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Washington, DC 20420
202-461-8009
www.cfm.va.gov

Whole Building Commissioning Process Manual

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Prepared by:
Sebesta Blomberg and Associates, Inc.
Contact: **William S. Bliven, PE**
2231 Crystal Drive, Suite 400
Arlington, VA 22202
Main: **703-522-3800**
Fax: **703-522-8070**
Email: **bbliven@sebesta.com**

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1 Introduction

Guidelines and Policy: Executive Order 13423 - Strengthening Federal Environmental, Energy and Transportation Management (January, 2007) and Executive Order 13514 - Federal Leadership in Environmental, Energy and Economic Performance (October, 2009) along with the Energy Policy Act of 2005 and the Energy Independence and Security Act of 2007, mandate that every federal agency reduce energy consumption in the existing stock of federal buildings under their management. Executive Order 13423 was formalized into policy by a Memorandum of Understanding signed by every federal agency in 2006. In these documents, the Department of Veterans Affairs committed to the following goals:

- Reduce energy consumed in new and renovated federal buildings to 30% below the ASHRAE standard for energy efficient buildings.
- Reduce water consumption in new and renovated buildings by 20% below the baseline water consumption for these facilities.
- To employ sustainable practices as incorporated into the Memorandum of Understanding in all federal projects.

The Memorandum of Understanding further requires that the Veterans Affairs Department employ both integrated design practices and, as an integral part of these practices:

> "Employ total building commissioning practices tailored to the size and complexity of the building and its system components in order to verify performance of building components and systems and help ensure that design requirements are met. This should include a designated commissioning agent, inclusion of commissioning requirements in construction documents, a commissioning plan, verification of the installation and performance of systems to be commissioned, and a commissioning report."[1] (FEDERAL LEADERSHIP IN HIGH PERFORMANCE and SUSTAINABLE BUILDINGS MEMORANDUM OF UNDERSTANDING," 2006)

The commissioning process outlined in this manual should integrate into the Department of Veterans Affairs (VA) well-documented process for the design and construction of new facilities. The tasks and deliverables included in this process either utilize the documentation required by the existing VA process or supplement the requirements of this process to improve accountability and the transfer of information and knowledge to each member of the construction and operations team.

Commissioning and acceptance testing is integral to the design and construction process, not additive. Execution of commissioning tasks should enhance the ability of the design and construction team to meet demanding building performance requirements while maintaining project budget and

schedule. The Commissioning Agent is charged with identifying the 'performance impacts' of all significant design and construction decisions so that the VA can make informed decisions when budget, schedule or convenience impact the outcome of a project.

In accordance with ASHRAE Guideline 0, the anticipated outcomes of the VA Commissioning Process are:

- Document VA Owner's Project Requirements (OPR)
- Document and improve the quality of project deliverables
- Document systems performance in accordance with OPR
- Verify adequate documentation is provided to VA
- Verify and document proper training of VA's personnel
- Provide a uniform delivery process for construction projects
- Deliver completed construction projects that conform to the OPR
- Verify proper coordination among systems, equipment, and assemblies in completed project

1.1 References

a. Executive Order 13514: "Federal Leadership in Environmental, Energy and Economic Performance," October, 2010

b. Executive Order 13423 "Strengthening Federal Environmental Energy and Transportation Management," January, 2007

c. High Performance and Sustainable Buildings Guidance, www.wbdg.org/pdfs/hpsb_guidance.pdf

d. Memorandum of Understanding on Federal Leadership in High Performance www.fedcenter.gov/_kd/Items/actions.cfm?action=Show&item_id...

e. Green Buildings Action Plan, Implementing the Memorandum of Understanding on Federal Leadership in High Performance and Sustainable Buildings, Department of Veterans Affairs, www.cfm.va.gov/TIL/sustain/GreenBuildAction.pdf

   1. ASHRAE Guideline 0-2005 – The Commissioning Process, American Society of Heating, Refrigeration and Air Conditioning, , 2005

   2. ASHRAE Guideline 1.1 – The HVAC&R Technical Requirements for the Commissioning Process, American Society of Heating, Refrigeration and Air Conditioning, , 2008

f. NEBB Procedural Standards for Whole Building Systems Commissioning of New Construction – Third Edition, National Environmental Balancing Bureau, 2009, www.nebb.org

g. VA BIM Guide, Department of Veterans Affairs, http://www.cfm.va.gov/til/bim/BIMGuide/lifecycle.htm

h. VA Sustainable and Energy Reduction Manual, Department of Veterans Affairs, http://www.cfm.va.gov/til/sustain.asp

1.2 Acronyms

Architect Engineer Design Team (A/E)

Association Society for Heating Air Condition and Refrigeration Engineers (ASHRAE)

Commissioning (Cx)

Commissioning Agent (CxA)

Contracting Officer's Technical Representative (COTR)

Green Building Initiative Green Globes (GBI-GG)

Heating, Ventilation, and Air Conditioning (HVAC)

Leadership in Energy and Environmental Design (LEED)

National Environmental Balancing Bureau (NEBB)

Operations & Maintenance (O&M)

Test and Balance (TAB)

VA Medical Center (VAMC)

VA Medical Center Facilities Manager / Facilities Management (VA FM)

VA Office of Construction and Facilities Management (VA CFM)

VA Project Manager and/or Resident Engineer (VA PM/RE)

United States Green Building Council (USGBC)

1.3 Definitions

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

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

AHJ: The local governing **A**uthority **H**aving **J**urisdiction over the installation.

ASHRAE: The American Society of Heating Refrigerating and Air-Conditioning Engineers

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.

BIM: Building Information Modeling utilizes a 3-dimensional computer-aided design and drafting program to model all aspects of a building which allows discovery of space conflicts, scheduling conflicts and improved design due to improved coordination.

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.

Checklists: Lists of data or inspections that should 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.

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 (CA): The NEBB Certified BSC Professional who administers the Cx process by managing the Cx team. Where CA is used in the standard it means the CA, members of his staff or appointed members of the commissioning team.

Commissioning Plan: A document that outlines the 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 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 Team: Individual team members whose coordinated actions are responsible for implementing the Commissioning Process.

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.

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 "Issue".

Design Criteria: A listing of the projects design requirements, including its source. These are used during the design process to show the design element meets 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. The preparation of this document is the responsibility of the Engineer. The narrative should include a description of the systems selected and why they were chosen. It should also include reasons other systems were considered and rejected. Acceptance of the items in the Design Narrative should be the consensus of both the Owner and the Engineer.

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

Design Professional: The architect(s) or engineer(s) of record 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 Performance Test (FPT): Functional performance tests are tests that are intended to prove functionality of the component or system. FPT tests are done after all PFT tests are complete.

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.

Issue: Any condition that adversely affects the commissionability, operability, maintainability or functionality of a system, equipment or component or an issue that does not conform to the project OPR, contract documents or standard industry best practices.

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.

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.

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.

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-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: 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.

Schematic Design (SD): A conceptual image of the projects engineering requirements. Load calculations, preliminary system selection, and flow sheets are developed in this phase of the project. This phase could represent the project at approximately 35% of the design effort.

Site Observation Reports (SO): Reports of site inspections and observations made by the CA. 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.

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 all building systems such as Building Envelope, HVAC, Electrical, Special Electrical (Fire Alarm, Security & Communications), Plumbing and Fire Protection.

2 Commissioning Process Overview

2.1 General

The Implementation Guide for Executive Order 13423 describes Commissioning and the Commissioning Process as:

> Building Commissioning is a systematic approach to improving system performance, operation & maintenance, indoor air quality & thermal comfort, and energy efficiency, as well as benefits like improving occupant comfort, health & welfare, and productivity, in both new and existing buildings. These activities are not, as many owners and managers believe, part of the typical design and construction process or part of standard operation & maintenance service contracts. Commissioning goes beyond testing, adjusting and balancing (TAB) and traditional inspections. Commissioning involves functional testing to determine how well the building systems, like Heating, Ventilating and Air Conditioning (HVAC) and Lighting, work together. Commissioning also seeks to determine whether the installed building equipment (e.g. chillers, boilers, motors, airflow system) meets a facility's goals or whether it needs to be adjusted to improve the efficiency and overall performance, consistent with the original design intent. The long-term life-cycle benefits of commissioning far outweigh the short-term up-front investments, as borne out by many documented case studies, both in the public and private sector building/facility infrastructure. Green building rating systems and certification programs have given a significant boost to the role of Building Commissioning, as part of the Efficient and High Performance Building stock.

Through this executive order and the interagency memorandum of understanding, incorporating commissioning into VA Construction projects is a legal obligation.

