valve	AO	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 2 Fan Speed	AO	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 Fan Start / Stop	DO	COV	12 Hours	3 days	N/A		
Cooling Tower 2 Fan Start / Stop	DO	COV	12 Hours	3 days	N/A		
Condenser Water Pump 1 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Condenser Water Pump 2 Start / Stop	DO	COV	12 Hours	3 days	N/A		

Steam Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 1 Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 1 Steam Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 1 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 2 Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min

Steam Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 2 Steam Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 2 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
System Steam Pressure	AI	15 Minutes	12 Hours	3 days	P	±5% from SP	10 Min
Boiler 1 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 1 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 1 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 1 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 1 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 1 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 1 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 2 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 2 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Low Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 High Water Alarm	DI	COV	12 Hours	3 days	C	True	5 Min
Boiler 2 Feed Pump	DI	COV	12 Hours	3 days	N/A		
Combustion Damper Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min

Steam Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Condensate Recovery Pump Status	DI	COV	12 Hours	3 days	P	Status <> Command	5 min
Boiler 1 Feed Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		
Boiler 2 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Combustion Damper Command	DO	COV	12 Hours	3 days	N/A		
Condensate Recovery Pump Start / Stop	DO	COV	12 Hours	3 days	N/A		

Hot Water Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Outside Air Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 1 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 1 Entering Water Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 1 Leaving Water Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 2 Fire Signal	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 2 Entering Water Temperature	AI	15 Minutes	12 Hours	3 days	N/A		

Hot Water Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Boiler 2 Leaving Water Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Hot Water Supply Temperature	AI	15 Minutes	12 Hours	3 days	P	±5 oF from SP	10 Min
Hot Water Return Temperature	AI	15 Minutes	12 Hours	3 days	N/A		
Secondary Loop Differential Pressure	AI	15 Minutes	12 Hours	3 days	C	±5% from SP	10 Min
Lead Boiler	AI	15 Minutes	12 Hours	3 days	N/A		
Boiler 1 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 1 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 1 Isolation Valve	DI	COV	12 Hours	3 days	N/A		
Boiler 1 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 1 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Boiler 2 Enable	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Boiler 2 Isolation Valve	DI	COV	12 Hours	3 days	N/A		
Boiler 2 on Fuel Oil	DI	COV	12 Hours	3 days	N/A		
Boiler 2 Alarm	DI	COV	12 Hours	3 days	C	True	1 Min
Combustion Dampers Open	DI	COV	12 Hours	3 days	P	Status <> Command	10 min

Hot Water Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Primary Pump 1 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Primary Pump 2 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Secondary Pump 1 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Secondary Pump 2 Status	DI	COV	12 Hours	3 days	P	Status <> Command	10 min
Primary Pump 1 VFD Speed	AO	COV	12 Hours	3 days	N/A		
Primary Pump 2 VFD Speed	AO	COV	12 Hours	3 days	N/A		
Secondary Pump 1 VFD Speed	AO	COV	12 Hours	3 days	N/A		
Secondary Pump 2 VFD Speed	AO	COV	12 Hours	3 days	N/A		
Hot Water System Enable	DO	COV	12 Hours	3 days	N/A		
Combustion Dampers Command	DO	COV	12 Hours	3 days	N/A		
Primary Pump 1 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Primary Pump 2 Start / Stop	DO	COV	12 Hours	3 days	N/A		
Secondary Pump 1 Start / Stop	DO	COV	12 Hours	3 days	N/A		

Hot Water Boiler System Trending and Alarms							
Point	Type	Trend Interval	Operational Trend Duration	Testing Trend Duration	Alarm Type	Alarm Range	Alarm Delay
Secondary Pump 2 Start / Stop	DO	COV	12 Hours	3 days	N/A		

E. The Contractor shall provide the following information prior to Systems Functional Performance Testing. Any documentation that is modified after submission shall be recorded and resubmitted to the COR, CxM and CxA.