2.2 Introduction to Commissioning

Whole Building Commissioning is a Project Management and Technical Execution practice that is being embraced by public and private organizations because of its benefits in improved project delivery results. It is a *multi-disciplined, collaborative* effort involving owners, design professionals, construction managers, and commissioning agents to achieve optimal results from the commissioning process.

Commissioning information, guidance, and resources can be addressed under the following four broad principles:

- Establish Measureable Project Performance Requirements,
- Plan and Execute the Commissioning Process,

- Verify and Document Compliance with Requirements, and
- Effectively Transfer Knowledge to the Building Operations Team.

It is important to note that all four principles are applied over the life of a capital design and construction project.

2.3 Commissioning Goals

Whole Building Commissioning is a collaborative process for planning, delivering, and operating buildings to work as the VA and Designer intended. Commissioning begins with project planning and includes design, construction, start-up, acceptance and training and warranty phase services. The goals of the commissioning process are to:

a. Define, document, and maintain a clearly stated set of measureable integrated system performance requirements throughout the design and construction of the project;

b. Verify and document compliance with these requirements at each completion milestone in;

c. Establish a clear set of tasks, deliverables, and schedule milestones for every member of the commissioning team to drive building delivery to a successful conclusion;

d. Demonstrate and document effective integrated buildings performance through a rigorous process of system testing;

e. Verify that operation and maintenance personnel and occupants are properly trained; and

f. Provide documentation, training tools, and building performance metrics that will allow the VA to sustain High Performance Building systems over the life of the building.

2.4 Commissioning Principles

Regardless of the extent to which the commissioning process is applied to a project, there are four overarching principles in the Commissioning Process that begin at project inception and continue through Occupancy and Operations.

a. Establish Measureable Project Performance Requirements,

As projects progress through successive Design Stages, design teams establish Owner's Project Requirements, project work scopes and design solutions that meet the needs of the operation that will be housed in the new facility. It is the task of the commissioning process to establish *measureable dynamic system performance requirements* that can be definitively measured

through field testing methodologies. These criteria, properly documented and measured, ultimately form the basis for project final acceptance.

Since building performance decisions are successively refined over the course a of project's life cycle, it is imperative that these 'measureable requirements' be refined and documented at the same time. During the pre-design and design phases of a project, the critical objectives of the commissioning process include:

- Develop Owner's Project Requirements (OPR)
    - Define Dynamic Performance Requirements of the Project, including:
        - Environmental Control Criteria
        - Response to Threats, Risks, and Failures
        - Static and Dynamic Performance Requirements
- Review Design Documents for Compliance with the OPR
    - Design Narrative (Basis of Design) Document
    - Plans & Specifications
- Document Design Development Decisions
    - Deviations for OPR or Design Narrative
    - Value Engineering Decisions & Consequences
- Document the Process
    - Develop & Maintain a Project Commissioning Plan
    - Develop a Commissioning Specification

b. Plan and Execute the Commissioning Process

Since Commissioning is a collaborative process involving multiple parties with potentially conflicting interests, it is critical that the process be well planned, documented and communicated to all project team members. Planning is accomplished through development and maintenance of the project Commissioning Plan. Planning must include

- Clear Roles and Responsibilities for all Team Members
- Well Defined Commissioning Work Scope and Deliverables
- Project Commissioning Schedules
- Effective Inspection and Testing Plans
    - Pre-Functional and Functional Test Plans
    - Integrated System Test Plans
    - Special testing needs for unique or innovative assemblies

        - Clear definition of team member testing responsibilities
    - Clear Commissioning Specifications consistent with the Project Commissioning Plan
    - Clear Definitions of Training Requirements to Support Long Term Sustainability

c. Verify and Document Compliance with Requirements

Commissioning serves as the historical record of both the VA's expectations for project performance and the performance achieved in the construction process. Commissioning documentation should provide a record of standards of performance for building systems and that performance achieved in the delivered facility. Commissioning documentation should include

- A clear history of Project Development, Execution and Turnover
- A definitive record of all inspections, tests, performance issues and deficiencies and issue resolutions
- A clear methodology to evaluate building performance against that standard achieved a final acceptance of the Project (Re-Commissioning Plan)

d. Effectively Transfer Knowledge to the Building Operations Team

In order for the commissioning process to deliver sustainable results, the operations team responsible for the facility after final acceptance must be adequately prepared to assume responsibility for the installed equipment and systems at Final Acceptance of the project. It is a primary responsibility of the Commissioning Team to manage the training process to effectively prepare this team to understand and properly operate the high performance systems that will be required to sustain the VA mission. To this end, the Commissioning team should

- Engage the Operations Team in the Commissioning Process as early as possible,
- Organize and prepare all Contractors and Vendors to deliver coherent training to the Operations Team,
- Provide Systems Training and Key Performance Criteria to guide operators in monitoring and evaluating their operating systems,
- Provide Training, O&M, Performance and Re-Commissioning Documentation that will allow a facility to maintain a knowledgeable and effective operations team for the life of the facility.

2.5 Contractual Relationships

For any construction project, the Department of Veterans Affairs establishes A/E Design contracts for Design Phase and Construction Period Services. The Department also establishes a construction contract with a Prime Contractor to provide construction services. Both contracts are administered by a VA Contracting Officer and his/her designated representative. During the Design Phase, this representative is the Project Manager; during the construction phase, it is the Resident Engineer. On every project, the authority to modify any contract is strictly limited to the Contracting Officer and his/her designated representative.

In this structure, all communications on contractual issues are strictly limited to communications between the VA and these two prime contractors (A/E Team and Prime Contractor). It is the practice of the VA to require that communication between other parties to the contracts (A/E Subconsultants, Subcontractors and Vendors) be routed through these two prime contractors and the VA.

Whole Building Commissioning is a process that relies upon high levels of communications and collaboration between all parties to the construction process. By its nature, the levels of communication and cooperation between the Commissioning Agent and all other parties to the construction process (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc) is essential to the success of the Commissioning effort. In the absence of these relationships, cooperation and support created by this communication, the Commissioning Process will likely fail to achieve its ends.

With this fundamental conflict in mind, this manual has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Agent 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 his/her Designated Representative. Thus, all procedures outlined in this manual must be executed within the following limitations:

a. The Commissioning Agent may maintain a continuous open communication with the A/E team, including Subconsultants, the Contractor and Subcontractors and the VA's team to facilitate a collaborative commissioning process subject to the specific limitations outlined below.

b. All communications shall be copied to the VA Project Manager (Design Phase) and Resident Engineer (Construction Phase).

c. All Communications shall include specific reference to these contract limitations (e.g., *"All issues identified in this Commissioning Issues Log are subject to 'Specification Section 01 91 00: Paragraph 1.2: Contractual Relationships.'"*

d. All information from the Commissioning Agent to any party to the project must be transmitted with the following clear limitations:

- No communications (verbal or written) will be deemed to constitute direction that modifies the terms of any contract between the Department of Veterans Affairs and any party to the construction project.
- Commissioning Issues communicated in writing to the Contractor or A/E Team and copied to the PM/RE are provided to all parties to the contract to expedite communication. All issues must be understood as the professional opinion of the Commissioning Agent and suggestions for issue resolution only until expressly approved as direction by the Project Manager or Resident Engineer.
- In the event that any Commissioning Issues and suggested resolutions are deemed to require either an official interpretation of the construction documents or are determined to require a modification of the contract documents, Contracting Officer or designated Contracting Officer's Technical Representative (COTR) will issue an official directive to this effect.
- All parties to the Commissioning Process shall be individually responsible for alerting the COTR of any issues that they deem to constitute a potential contract change prior to acting on these issues.
- Authority for design and construction issues resolution rests solely with the Contracting Officer and his/her designated representative with appropriate technical guidance from the A/E Team and/or Commissioning Agent.

3 Applying the Commissioning Process

3.1 Projects to be Commissioned

The Commissioning Process provides universal benefits to any construction project undertaken by the Department of Veterans Affairs. While the formal process described in this manual will be mandated for many VA projects, the process should be applied by VA Construction teams in some form for all projects to insure that the desired values from any construction projects are, in fact, delivered.

The VA Office of Construction and Facilities Management has determined that in order to effectively implement the Memorandum of Understanding, all projects in excess of $5M, including new construction and major renovations, will be commissioned. For smaller projects, the decision to commission projects should be determined on a case-by-case basis based on consultation between VA CFM and the local VAMC. The driving principles for commissioning outlined in this manual should be universally applied to all projects.

3.2 Systems to be Commissioned

While buildings are comprised of static systems (e.g., building envelope, building structure) and dynamic systems (e.g., HVAC, emergency power, elevators), the commissioning process is intended to address the 'integrated dynamic performance of the 'building system.' Therefore, when considering which building systems to commission, the primary considerations are driven by the impacts of any given system on the overall performance of the building as a whole. So, for example, the building envelope, while a static system, will have a substantial impact on the performance of the building environmental controls, particularly if the air or vapor barriers installed are deficient. The list of commissioned systems included below is intended to identify all systems that can have a significant impact on the ability of the integrated building system to achieve the comfort, reliability and energy performance goals established by the OPR in the commissioning process.

The intent of the VA Standard for Whole Building Commissioning is to subject all building systems to the commissioning process. On a case by case basis, the VA recognizes that the nature of the project and its attendant budget may require that systems be selectively commissioned to maximize the value delivered by the process. With this in mind, the following criteria should be applied to evaluating each installed system (listed below) for inclusion in the commissioning process.

a. Systems with the most significant impacts on either the environmental performance or reliability of the installed 'building system' should have highest priority in the commissioning process.

   [For example, the building HVAC systems, central heating/cooling plant systems, Building Management Systems, Emergency Power Systems, Nurse Call Systems, and Security Systems]

b. Systems that have traditionally caused performance or maintenance problems on a site should have a high priority in the process.

   [For example, the Building Envelope Systems, Normal Power Distribution Systems]

c. Systems that have a significant dynamic performance component but may have a moderate impact on the net environmental building system performance should have a priority in the process.

   [For example, the building elevators, domestic water distribution]

The specific list of 'Systems to be Commissioned' included on any given project must be driven by the nature of the project, the installed systems and the opportunity to impact the quality of the installed system during the construction of the project.

[For example, in a renovation project, while all HVAC systems should be commissioned regardless of the construction impact on existing systems, commissioning of the building envelope would not be appropriate unless significant modifications of the envelope were included in the project and the work defined for the project allowed for correction of deficiencies that would materially improve the energy or comfort performance of the renovated area.]

It is important to note that the list of 'Systems to be Commissioned' will change over the course of the project's design phases. The list should be developed early and be kept updated throughout the Design Phase.

Finally, it is important to engage the facilities operating staff, if available, to consult on any list of commissioned systems. While the judgments of the operating team may not be final, their input will add significant value to the effort to collaborate in the commissioning process.

The following table provides a list of typical systems used in VA facilities that should be commissioned in a Whole Building Commissioning Process. The list is intended for guidance only and is not considered comprehensive. Definition of the specific list of systems to be commissioned is the responsibility of the VA project team in consultation with the operator of the facility, the designers and the commissioning agent.

Systems To Be Commissioned	
System	**Description**
Building Exterior Closure	
Exterior Walls	Air and Vapor Infiltration, Water Leakage, Thermal Value
Roofing	Air and Vapor Infiltration, Water Leakage, Thermal Value, Positive Drainage of Storm Water
Windows, Doors, Louvers and Other Penetrations	Air and Vapor Infiltration, Water Leakage, Thermal Value
Specialties	
Patient Bed Service Walls	Medical gas certification and cross check, electrical connections
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]
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

Systems To Be Commissioned	
System	**Description**
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
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.
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

Systems To Be Commissioned	
System	**Description**
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
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	
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	
Grounding & Bonding System	Witness 3rd party testing, review reports
Structured Cabling System	Witness 3rd party testing, review reports

Systems To Be Commissioned	
System	**Description**
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.
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
Renewable Energy Systems	Photovoltaic Electrical Systems, Wind Turbines
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

d. Commissioning Specification Requirements

In order for the Commissioning Process to be successfully integrated into the construction of VA projects, the obligations of all parties to the construction project must be clearly delineated in the Project Specifications. While the Commissioning Plan is intended to include task and responsibilities for Commissioning from Design thru Warranty Phases, the construction specifications establish the legal and binding obligations of the construction team members for participation in the process.

Commissioning Specifications are specifically designed to address the obligations of parties to the commissioning process in regard to the services, technical personnel and documentation required to satisfy the need

- to successfully demonstrate integrated system performance,
- to document the performance in a manner that enhances long term sustainable operation of the systems, and
- to effectively train the facility operating teams to maintain high performance operation of the installed building systems.

As part of the development of these specifications, it is the obligation of the Commissioning specification writer to verify the training requirements specified in other specifications sections are consistent with training obligations and scheduling requirements in the Commissioning Specification and Commissioning Plan. Coordination of the commissioning specifications with other pertinent sections of the specification is essential to avoiding conflicts and misunderstandings in the construction phase of a project.

It is essential to the success of the process that Commissioning responsibilities be referenced in each applicable section of the specifications along with references to the Commissioning Specification Section.

As a minimum, the following specification sections should be included in each Project Specification Manual to the extent the systems referenced in these sections are included in the commissioning process. It is the responsibility of the A/E Team and the Commissioning Agent to review all specification sections and include language in every appropriate section based on the scope of Commissioning activities on the project.

General Requirements (Division 1)

Building Exterior Closure (Divisions 7 and 8)

Conveying Equipment (Division 14)

Fire Protection (Division 21)

Plumbing (Division 22)

HVAC (Division 23)

Electrical (Division 26)

Communications (Division 27)

Electronic Safety and Security (Division 28)

Site Utilities (Division 31)

4 Pre-Design Commissioning

4.1 Commissioning Agent Contracting Methods

Commissioning Services are most appropriately contracted as a Professional Service to the Department of Veterans Affairs. With responsibility spanning from the Pre-Design Phase through the Warranty Phase, the Commissioning Agent will be charged with representing critical VA interests in the design, installation, and operation of VA facilities. The responsibilities associated with Whole Building Commissioning best match the responsibilities of Professional Service Providers to the VA rather than construction providers.

It is the intent of the Department of Veterans Affairs to acquire Commissioning Services at the Pre-Design Phase of the project. The preferred method of acquiring Commissioning Services is through Indefinite Delivery Indefinite Quantity (IDIQ) contracts with qualified Commissioning Agents. This method of acquisition provides a readily available; qualifications based selection for the Commissioning Agent. It is important that the Commissioning Agent be selected as a Professional service with primary allegiance to the interests of the VA.

For specific, large projects as determined by the VA Contracting Officer, the VA may elect to acquire Commissioning Services through a direct, stand-alone contract between the VA and the Commissioning Agent.

In acquiring the Commissioning Agent, it is the intent of the VA is to award a contract to an experienced and qualified Commissioning Agent. It is the intent of the VA that a single Commissioning Agent will be acquired for the entire project, subject to satisfactory performance.

During the Commissioning Agent acquisition process, the VA will provide experienced Commissioning Agents with the project Feasibility Study or other programming document that describes the project, anticipated design period, and anticipated construction period. The expectation is that prospective Commissioning Agents will submit pricing proposals that separately identify fees for the Design Phase and the Construction Phase. It is understood that the fees for the Design Phase should not require significant adjustment, however it is also understood that the fees for the Construction Phase Commissioning Services may be adjusted as the design progresses. .

Recognizing that the acquisition of IDIQ or Stand-Alone contract relationships with qualified Commissioning Agents may take some time, it may be necessary to utilize other contracting arrangements to secure the services of qualified providers in the interim. The following information provides

guidance regarding the options, risks and benefits of each contracting arrangement.

a. Commissioning services can be procured through GSA Schedule Contracts with qualified Commissioning Agents. This avenue allows the VA to select Commissioning Agents on a qualifications basis and solicit competitive bids or sole source providers depending on the circumstances of each individual project.

b. For Design-Bid-Build projects, the Commissioning Agent can be engaged through the A/E Contract. This arrangement provides the VA Contracting Officer and the VA Project Manager/Resident Engineer with an opportunity to participate the in the selection of the Commissioning Agent and to develop a relationship that encourages direct communication between the Commissioning Agent, the VA and all other members of the commissioning team.

   The most significant risk of this contracting method is that the Commissioning Agent, as a subconsultant to the design team, may be more reluctant to surface design issues than when directly contracted to the VA. The VA Project Manager / Resident Engineer can mitigate this risk by both participating in the A/E team's selection process as an advisor and by requiring the open communication outlined in this manual between all parties. In particular, all communications from the Commissioning Agent must be delivered simultaneously to the A/E team and the VA Project Manager.

   An alternative occasionally employed in other federal agencies is to procure Commissioning Agent services through the Contractor. This method is not recommended because the conflicts of interest created by the relationship between the Commissioning Agent and the Contractor can seriously impact both the rigor of commissioning and the open communication that is critical to the success of the commissioning process.

c. For Design-Build projects, the Commissioning Agent should be contracted directly with the VA. In this procurement environment, the Commissioning Agent can provide technical support and representation of the VA most vital interests when contracted either through an A/E type contract or a GSA Schedule contracting contract.