1. Point-to-Point checkout documentation;
2. Sensor field calibration documentation including system name, sensor/point name, measured value, DDC value, and Correction Factor.
3. A sensor calibration table listing the referencing the location of procedures to following in the O&M manuals, and the frequency at which calibration should be performed for all sensors, separated by system, subsystem, and type. The calibration requirements shall be submitted both in the O&M manuals and separately in a standalone document containing all sensors for inclusion in the commissioning documentation. The following table is a sample that can be used as a template for submission.

SYSTEM		
Sensor	Calibration Frequency	O&M Calibration Procedure Reference
Discharge air temperature	Once a year	Volume I Section D.3.aa
Discharge static pressure	Every 6 months	Volume II Section A.1.c

4. Loop tuning documentation and constants for each loop of the building systems. The documentation shall be submitted in outline or table separated by system, control type (e.g. heating valve temperature control); proportional, integral and derivative constants, interval (and bias if used) for each loop. The following table is a sample that can be used as a template for submission.

AIR HANDLING UNIT AHU-1				
Control Reference	Proportional Constant	Integral Constant	Derivative Constant	Interval
Heating Valve Output	1000	20	10	2 sec.

3.6 SYSTEMS FUNCTIONAL PERFORMANCE TESTING

- A. This paragraph applies to Systems Functional Performance Testing of systems for all referenced specification Divisions.
- B. Objectives and Scope: The objective of Systems Functional Performance Testing is to demonstrate that each system is operating according to the Contract Documents. Systems Functional Performance Testing facilitates bringing the systems from a state of substantial completion to full dynamic operation. Additionally, during the testing process, areas of noncompliant performance are identified and corrected, thereby improving the operation and functioning of the systems. In general, each system shall be operated through all modes of operation (seasonal, occupied, unoccupied, warm-up, cool-down, part- and full-load, fire alarm and emergency power) where there is a specified system response. The Contractor shall verify each sequence in the sequences of operation. Proper responses to such modes and conditions as power failure, freeze condition, low oil pressure, no flow, equipment failure, etc. shall also be tested.
- C. Development of Systems Functional Performance Test Procedures: Before Systems Functional Performance Test procedures are written, the Contractor shall submit 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. Using the testing parameters and requirements found in the Contract Documents and approved submittals and shop drawings, the CxM will develop specific Systems Functional Test Procedures to verify and document proper operation of each piece of equipment and system to be commissioned. The Contractor shall assist the CxM in developing the Systems Functional Performance Test procedures as requested by the CxM i.e. by answering questions about equipment, operation, sequences, etc. Prior to execution, the CxM will provide a copy of the Systems Functional Performance Test procedures to the COR, CxA, Architect/Engineer, and

Contractor, who shall review the tests for feasibility, safety, equipment and warranty protection.

- D. Purpose of Test Procedures: The purpose of each specific Systems Functional Performance Test is to verify and document compliance with the stated criteria of acceptance given on the test form. Representative test formats and examples are found in the Commissioning Plan for this project. (The Commissioning Plan is issued as a separate document and is available for review.) The test procedure forms developed by the CxM will 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 test ID number, and reference to unique Pre-Functional Checklists and startup documentation, and ID numbers for the piece of equipment
 4. Date
 5. Project name
 6. Participating parties
 7. A copy of the specification section describing the test requirements
 8. A copy of the specific sequence of operations or other specified parameters being verified
 9. Formulas used in any calculations
 10. Required pretest field measurements
 11. Instructions for setting up the test.
 12. Special cautions, alarm limits, etc.
 13. Specific step-by-step procedures to execute the test, in a clear, sequential and repeatable format
 14. 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 test was achieved.
 15. A section for comments.
 16. Signatures and date block for the CxM. A place for the Contractor to initial to signify attendance at the test.
- E. Test Methods: Systems Functional Performance Testing shall be achieved by manual testing (i.e. persons manipulate the equipment and observe performance) and/or by monitoring the performance and analyzing the results using the control system's trend log capabilities or by standalone data loggers. The Contractor, CxM and CxA shall determine

which method is most appropriate for tests that do not have a method specified.