   In other federal agencies, the commissioning provider is often procured through the Design Build contract with a Construction Manager or General Contractor. Under a contract to the Prime Design Build entity, the Commissioning Agent will be faced with conflicts of interest at every stage of the construction process.

d. For Lease/Developer projects, similar to the Design Build contracts, the Commissioning Agent should contracted as directly with the VA as possible. In this procurement environment, the Commissioning Agent can provide

technical support and representation of the VA most vital interests when contracted either through an A/E type contract or a GSA Schedule contracting contract.

Recognizing that the acquisition of IDIQ contract relationships with qualified Commissioning Agents may take some time, it may be that the Commissioning Agent is not identified until later design phases. In this event, the VA Project Manager and the Commissioning Agent must identify the key deliverables, as described in this Manual, which must be submitted on an expedited basis. These key deliverables include:

a. Commissioning Plan
b. Commissioning Specifications
c. Review of the Owner's Project Requirements and Design Narrative

4.2 Pre- Design Commissioning Kickoff Meeting

Once a Commissioning Agent is contracted for a project, a Pre-Design Commissioning Kickoff Meeting should be held with the selected Commissioning Agent to confirm the work scope. This will allow both the Commissioning Agent and the VA to - better understand the project, project team and develop a Preliminary Commissioning Plan that is responsive to both the project objectives and the particular make up of the project team.

Attendees at the Pre-Design Commissioning Kickoff Meeting should include, but not limited to the following:

a. VA Contracting Officer
b. VA Project Management Team
c. Commissioning Agent
d. Key A/E Design Team representatives

The Pre-Design Commissioning Kickoff Meeting should address the following issues:

a. Project Scope of Work and Critical Objectives
b. Project Schedule and Budget Requirements and Limitations
c. Significant Project Challenges
d. Commissioning Team Members that can be identified at the time of this meeting, including strengths and weaknesses of these participants.
e. Administrative Requirements for Commissioning Contract Management

5 Design Phase Commissioning

5.1 Design Phase Commissioning Objectives

The objectives of the Commissioning Process in the Design Phase of a project are as follows:

a. Establish project 'Acceptance Criteria' for the project and the systems to be incorporated into the project that are clear and measureable. This will provide a clearly defined methodology for establishing 'substantial completion' and 'final acceptance' of the commissioned project based on delivered system performance;

b. Provide the Commissioning Agent with a clear understanding of the designer's response to the Owner's Project Requirements. This understanding allows the Commissioning Agent to act as an advocate for these design requirements and to protect the designer's intent during the construction process; and,

c. Provide technical support for the design team in developing construction documents that meet the requirements of the VA and provide systems that are functional, maintainable and commissionable, and that provide an effective response to the Owner's Project Requirements (OPR).

5.2 Design Phase Commissioning Team

Commissioning, at every stage of a project, is a collaborative effort between all parties to the construction project. The table below identifies the necessary members of the Design Phase Commissioning Team. As part of the Commissioning Plan, the list of responsible parties noted below will be tailored to the project team and populated with names and contact information. It is critical that this information be kept current throughout the project. It is, likewise, important that the history of personnel responsible for commissioning tasks be retained in the project record.

The Commissioning Process includes record keeping methodologies that retain the input from all team members for the duration of the project. By clearly establishing the Commissioning Team and individual responsibilities, the process execution becomes easier, more effective and more accountable.

Commissioning Team Design Phase		
Designation	**Team Member**	**Description**
VA-CFM	VA Construction and Facilities Management	Key Stakeholders from the VA Office of Construction and Facilities Management
VA-CO	VA Contracting Officer	Contracting Officer Responsible for the Contract between the VA and the Commissioning Agent (or the VA and the prime consultant holding the Commissioning Agent contract). Contracting Officer Responsible for the Contract between the VA and the A/E Team, if different from above.
VA-PM	Department of Veterans Affairs Project Manager	Technical Representative of the VA Contracting Officer responsible for project delivery
VAMC-FM	VAMC Facilities Management and/or using agency	Representatives of the local VA Medical Center responsible for Facilities Operation & Maintenance, Construction Coordination and/or other VAMC departments.
A/E	Architect/Engineer Design Team	Representatives of the Architect and Engineering Design Team responsible for Design Phase Services
CxA	Commissioning Agent	Representatives of the independent 3rd Party Commissioning Contractor
IDIQ-A/E	Peer Review A/E	Representatives of the A/E firm(s) selected to perform Peer Reviews during the Design Phase

5.3 Commissioning Roles and Responsibilities

The objective of the Design Phase Commissioning process is to facilitate a collaborative effort to deliver construction documents

- that are clear and constructible;
- that are free of confusion or conflicts that might result in project changes in cost or schedule; and,
- that clearly identify performance objectives that must be met to consider the project acceptable for final acceptance at the schedule conclusion of the project schedule.

To this end, the Commissioning Agent is tasked with the responsibility to support the Designers of Record (Architect and Engineers) with focused design reviews and supportive recommendations regarding construction document clarity, system and component accessibility and maintainability, training requirements and commissionability of the installed systems. The Commissioning Agent and the commissioning team members are expected to offer their experience and expertise in systems operations, testing and operator training to support the Designers of Record in meeting the team's quality objectives for the project design documents.

It is important to note that the Design Phase Commissioning activities are not intended to compromise the authority of the Designers of Record. Design Phase Commissioning reviews do not meet the standard of Peer Reviews and do not replace the Peer Review process in place for VA projects. The obligation of the Commissioning Agent is to offer the full benefit of his/her experience in constructing, starting up and operating buildings and building systems. It is the obligation of the Designers of Record to provide sufficient and clear responses to the issues raised by the Commissioning Agent so that he/she can facilitate a process that achieves the performance objectives expressed by the collective project documents.

The following tables describe both the task associated with executing the Design Phase commissioning process and the responsibilities of each commissioning team member in execution of each task. It is imperative that the Team Members are identified, and that the roles and responsibilities are clearly identified and tailored to each specific project, as well as to the systems to be commissioned.

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Pre-Design Commissioning Kickoff Meeting	Conduct Pre-Design Commissioning Kickoff Meeting with the VA and the Design Team. Establish the purpose and proposed process for commissioning the project. Establish the individual roles of each participating commissioning team member.	Draft Commissioning Plan Meeting Minutes
SD1 PHASE		
Design Submission Review	Complete a thorough review of the SD1 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the Owner's Project Requirements (OPR). Documents provided to the Commissioning Agent should include, SD1 Design Narrative and other submittal documents required by PG 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Review and Reconcile the Project Design Narrative. Narrative should incorporate OPR requirements from VA Standards and other Project Contracts. Design Narrative should describe designer's response to the project requirements. Design Narrative can include both the Owner's Project Requirements (OPR) and the Basis of Design (BOD) information. Likewise separate documents can be developed and retained in the project record.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Commissioning Plan	Develop the Project Commissioning Plan that outlines process requirements, deliverables, roles, responsibilities, schedule and milestones. Provide a copy of the Commissioning Plan to the A/E. The A/E will incorporate the Commissioning Plan into the Design Narrative as described in PG 18-15	Project Commissioning Plan

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Design Review Meeting	Attend and participate in SD1 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log. (Note that resolution of some issues may be deferred to later design stages.)
SD2 PHASE		
Design Submission Review	Complete a thorough review of the SD2 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. Documents provided to the Commissioning Agent should include, SD2 Design Narrative, calculations, room locations and preliminary layouts and other submittal documents required by PGA 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Review the updated Project Design Narrative. The Design Narrative should incorporate OPR requirements from VA Standards and other Project Contracts. Design Narrative should describe designer's response to the project requirements.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Commissioning Plan	Update the Project Commissioning Plan. Provide a copy of the Commissioning Plan to the A/E. The A/E will incorporate the Commissioning Plan into the Design Narrative as described in PG 18-15	Updated Project Commissioning Plan