1. Simulated Conditions: Simulating conditions (not by an overwritten value) shall be allowed, although timing the testing to experience actual conditions is encouraged wherever practical.
 2. 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, but shall be used with caution and avoided when possible. Such testing methods often can only test a part of a system, as the interactions and responses of other systems will be erroneous or not applicable. Simulating a condition is preferable. e.g., for the above case, by heating the outside air sensor with a hair blower rather than overwriting the value or by altering the appropriate setpoint to see the desired response. Before simulating conditions or overwriting values, sensors, transducers and devices shall have been calibrated.
 3. Simulated Signals: Using a signal generator which creates a simulated signal to test and calibrate transducers and DDC constants is generally recommended over using the sensor to act as the signal generator via simulated conditions or overwritten values.
 4. Altering Setpoints: Rather than overwriting sensor values, and when simulating conditions is difficult, altering setpoints to test a sequence is acceptable. For example, to see the Air Conditioning compressor lockout initiate at an outside air temperature below 12 C (54 F), when the outside air temperature is above 12 C (54 F), temporarily change the lockout setpoint to be 2 C (4 F) above the current outside air temperature.
 5. 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 tested parameters, that the indirect readings through the control system represent actual conditions and responses. Much of this verification shall be completed during systems startup and initial checkout.
- F. Setup: Each function and test shall be performed under conditions that simulate actual conditions as closely as is practically possible. The Contractor shall provide all necessary materials, system modifications, etc. to produce the necessary flows, pressures, temperatures, etc.

necessary to execute the test according to the specified conditions. At completion of the test, the Contractor shall return all affected building equipment and systems, due to these temporary modifications, to their pretest condition.

- G. Sampling: No sampling is allowed in completing Pre-Functional Checklists. Sampling is allowed for Systems Functional Performance Test Procedures execution. The CxM and CxA will jointly determine the sampling rate. Functional Performance Testing must be performed on 100% of all plant equipment (chillers, cooling towers, exchangers, primary and secondary pumps, emergency generators, boilers and associated ancillary equipment, fuel delivery system, etc.), central vacuum pumps and air compressors, renewable energy systems (as applicable), and critical terminal equipment (isolation exhaust), and 20% of all terminal equipment (VAVs, fan coils, non-critical exhaust fans, etc.) If at any point, frequent failures are occurring and testing is becoming more troubleshooting than verification, the CxM and/or CxA may stop the testing and require the Contractor to perform and document a checkout of the remaining units, prior to continuing with Systems Functional Performance Testing of the remaining units.

Spec Writer Note: Verify that the following paragraph regarding cost of expanded sample testing is allowed for the specific project. Retain or delete the paragraph as necessary.

- H. Cost of Retesting: The cost associated with expanded sample System Functional Performance Tests shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.
- I. Coordination and Scheduling: The Contractor shall provide a minimum of 7 days' notice to the CxM, CxA, and the COR regarding the completion schedule for the Pre-Functional Checklists and startup of all equipment and systems. The CxM will schedule Systems Functional Performance Tests with the Contractor, CxA and COR. The CxM will witness and document the Systems Functional Performance Testing of systems. The CxA and other Government representative(s) may choose to participate in some or all of the Systems Functional Performance Testing. The Contractor shall

execute the tests in accordance with the Systems Functional Performance Test Procedure.

- J. Testing Prerequisites: In general, Systems Functional Performance Testing will be conducted only after Pre-Functional Checklists have been satisfactorily completed. The control system shall be sufficiently tested and approved by the CxM, CxA, and the COR before it is used to verify performance of other components or systems. The air balancing and water balancing shall be completed before Systems Functional Performance Testing of air-related or water-related equipment or systems are scheduled. Systems Functional Performance Testing will proceed 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 will be checked.
- K. Problem Solving: The CxM and CxA will recommend solutions to problems found, however the burden of responsibility to solve, correct and retest problems is with the Contractor.

3.7 DOCUMENTATION, NONCONFORMANCE AND APPROVAL OF TESTS

- A. Documentation: The CxM will witness, and document the results of all Systems Functional Performance Tests using the specific procedural forms developed by the CxA and CxM for that purpose. Prior to testing, the CxM will provide these forms to the CxA, COR and the Contractor for review and approval. The Contractor shall include the filled out forms with the O&M manual data.
- B. Nonconformance: The CxM will record the results of the Systems Functional Performance Tests on the procedure or test form. All items of nonconformance issues will be noted and reported to the COR and CxA on Commissioning Field Reports and/or the Commissioning Master Issues Log.
1. Corrections of minor items of noncompliance identified may be made during the tests. In such cases, the item of noncompliance and resolution shall be documented on the Systems Functional Test Procedure.
 2. Every effort shall be made to expedite the systems functional Performance Testing process and minimize unnecessary delays, while not compromising the integrity of the procedures. However, the CxM and CxA shall not be pressured into overlooking noncompliant work or loosening acceptance criteria to satisfy scheduling or cost issues,

unless there is an overriding reason to do so by direction from the COR.

3. As the Systems Functional Performance Tests progresses and an item of noncompliance is identified, the CxM shall discuss the issue with the Contractor, CxA and the COR.
4. When there is no dispute on an item of noncompliance, and the Contractor accepts responsibility to correct it:
 - a. The CxM will document the item of noncompliance and the Contractor's response and/or intentions. The Systems Functional Performance Test then continues or proceeds to another test or sequence. After the day's work is complete, the CxM will submit a Commissioning Field Report to the CxA and COR. The CxM will also note items of noncompliance and the Contractor's response in the Master Commissioning Issues Log. The Contractor shall correct the item of noncompliance and report completion to the COR, CxM and CxA.
 - b. The need for retesting will be evaluated by the CxM and CxA. The COR will make the final determination for retesting based on input from CxM and CxA. If retesting is required, the CxM and the Contractor shall reschedule the test and the test shall be repeated.
5. If there is a dispute about item of noncompliance, regarding whether it is an item of noncompliance, or who is responsible:
 - a. The item of noncompliance shall be documented on the test form with the Contractor's response. The item of noncompliance with the Contractor's response shall also be reported on a Commissioning Field Report and on the Master Commissioning Issues Log.
 - b. Resolutions shall be made at the lowest management level possible. Other parties are brought into the discussions as needed. Final interpretive and acceptance authority is with COR.
 - c. The CxM will document the resolution process.
 - d. Once the interpretation and resolution have been decided, the Contractor shall correct the item of noncompliance, report it to the DVA/USCAE, CxM and CxA. The requirement for retesting will be determined by the CxM and CxA. If retesting is required, the CxM and the Contractor shall reschedule the test. Retesting shall be repeated until satisfactory performance is achieved.

Spec Writer Note: Verify that the following paragraph regarding cost of retesting is allowed for the specific project. Retain or delete the paragraph as necessary.

C. Cost of Retesting: The cost to retest a System Functional Performance Test shall be solely the responsibility of the Contractor. Any required retesting by the Contractor shall not be considered a justified reason for a claim of delay or for a time extension by the Contractor.

Spec Writer's Note: Verify that the paragraph and subparagraphs below do not conflict with other general or specific contract documents regarding manufacturer's defects. Retain, delete, or modify the paragraphs accordingly.