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Commissioning Specifications	Provide Outline Commissioning Specifications Sections utilizing the VA Master Construction Specification. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Outline Commissioning Specifications Specification Coordination Matrix for Commissioning Agent/A/E coordination.
Design Review Meeting	Attend and participate in SD2 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log Note that resolution of some issues may be deferred to later design stages.
Design Phase Issue Log Resolution	Update the Commissioning Issues Log by recording resolutions to identified Commissioning Issues.	Revised Design Phase Commissioning Issue Log
DD1 PHASE		
Design Submission Review	Complete a thorough review of the DD1 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. Documents provided to the Commissioning Agent should include: DD1 Updated Design Narrative, calculations, equipment schedules, system and control schematic diagrams and appropriate schematics and other submittal documents required by PG 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Review the updated Project Design Narrative. The Design Narrative should be updated to reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Commissioning Plan	Update the Project Commissioning Plan, including any revisions to Commissioning Team Members, Schedules and other modifications required by the progress of the project. Include a Draft Construction Phase Commissioning Plan, including systems to be commissioned, an outline of construction phase roles and responsibilities, and an outline of required system documentation requirements. Provide a copy of the Commissioning Plan to the A/E. The A/E will incorporate the Commissioning Plan into the Design Narrative as described in PG 18-15	Updated Project Commissioning Plan
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Commissioning Specifications	Provide Draft Commissioning Specifications Sections utilizing the VA Master Construction Specification. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Draft Commissioning Specifications Specification Coordination Matrix for Commissioning Agent/A/E coordination.
Design Review Meeting	Attend and participate in DD1 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log. (Note that resolution of some issues may be deferred to later design stages.)
Design Phase Issue Log Resolution	Update the Commissioning Issues Log by recording resolutions to identified Commissioning Issues.	Revised Design Phase Commissioning Issue Log

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
DD2 PHASE		
Design Submission Review	Complete a thorough review of the DD2 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. Documents provided to the Commissioning Agent should include: DD2 Updated Design Narrative, calculations, equipment schedules, system and control schematic diagrams, floor plans and appropriate schematics and other submittal documents required by PG 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Commissioning Agent to update, review and reconcile the Project Design Narrative. The Design Narrative should reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Commissioning Plan	Update the Project Commissioning Plan, including any revisions to Commissioning Team Members, Schedules and other modifications required by the progress of the project. Update the Construction Phase elements of the Commissioning Plan, including systems to be commissioned, an outline of construction phase roles and responsibilities, and an outline of required system documentation requirements. Include the updated Commissioning Plan in the revised Design Narrative	Updated Project Commissioning Plan
Commissioning Specifications	Provide Preliminary Commissioning Specifications Sections utilizing the VA Master Construction Specification. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Preliminary Commissioning Specifications Specification Coordination Matrix for Commissioning Agent/A/E coordination.

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Design Review Meeting	Attend and participate in DD2 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log. (Note that resolution of some issues may be deferred to later design stages.)
Design Phase Issue Log Resolution	Update the Commissioning Issues Log by recording resolutions to identified Commissioning Issues.	Revised Design Phase Commissioning Issue Log
CD1 PHASE		
Design Submission Review	Complete a thorough review of the CD1 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. Documents provided to the Commissioning Agent should include: calculations, equipment schedules, system and control schematic diagrams, floor plans and appropriate schematics and other submittal documents required by PG 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Commissioning Agent to update, review and reconcile the Project Design Narrative. The Design Narrative should be updated to reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements.	Revised Design Narrative

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Commissioning Plan	Update the Project Commissioning Plan, including any revisions to Commissioning Team Members, Schedules and other modifications required by the progress of the project. Update the Construction Phase Commissioning Plan, including systems to be commissioned, an outline of construction phase roles and responsibilities, and an outline of required system documentation requirements. Include the updated Commissioning Plan in the revised Design Narrative	Updated Project Commissioning Plan
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Commissioning Specifications	Provide Final Commissioning Specifications Sections utilizing the VA Master Construction Specification. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Final Project Commissioning Specifications Specification Coordination Matrix for Commissioning Agent/A/E coordination.
Design Review Meeting	Attend and participate in CD1 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log. (Note that resolution of some issues may be deferred to later design stages.)
Design Phase Issue Log Resolution	Update the Commissioning Issues Log by recording resolutions to identified Commissioning Issues.	Revised Design Phase Commissioning Issue Log
FINAL DESIGN DOCUMENTS		
Design Final Design Submission Review	Review Final Design Submission for resolution of Outstanding Commissioning Issues	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Design Narrative	Commissioning Agent to provide a Final Design Narrative to Include all modifications and/or deviations from CD1 Design Narrative. The Design Narrative should be updated to reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements. Where appropriate, provide documentation of approved deviations from design standards and reasoning for same.	Revised Design Narrative
Commissioning Plan	Update & Submit Project Commissioning Plan Include the updated Commissioning Plan in the revised Design Narrative	Project Commissioning Plan
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Commissioning Specification	Provide updated Final Cx Specifications. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Updated Project Commissioning Specifications
Design Phase Issue Log Resolution	Record resolutions to Cx Issues on the Design Phase Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Commissioning Kick Off Meeting	Facilitate the Kick Off Meeting Provide VA Schedule Requirements and Milestones Review Meeting Minutes & Comment	Identify Cx Team Members Review Meeting Minutes & Comment	Identify Cx Team Members Review Meeting Minutes & Comment	Identify Cx Team Members Discuss Design Schedule and Critical Milestones Review Meeting Minutes & Comment	Prepare and disseminate Agenda Lead Kick Off Meeting Produce Meeting Minutes and Incorporate Comments Prepare Draft Commissioning Plan
SD1 PHASE					
Design Submission Review	Facilitate delivery of Design Submission Documents to Commissioning Agent Review Commissioning Agent Issues Log & Provide Feedback as appropriate Facilitate Resolution of Comments by A/E Team	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Deliver Documents to Commissioning Agent for review. Review Commissioning Agent Issues Log Provide Written Responses to Issues	Review and comment on SD1 Design Review Log. Provide clarifications as required. Record resolution for each issues based on A/E Response

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Design Narrative	Review Design Narrative & Comment	Review Design Narrative & Comment	Review Design Narrative & Comment	Develop Design Narrative to Include OPR and Basis of Design response to OPR.	Review Design Narrative for compliance with VA Standards and other stated VA Objectives for project. Provide support for developing measurable performance criteria for installed systems.
Commissioning Plan	Distribute Design Phase Cx Plan Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Develop & Submit Project Commissioning Plan
Design Review Meeting	Facilitate Design Review Meeting. Facilitate Resolution of Cx Issues	Attend Design Review Meeting as req'd by other VA requirements.	Attend Design Review Meeting	Attend Design Review Meeting. Provide responses to and clarifications of identified Commissioning Issues.	Attend Design Review Meeting. Provide clarification and facilitate resolution to Commissioning Issues Identified

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
SD2 PHASE					
Design Submission Review	Facilitate delivery of Design Submission Documents to Commissioning Agent Review Commissioning Agent Issues Log & Provide Feedback as appropriate Facilitate Resolution of Comments by A/E Team	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Deliver Documents to Commissioning Agent for review. Review Commissioning Agent Issues Log Provide Written Responses to Issues	Review and comment on SD2 Design Review Log. Provide clarifications as required. Record resolution for each issues based on A/E Response
Design Narrative	Review Design Narrative & Comment	Review Design Narrative & Provide Feedback as appropriate	Review Design Narrative & Provide Feedback as appropriate	Update Design Narrative to Include OPR and Basis of Design response to OPR.	Review Design Narrative for compliance with VA Standards and other stated VA Objectives for project. Provide support for developing measurable performance criteria for installed systems.
Commissioning Plan	Distribute Updated Design Phase Cx Plan Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Update & Submit Project Commissioning Plan

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Design Review Meeting	Facilitate Design Review Meeting. Facilitate Resolution of Cx Issues.	Attend Design Review Meeting as required by other VA requirements. Participate in Issue Resolution as appropriate.	Attend Design Review Meeting as required by other VA requirements. Participate in Issue Resolution as appropriate.	Attend Design Review Meeting. Provide responses to and clarifications of identified Commissioning Issues.	Attend Design Review Meeting. Provide clarification and facilitate resolution to Commissioning Issues Identified
Design Phase Issue Log Resolution	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Record resolutions to Cx Issues on the Design Phase Commissioning Issues Log.
DD1 PHASE					
Design Submission Review	Facilitate delivery of Design Submission Documents to Commissioning Agent Review Commissioning Agent Issues Log & Provide Feedback as appropriate Facilitate Resolution of Comments by A/E Team	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Deliver Documents to Commissioning Agent for review. Review Commissioning Agent Issues Log Provide Written Responses to Issues	Review and comment on DD1 Design Review Log. Provide clarifications as required. Record resolution for each issues based on A/E Response

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Design Narrative	Review Design Narrative & Comment	Review Design Narrative & Provide Feedback as appropriate	Review Design Narrative & Provide Feedback as appropriate	Update Design Narrative to Include OPR and Basis of Design response to OPR.	Review Design Narrative for compliance with VA Standards and other stated VA Objectives for project. Provide support for developing measurable performance criteria for installed systems.
Commissioning Plan	Distribute Updated Design Phase Cx Plan Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Update & Project Commissioning Plan
Commissioning Specification	Review Cx Draft Specs & Comment	Review Cx Draft Specs & Comment	Review Cx Draft Specs & Comment	Incorporate Draft Cx Specifications into Project Specification Submittal. Review Cx Draft Specs & Comment	Develop Draft Cx Specifications & Cx Coordination Matrix. Deliver to A/E Team for incorporation into Specification Submittal.
Design Review Meeting	Facilitate Design Review Meeting. Facilitate Resolution of Cx Issues.	Attend Design Review Meeting as required by other VA requirements. Participate in Issue Resolution as appropriate.	Attend Design Review Meeting as required by other VA requirements. Participate in Issue Resolution as appropriate.	Attend Design Review Meeting. Provide responses to and clarifications of identified Commissioning Issues.	Attend Design Review Meeting. Provide clarification and facilitate resolution to Commissioning Issues Identified