D. Failure Due to Manufacturer Defect: If 10%, or three, whichever is greater, of identical pieces (size alone does not constitute a difference) of equipment fail to perform in compliance with the Contract Documents (mechanically or substantively) due to manufacturing defect, not allowing it to meet its submitted performance specifications, all identical units may be considered unacceptable by the COR. In such case, the Contractor shall provide the COR with the following:

1. Within one week of notification from the COR, the Contractor shall examine all other identical units making a record of the findings. The findings shall be provided to the VA within two weeks of the original notice.
2. Within two weeks of the original notification, the Contractor shall provide a signed and dated, written explanation of the problem, cause of failures, etc. and all proposed solutions which shall include full equipment submittals. The proposed solutions shall not significantly exceed the specification requirements of the original installation.
3. The COR shall determine whether a replacement of all identical units or a repair is acceptable.
4. Two examples of the proposed solution shall be installed by the Contractor and the Government shall be allowed to test the

installations for up to one week, upon which the COR will decide whether to accept the solution.

5. Upon acceptance, the Contractor shall replace or repair all identical items, at their expense and extend the warranty accordingly, if the original equipment warranty had begun. The replacement/repair work shall proceed with reasonable speed beginning within one week from when parts can be obtained.
 6. After replacement of all identical items, commissioning of these replaced items shall be restarted to include verification of startup, field testing, pre-functional checklists, and functional performance tests.
- E. Approval: The CxM will note each satisfactorily demonstrated function on the test form. Formal approval of the Systems Functional Performance Test shall be made later after review by the CxM, CxA, and by the COR. The CxM will evaluate each test and report to the CxA and COR using a standard form. The COR will give final approval on each test using the same form, and provide signed copies to the CxM, CxA and the Contractor.

3.8 DEFERRED TESTING

- A. Unforeseen Deferred Systems Functional Performance Tests: If any Systems Functional Performance Test cannot be completed due to the building structure, required occupancy condition or other conditions, execution of the Systems Functional Performance Testing may be delayed upon approval of the COR. These Systems Functional Performance Tests shall be conducted in the same manner as the seasonal tests as soon as possible.
- B. Deferred Seasonal Testing: Deferred Seasonal Systems Functional Performance Tests are those that must be deferred until weather conditions are closer to the systems design parameters. The CxM and CxA will review systems parameters and recommend which Systems Functional Performance Tests should be deferred until weather conditions more closely match systems parameters. The Contractor shall review and comment on the proposed schedule for Deferred Seasonal Testing. The COR will review and approve the schedule for Deferred Seasonal Testing. Deferred Seasonal Systems Functional Performances Tests shall be witnessed and documented by the CxM. Deferred Seasonal Systems Functional Performance Tests shall be executed by the Contractor in accordance with these specifications.

3.9 OPERATION AND MAINTENANCE TRAINING REQUIREMENTS

- A. Training Preparation Conference: Before operation and maintenance training, the CxM will convene a training preparation conference to include COR, VA's Resident Engineer, VA's Operations and Maintenance personnel, and the Contractor. The purpose of this conference will be to discuss and plan for Training and Demonstration of VA Operations and Maintenance personnel.
- B. The Contractor shall provide training and demonstration as required by other Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 sections. The Training and Demonstration shall include, but is not limited to, the following:
 - 1. Review the Contract Documents.
 - 2. Review installed systems, subsystems, and equipment.
 - 3. Review instructor qualifications.
 - 4. Review instructional methods and procedures.
 - 5. Review training module outlines and contents.
 - 6. Review course materials (including operation and maintenance manuals).
 - 7. Review and discuss locations and other facilities required for instruction.
 - 8. Review and finalize 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. Training Module Submittals: The Contractor shall submit the following information to the CxM, CxA and COR:
 - 1. Instruction Program: Submit two copies of outline of instructional program for demonstration and training, including a schedule of proposed dates, times, length of instruction time, and instructors' names for each training module. Include learning objective and outline for each training module. At completion of training, submit two complete training manuals for VA's use.
 - 2. Qualification Data: Submit qualifications for facilitator and/or instructor.
 - 3. Attendance Record: For each training module, submit list of participants and length of instruction time.