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Design Phase Issue Log Resolution	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Record resolutions to Cx Issues on the Design Phase Commissioning Issues Log.
DD2 PHASE					
Design Submission Review	Facilitate delivery of Design Submission Documents to Commissioning Agent Review Commissioning Agent Issues Log & Provide Feedback as appropriate Facilitate Resolution of Comments by A/E Team	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Deliver Documents to Commissioning Agent for review. Review Commissioning Agent Issues Log Provide Written Responses to Issues	Review and comment on DD2 Design Review Log. Provide clarifications as required. Record resolution for each issues based on A/E Response

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Design Narrative	Review Design Narrative & Comment	Review Design Narrative & Provide Feedback as appropriate	Review Design Narrative & Provide Feedback as appropriate	Review Updated Design Narrative to Include OPR and Basis of Design response to OPR.	Commissioning Agent to update, review and reconcile the Project Design Narrative. The Design Narrative should reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements. Where appropriate, provide documentation of approval of deviations from VA Design Criteria and reasoning for same. Provide support for developing measurable performance criteria for installed systems.
Commissioning Plan	Distribute Updated Design Phase Cx Plan Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Update & Submit Project Commissioning Plan

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Commissioning Specification	Review Cx Preliminary Specs & Comment	Review Cx Draft Preliminary & Comment	Review Cx Draft Preliminary & Comment	Incorporate Preliminary Cx Specifications into Project Specification Submittal. Review Cx Draft Specs & Comment	Develop Preliminary Cx Specifications & Cx Coordination Matrix. Deliver to A/E Team for incorporation into Specification Submittal.
Design Review Meeting	Facilitate Design Review Meeting. Facilitate Resolution of Cx Issues.	Attend Design Review Meeting as required by other VA requirements. Participate in Issue Resolution as appropriate.	Attend Design Review Meeting as required by other VA requirements. Participate in Issue Resolution as appropriate.	Attend Design Review Meeting. Provide responses to and clarifications of identified Commissioning Issues.	Attend Design Review Meeting. Provide clarification and facilitate resolution to Commissioning Issues Identified
Design Phase Issue Log Resolution	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Record resolutions to Cx Issues on the Design Phase Commissioning Issues Log.

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
CD1 PHASE					
Design Submission Review	Facilitate delivery of Design Submission Documents to Commissioning Agent Review Commissioning Agent Issues Log & Provide Feedback as appropriate Facilitate Resolution of Comments by A/E Team	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Review Commissioning Agent Issues Log & Provide Feedback as appropriate	Deliver Documents to Commissioning Agent for review. Review Commissioning Agent Issues Log Provide Written Responses to Issues	Review and comment on CD1 Design Review Log. Provide clarifications as required. Record resolution for each issues based on A/E Response

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Design Narrative	Review Design Narrative & Comment	Review Design Narrative & Provide Feedback as appropriate	Review Design Narrative & Provide Feedback as appropriate	Review Design Narrative for conformance with current project status. Verify recorded decisions are consistent with Design Team intent and contracts with the VA.	Commissioning Agent to update, review and reconcile the Project Design Narrative. The Design Narrative should reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements. Where appropriate, provide documentation of approval of deviations from VA Design Criteria and reasoning for same.
Commissioning Plan	Distribute Updated Design Phase Cx Plan Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Update & Submit Project Commissioning Plan

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Commissioning Elapsed Time Schedule	Distribute Schedule Review & Comment	Review Schedule Comment	Review Schedule Comment	Review Schedule Comment	Provide a Draft Commissioning Elapsed Time Schedule that establishes critical construction and commissioning milestones as a guide for the Contractor in incorporating commissioning into the project schedule.
Commissioning Specification	Review Cx Final Specs & Comment	Review Cx Final Specs & Comment	Review Cx Final Specs & Comment	Incorporate Final Cx Specifications into Project Specification Submittal. Review Cx Final Specs & Comment	Develop Final Cx Specifications & Cx Coordination Matrix. Deliver to A/E Team for incorporation into Specification Submittal.
Design Review Meeting	Facilitate Design Review Meeting. Facilitate Resolution of Cx Issues.	Attend Design Review Meeting as required by other VA requirements. Participate in Issue Resolution as appropriate.	Attend Design Review Meeting as required by other VA requirements. Participate in Issue Resolution as appropriate.	Attend Design Review Meeting. Provide responses to and clarifications of identified Commissioning Issues.	Attend Design Review Meeting. Provide clarification and facilitate resolution to Commissioning Issues Identified
Design Phase Issue Log Resolution	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Review & Comment on Revised Design Phase Commissioning Issues Log	Record resolutions to Cx Issues on the Design Phase Commissioning Issues Log.

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
FINAL DESIGN SUBMISSION					
Design Final Design Submission Review	Facilitate delivery of Design Submission Documents to Commissioning Agent Facilitate Resolution of Comments by A/E Team	None	None	Deliver Documents to Commissioning Agent for review. Review Commissioning Agent Issues Log Provide Written Responses to all Outstanding Issues	Review Final Design Submission for resolution of Outstanding Commissioning Issues

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Design Narrative	Review & Approve Final Design Narrative	None	None	Review Design Narrative for conformance with current project status. Verify recorded decisions are consistent with Design Team intent and contracts with the VA.	Commissioning Agent to provide Final Project Design Narrative. The Design Narrative should reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements. Where appropriate, provide documentation of approval of deviations from VA Design Criteria and reasoning for same.
Commissioning Plan	Distribute Updated Design Phase Cx Plan Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment	Update & Submit Project Commissioning Plan

Commissioning Team Roles and Responsibilities Design Phase					
Project Phase/Cx Task **(ref Table above for description)**	**Commissioning Team Member Responsibilities**				
	VA PM	**VA-CFM**	**VAMC**	**A/E Team**	**Commissioning Agent**
Commissioning Specification	Review Cx Updated Specs & Approve	Review Cx Updated Specs & Comment	Review Cx Updated Specs & Comment	Incorporate Updated Cx Specifications into Project Specification Submittal.	Provide updated Final Cx Specifications & Cx Coordination Matrix. Deliver to A/E Team for incorporation into Specification Submittal.
Design Phase Issue Log Resolution	Review & Comment on Revised Design Phase Commissioning Issues Log	None	N one	None	Record resolutions to Cx Issues on the Design Phase Commissioning Issues Log.

5.4 Design Narrative

The Department of Veterans Affairs Design Guide provides detailed guidance and templates for the various type spaces included in projects. These guides include typical space allocation, space functions, furnishings, equipment, environmental, electrical, telecommunications/data, and security requirements. When combined with specific project programming documents they provide the VA and the A/E with sufficient information to develop the project requirements.

The Department of Veterans Affairs Design Manual provides general guidance on the types and configuration of systems necessary to support the project requirements. The project requirements, along with the guidance provided in the Design Manuals, allows the A/E to develop the project infrastructure system requirements and begin the process of engineering and selecting the appropriate systems needed to support the facility operations. These documents (available in the VA Technical Information Library, http://www.cfm.va.gov/TIL) constitute the fundamental Owner's Project Requirements (OPR as described in ASHRAE Guideline 0.

The A/E design team develops the Design Narrative to document their understanding of the overall Owner's Project Requirements and to describe how their design will satisfy the requirements outlined in the VA Design Guides. The Design Narrative is submitted as a key component of the A/E submission to the VA at the SD1, SD2, and DD1 stages of design.

As the design progresses into the DD2, CD1 and Final Construction Document stages, the A/E is focused on completing the design and is making only a few engineering or architectural changes to the project. However, an updated Design Narrative remains a critical part of the project documentation. It provides information that is useful to the VAMC FM long after the project is complete.

Therefore, the focus of the Design Narrative shifts from one where the A/E design team describes what they intend to design, to a focus of documenting why key design decisions were made and what was designed. In reality, this focus begins to match several of the key elements of the Systems Manual.

In order to preserve this critical design information in a form that will facilitate preparing the Systems Manual, the Commissioning Agent should update the Design Narrative beginning with the DD2 submittal. During the commissioning design review, while evaluating the design documents with the Design Narrative, the Commissioning Agent will update the Design Narrative. This will maintain the accuracy of the Design Narrative while allowing the A/E to concentrate on completing the design documents.

At the completion of the Final Construction Documents, the Design Narrative should include all the design information needed to complete the design-

related sections of the Systems Manual. See the discussion of the Systems Manual in Chapter 8 of this manual for further information.

5.5 Commissioning Plan

The Commissioning Plan is the execution plan for the Commissioning Process. The Commissioning Agent will prepare a Design Phase Commissioning Plan during the SD1 Phase of the project. This plan will be updated throughout the project to reflect both increasing levels of available project detail and the evolution in development of the commissioned systems. Prior to the Final Design submit, the plan will be updated into Construction Phase Commissioning Plan and inserted in the project specifications. The Construction Phase Commissioning Plan will identify members of the Commissioning Team (by discipline) that will represent the Contractor, subcontractors and other team members with construction, acceptance and warranty phase responsibilities. The names and contact information will be added to this plan once the Contractor mobilizes for the work

The Commissioning Plan should include the following components:

a. Commissioning Program Overview
    - Goals and Objectives
    - General project information
    - Systems to be commissioned
b. Commissioning Team
    - Team members,
    - Team member roles, and responsibilities
    - Communication protocol, coordination, meeting, and management
c. Commissioning Process Activities
    - Documenting the VA's project requirements
    - Preparing the Design Narrative
    - Documenting the commissioning design review process
    - Reviewing contractor submittals
    - Developing Pre-Functional Checklists
    - Developing Systems Functional Performance Test procedures
    - Reporting observations and issues, as well as the resolution process
    - Developing the System Manual
    - Verifying the training requirements for operations personnel

- Accepting the building systems
- Reviewing building operations after final acceptance

d. Pre-functional Checklists (PFT), Systems Functional Performance Tests (FPT) and Integrated Systems Tests (IST)

- Provide a list of PFT's, FPT's and Integrated System Testing Documents that will be required to complete the project.
- The list of documents will be updated as the project progresses.

5.6 Commissioning Specifications

Typically, the project specifications are used to inform contractors of their responsibilities in the commissioning process. These specifications should be developed by the Commissioning Agent based on the VA Guide Specifications and the particular requirements of each project and should include the following components:

- Commissioning team involvement
- Commissioning Team roles and responsibilities for VA RE, A/E, Commissioning Agent, and the Contractor
- Submittal review procedures
- Systems Manuals
- Meetings
- Construction verification process
- Startup plan development and implementation
- System Functional Performance Testing and verification
- Acceptance and closeout
- Training
- Warranty review site visit

5.7 Commissioning Design Reviews

The Commissioning Agent should conduct commissioning design reviews at each submission. The review should include review of the Owner's Project Requirements, Design Narrative, design drawings, design specification, and other design submissions (e.g. design calculations) to give the VA PM an independent assessment of the state of the design for the commissioned systems. Typically a design review performed by the Commissioning Agent focuses on the following issues:

Design Area	Review Description
General Review	Identify major concerns that could potentially affect operations, maintenance or testing of the systems.
OPR and Design Narrative	Review to identify major discrepancies between the OPR and Design Narrative documents and the construction documents.
Commissioning Facilitation	Identify to what extent commissioning activities are included in the construction documents including testing, training and O&M documentation requirements.
Energy Efficiency	Review the efficiency of system types and components for HVAC systems, lighting systems and building envelope for the purposes of understanding the objectives of the Design Engineer. The Commissioning Agent shall develop techniques to confirm the energy performance of the installed and commissioned system during the first year of system operation.
Control System & Control Strategies	Review HVAC, lighting, fire control, emergency power, strategies and sequences of operation are sufficient to develop functional test procedures.
Operations And Maintenance (O&M)	Review for effects of specified systems and layout toward facilitating O&M (equipment accessibility, system control, etc.).
Indoor Environmental Quality	Review to verify that systems relating to air quality comfort and air distribution comfort are in accordance with the VA Requirements.
O&M Documentation	Verify adequate building O&M documentation requirements.
Training	Verify adequate operator training requirements.
Commissioning Specifications	Verify that bid documents adequately specify building commissioning, including testing requirements by system type.
VA's Design Guideline Or Standard	Review to identify major discrepancies between VA's design guidelines and the construction documents.
Environmental Sustainability	Review to verify that the building materials, site design and use of water and energy are in accordance with VA objectives.
Fire Protection	Review the fire protection design to facilitate commissioning.
Plumbing	Review the plumbing design to facilitate commissioning.
Mechanical	Review the mechanical design to facilitate commissioning.
Electrical	Review the electrical systems to facilitate commissioning.
Communications	Review the communications design to facilitate commissioning.
Electronic Safety & Security	Review the electronic safety & security design to facilitate commissioning.
Site Utilities	Review the site utilities design to facilitate commissioning.
Equipment	Review the equipment design to facilitate commissioning.

Design Area	Review Description
Conveying Equipment	Review the conveying equipment design to facilitate commissioning.
Building Exterior Closure	Review to identify major discrepancies between VA's design guidelines and the construction documents. Review the systems to facilitate commissioning.
Design Review Comment Back-Check	Verify the all issues identified and discussed in previous design reviews have been adequately addressed.

5.8 Design Review Meetings

Design Review Meetings are an opportunity for the design team to meet and candidly discuss the review comments made by the Peer Reviewer, VACO, VA CFM, VAMC, and the Commissioning Agent. Therefore, as a key member of the project team, the Commissioning Agent should attend and actively participate in these meetings to discuss the commissioning review comments.

The focus is on providing constructive feedback to the design team. It should be a free exchange of issues aimed at improving the design and ensuring the design continues to meet the project requirements, codes and standards, and other guidance. These meetings are discussed in other VA documents and handbooks.

5.9 Design Review Comment Follow-up

The Commissioning Agent should maintain a Commissioning Design Review Comment Log of all comments generated by the Commissioning Agent during the review process. This log is submitted to the VA PM and to the A/E. Additionally, these review comments should be entered into the Dr. Checks system used by the VA and the Peer Reviewers.

The A/E should evaluate the commissioning review comments and provide written responses to the Commissioning Agent. The commissioning design review comments are discussed during the Design Review Meetings. The A/E responses are documented on the Commissioning Design Review Comment Log and/or in the Dr. Checks system.

The comments should also be incorporated into the design drawings and specifications. During subsequent design reviews, the Commissioning Agent will evaluate the A/E response to the comment and verify that the design documents have adequately addressed the review comments.

5.10 SD1 Design Submission

Design review is the responsibility of VA staff, the A/E QC team, the Peer Reviewer (if applicable) and the Commissioning Agent. The SD1 Design Review consists of the following elements:

a. OPR Review and Update:

The Commissioning Agent will review the initial OPR and provide comments and/or recommended updates. The review will focus on any initial deviation requests and/or revised directives from the VACO

b. Design Narrative Review:

The Commissioning Agent will review the Design Narrative prepared by the A/E for compliance with the OPR. The review will also focus on any deviations from the Design Manuals that would require deviation requests be submitted to VACO.

c. SD1 Design Review

Design review is the responsibility of VA staff, the A/E QC team, the Peer Reviewer (if applicable) and the Commissioning Agent. The SD1 Design Review will include the review elements identified above.

d. Commissioning Design Review Comment Log/Dr. Checks:

The Commissioning Agent should enter commissioning review comments on the Commissioning Design Review Comment Log and/or in the Dr. Checks System.

e. SD1 Design Review Meeting

Clearly, the Design Review Meeting's purpose is to review, discuss, and make final decisions on the comments generated from various sources during the SD1 Design Review outlined above. These meetings are well-defined in other VA documents and handbooks. The purpose of these meetings is also well-defined in other documents. The requirement should simply be that the Commissioning Agent participates in both the review process and the review meetings. Attendance at the meeting by a representative of the Commissioning Agent should be mandatory.

f. SD1 Design Review Comment Follow-Up

This is the feedback (or back-check) step in the process to ensure the A/E team has addressed each comment and that the Schematic Design is revised as agreed in the SD1 Design Review Meeting. This is a sort of "Trust But Verify" step. The responsibility for follow-up should be assigned to each team member. VA staff should verify their comments have been addressed and appropriate design changes made; similarly the Peer Reviewer should verify Peer Review comments and the Commissioning Agent should verify Commissioning comments.

5.11 Schematic Design Phase II Submission

The Commissioning Agent will conduct a commissioning design review in parallel to the Peer Review. The Commissioning Design Review process is discussed in above.