4. Evaluations: For each participant and for each training module, submit results and documentation of performance-based test.
5. Demonstration and Training Recording:
 - a. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. At beginning of each training module, record each chart containing learning objective and lesson outline.
 - b. Video Format: Provide high quality color DVD color on standard size DVD disks.
 - c. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
 - d. Narration: Describe scenes on video recording by audio narration by microphone while demonstration and training is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.
 - e. Submit two copies within seven days of end of each training module.
6. Transcript: Prepared on 8-1/2-by-11-inch paper, punched and bound in heavy-duty, 3-ring, vinyl-covered binders. Mark appropriate identification on front and spine of each binder. Include a cover sheet with same label information as the corresponding videotape. Include name of Project and date of videotape on each page.

D. Quality Assurance:

1. Facilitator Qualifications: A firm or individual experienced in training or educating maintenance personnel in a training program similar in content and extent to that indicated for this Project, and whose work has resulted in training or education with a record of successful learning performance.
2. Instructor Qualifications: A factory authorized service representative, complying with requirements in Division 01 Section "Quality Requirements," experienced in operation and maintenance procedures and training.
3. Photographer Qualifications: A professional photographer who is experienced photographing construction projects.

E. Training Coordination:

1. Coordinate instruction schedule with VA's operations. Adjust schedule as required to minimize disrupting VA's operations.
2. Coordinate instructors, including providing notification of dates, times, length of instruction time, and course content.
3. Coordinate content of training modules with content of approved emergency, operation, and maintenance manuals. Do not submit instruction program until operation and maintenance data has been reviewed and approved by the COR.

F. Instruction Program:

1. Program Structure: Develop an instruction program that includes individual training modules for each system and equipment not part of a system, as required by individual Specification Sections, and as follows:
 - a. Fire protection systems, including fire alarm, fire pumps, and fire suppression systems.
 - b. Intrusion detection systems.
 - c. Conveying systems, including elevators, wheelchair lifts, escalators, and automated materials handling systems.
 - d. Medical equipment, including medical gas equipment and piping.
 - e. Laboratory equipment, including laboratory air and vacuum equipment and piping.
 - f. Heat generation, including boilers, feedwater equipment, pumps, steam distribution piping, condensate return systems, heating hot water heat exchangers, and heating hot water distribution piping.
 - g. Refrigeration systems, including chillers, cooling towers, condensers, pumps, and distribution piping.
 - h. HVAC systems, including air handling equipment, air distribution systems, and terminal equipment and devices.
 - i. HVAC instrumentation and controls.
 - j. Electrical service and distribution, including switchgear, transformers, switchboards, panelboards, uninterruptible power supplies, and motor controls.
 - k. Packaged engine generators, including synchronizing switchgear/switchboards, and transfer switches.
 - l. Lighting equipment and controls.
 - m. Communication systems, including intercommunication, surveillance, nurse call systems, public address, mass

evacuation, voice and data, and entertainment television equipment.

- n. Site utilities including lift stations, condensate pumping and return systems, and storm water pumping systems.

G. Training Modules: Develop a learning objective and teaching outline for each module. Include a description of specific skills and knowledge that participants are expected to master. For each module, include instruction for the following:

- 1. Basis of System Design, Operational Requirements, and Criteria:

Include the following:

- a. System, subsystem, and equipment descriptions.
- b. Performance and design criteria if Contractor is delegated design responsibility.
- c. Operating standards.
- d. Regulatory requirements.
- e. Equipment function.
- f. Operating characteristics.
- g. Limiting conditions.
- H, Performance curves.

- 2. Documentation: Review the following items in detail:

- a. Emergency manuals.
- b. Operations manuals.
- c. Maintenance manuals.
- d. Project Record Documents.
- e. Identification systems.
- f. Warranties and bonds.
- g. Maintenance service agreements and similar continuing commitments.

- 3. Emergencies: Include the following, as applicable:

- a. Instructions on meaning of warnings, trouble indications, and error messages.
- b. Instructions on stopping.
- c. Shutdown instructions for each type of emergency.
- d. Operating instructions for conditions outside of normal operating limits.
- e. Sequences for electric or electronic systems.
- f. Special operating instructions and procedures.

- 4. Operations: Include the following, as applicable:

- a. Startup procedures.
 - b. Equipment or system break-in procedures.
 - c. Routine and normal operating instructions.
 - d. Regulation and control procedures.
 - e. Control sequences.
 - f. Safety procedures.
 - g. Instructions on stopping.
 - h. Normal shutdown instructions.
 - i. Operating procedures for emergencies.
 - j. Operating procedures for system, subsystem, or equipment failure.
 - k. Seasonal and weekend operating instructions.
 - l. Required sequences for electric or electronic systems.
 - m. Special operating instructions and procedures.
5. Adjustments: Include the following:
- a. Alignments.
 - b. Checking adjustments.
 - c. Noise and vibration adjustments.
 - d. Economy and efficiency adjustments.
6. Troubleshooting: Include the following:
- a. Diagnostic instructions.
 - b. Test and inspection procedures.
7. Maintenance: Include the following:
- a. Inspection procedures.
 - b. Types of cleaning agents to be used and methods of cleaning.
 - c. List of cleaning agents and methods of cleaning detrimental to product.
 - d. Procedures for routine cleaning
 - e. Procedures for preventive maintenance.
 - f. Procedures for routine maintenance.
 - g. Instruction on use of special tools.
8. Repairs: Include the following:
- a. Diagnosis instructions.
 - b. Repair instructions.
 - c. Disassembly; component removal, repair, and replacement; and reassembly instructions.
 - d. Instructions for identifying parts and components.
 - e. Review of spare parts needed for operation and maintenance.
- H. Training Execution:

1. Preparation: Assemble educational materials necessary for instruction, including documentation and training module. Assemble training modules into a combined training manual. Set up instructional equipment at instruction location.
 2. Instruction:
 - a. Facilitator: Engage a qualified facilitator to prepare instruction program and training modules, to coordinate instructors, and to coordinate between Contractor and COR for number of participants, instruction times, and location.
 - b. Instructor: Engage qualified instructors to instruct VA's personnel to adjust, operate, and maintain systems, subsystems, and equipment not part of a system.
 - 1) The CxM will furnish an instructor to describe basis of system design, operational requirements, criteria, and regulatory requirements.
 - 2) The Government may furnish an instructor to describe VA's operational philosophy.
 - 3) The COR will furnish the Contractor with names and positions of participants.
 3. Scheduling: Provide instruction at mutually agreed times. For equipment that requires seasonal operation, provide similar instruction at start of each season. Schedule training with the COR, CxA and the CxM with at least seven days' advance notice.
 4. Evaluation: At conclusion of each training module, assess and document each participant's mastery of module by use of an oral, or a written, performance-based test.
 5. Cleanup: Collect used and leftover educational materials and remove from Project site. Remove instructional equipment. Restore systems and equipment to condition existing before initial training use.
- I. Demonstration and Training Recording:
1. General: Engage a qualified commercial photographer to record demonstration and training. Record each training module separately. Include classroom instructions and demonstrations, board diagrams, and other visual aids, but not student practice. At beginning of each training module, record each chart containing learning objective and lesson outline.
 2. Video Format: Provide high quality color DVD color on standard size DVD disks.

3. Recording: Mount camera on tripod before starting recording, unless otherwise necessary to show area of demonstration and training. Display continuous running time.
4. Narration: Describe scenes on videotape by audio narration by microphone while demonstration and training is recorded. Include description of items being viewed. Describe vantage point, indicating location, direction (by compass point), and elevation or story of construction.

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