In addition to reviewing the design submission, the Commissioning Agent will evaluate previous design review comments to verify they have been adequately addressed in this submission.

a. OPR Review and Update:

   The Commissioning Agent will review the OPR and provide comments and/or recommended updates.

b. Design Narrative Review:

   The Commissioning Agent will review the Design Narrative prepared and updated by the A/E for compliance with the OPR. The review will also focus on any deviations from the Design Manuals that would require further evaluation.

c. SD2 Design Review

   Design review is the responsibility of VA staff, the A/E QC team, the Peer Reviewer (if applicable) and the Commissioning Agent. The SD2 Design Review will include the review elements identified above.

d. Outline Commissioning Specifications

   The Commissioning Outline Specifications should mimic other Divisions and Sections Outline Specifications, all of which will be part of the project Contract Documents. For the Cx Outline Specification, each Section Title should be included with a brief (i.e. one-paragraph) description of what will be included in the Section. The Cx Outline Specification should cover all Divisions and Technical Sections previously agreed to be part of the commissioning process. The requirements should parallel other VA documents that define for the A/E team what is required for the Technical Outline Specifications for the project.

e. Commissioning Design Review Log/Dr. Checks:

   The Commissioning Agent should enter commissioning review comments on the Commissioning Design Review Comment Log and/or in the Dr. Checks System.

f. SD2 Design Review Meeting

   The Commissioning Agent attends this meeting to discuss commissioning review comments with the A/E, VA, and Peer Reviewer.

g. SD2 Design Review Comment Follow-Up

The A/E should provide updated responses to the Commissioning Design Review comments based on the issues discussed during the design review meeting. The Commissioning Agent should review these updated responses to ensure they adequately address the results of the design review meeting.

5.12 Design Development Phase I Submission

The Commissioning Agent will conduct a commissioning design review in parallel to the Peer Review. In addition to reviewing the design submission, the Commissioning Agent will evaluate previous design review comments to verify they have been adequately addressed in this submission.

a. Outline Commissioning Plan

   Since the design is only partially developed at this stage of the project, an Outline Commissioning Plan should be developed in parallel with the design. The Outline Commissioning Plan should list each piece of system to be commissioned during the project. Where more detail is known, the Outline can be filled-in to further describe the commissioning requirements. Where little is known about a piece of equipment or system, only the existence of that item and the fact that it will be commissioned need be included in the Outline.

b. Draft Commissioning Specifications

   The Commissioning Draft Specifications should mimic other Divisions and Sections Preliminary Specifications, all of which will be part of the project Contract Documents. The Commissioning Agent will also prepare a Draft Commissioning Specification Coordination Matrix that provides commissioning language that should be included in the technical specifications prepared by the A/E.

c. OPR Review and Update:

   The Commissioning Agent will review the OPR and provide comments and/or recommended updates.

d. Design Narrative Review:

   The Commissioning Agent will review the Design Narrative prepared and updated by the A/E for compliance with the OPR. The review will also focus on any deviations from the Design Manuals that would require further evaluation.

e. DD1 Design Review

   Design review is the responsibility of VA staff, the A/E QC team, the Peer Reviewer (if applicable) and the Commissioning Agent. The DD1 Design Review will include the review elements identified above.

f. Commissioning Design Review Log/Dr. Checks:

The Commissioning Agent should enter commissioning review comments on the Commissioning Design Review Comment Log and/or in the Dr. Checks System.

g. DD1 Design Review Meeting

The Commissioning Agent attends this meeting to discuss commissioning review comments with the A/E, VA, and Peer Reviewer.

h. DD1 Design Review Comment Follow-Up

The A/E should provide updated responses to the Commissioning Design Review comments based on the issues discussed during the design review meeting. The Commissioning Agent should review these updated responses to ensure they adequately address the results of the design review meeting.

5.13 Design Development Phase II

The Commissioning Agent will conduct a commissioning design review in parallel to the Peer Review. In addition to reviewing the design submission, the Commissioning Agent will evaluate previous design review comments to verify they have been adequately addressed in this submission.

a. Design Development Controls Conference

It is expected that experts from all team members will participate in the conference to make major decisions about control system type, configuration, and capabilities together with key decisions about equipment and systems sequences of operation. The Commissioning Agent should play a major role in this conference since the ultimate decisions made will affect the ability to commission certain systems and their associated components.

b. Preliminary Commissioning Plan

The Preliminary Commissioning Plan is the completed and updated extension of the Outline Commissioning Plan. The Preliminary Commissioning Plan is a detailed document that includes all the required testing, review of balancing, and functional tests that will be required for each component and system. The Preliminary Commissioning Plan will include each piece of system to be commissioned during the project. The Preliminary Commissioning Plan will be adjusted (as hereinafter described) as project design or requirements change from Design Development through Final Design.

c. Preliminary Commissioning Specifications

As with other specifications Divisions and Sections, the Preliminary Commissioning Specifications and Commissioning Specification Coordination Matrix are completed specification Sections outlining all commissioning requirements for the project. Preliminary Specifications are subject to modifications as the project moves from Design Development to Final Design.

d. O & M Data Requirements:

The Commissioning Agent will review all technical Sections of the specifications to ensure appropriate O & M Manual requirements are included in the Technical Specifications. Continued proper operation of components and systems is a key goal of commissioning, since continued proper operation and maintenance help ensure the overall goal of energy efficiency. The Cx Standards document should outline key issues that are the Commissioning Agent's responsibility with regard to O & M Data/Manuals.

e. Training and Demonstration Requirements:

The Commissioning Agent is best positioned to help establish training and demonstration requirements for the VA's personnel. Since the Commissioning Agent oversees all functional tests included in the Commissioning Plan, they should assist the VA in establishing the training and demonstration requirements of the construction contract.

f. DD2 Design Review

Design review is the responsibility of VA staff, the A/E QC team, the Peer Reviewer (if applicable) and the Commissioning Agent. The DD2 Design Review will include the review elements identified above.

g. Design Narrative Update:

The Commissioning Agent will update the Design Narrative to incorporate any design changes that impact commissioned systems. The update will also be updated to incorporate design information that impacts system operations and maintenance that will need to be included in the Systems Manual.

h. Commissioning Design Review Log/Dr. Checks:

The Commissioning Agent should enter commissioning review comments on the Commissioning Design Review Comment Log and/or in the Dr. Checks System.

i. DD2 Design Review Meeting

The Commissioning Agent attends this meeting to discuss commissioning review comments with the A/E, VA, and Peer Reviewer.

j. DD2 Design Review Comment Follow-Up

The A/E should provide updated responses to the Commissioning Design Review comments based on the issues discussed during the design review meeting. The Commissioning Agent should review these updated responses to ensure they adequately address the results of the design review meeting.

5.14 Construction Documents Phase I

This is the final step and the last chance for the Commissioning Agent to provide input and exert influence on the design and to monitor systems design so they will operate effectively to minimize energy consumption. The

Commissioning Agent should have input during all design phases regarding system design and control, operations and maintenance procedures or design solutions that impact operations and maintenance.

The Commissioning Agent will conduct a commissioning design review in parallel to the Peer Review. In addition to reviewing the design submission, the Commissioning Agent will evaluate previous design review comments to verify they have been adequately addressed in this submission.

a. Construction Documents Controls Conference

   As a continuation from the Design Development Phase, the team should continue to meet and discuss the major issues/decisions about control system type, configuration, and capabilities together with key decisions about equipment and systems sequences of operation. The Commissioning Agent should play a major role in these conferences since the ultimate decisions made will affect the ability to commission certain systems and their associated components.

b. Final Commissioning Plan

   As the design reaches the Construction Documents Phase, all the major equipment and system decisions should be finalized, so the Preliminary Commissioning Plan can be revised into the Final Commissioning Plan.

c. Final Commissioning Specifications

   At the Construction Documents Phase, the final specification language can be developed form the Outlines prepared during the Design Development Phase. All Division and Sections should have full language information and text included in this Final version. The Commissioning Agent should also coordinate with the A/E to verify that commissioning language has been included in other technical specification sections as indicated in the Commissioning Specification Coordination Matrix.

d. O & M Data Requirements:

   The Commissioning Agent will again review all technical Sections of the specifications to ensure appropriate O & M Manual requirements are included in the Technical Specifications.

e. Training and Demonstration Requirements:

   The Commissioning Agent will again review the training and demonstration requirements for the VA's personnel to ensure appropriate requirements are included in the Technical Specifications.

f. Design Narrative Update:

   The Commissioning Agent will update the Design Narrative to incorporate any design changes that impact commissioned systems. The update will also be updated to incorporate design information that impacts system operations and maintenance that will need to be included in the Systems Manual.

g. CD1 Design Review

Design review is the responsibility of VA staff, the A/E QC team, the Peer Reviewer (if applicable) and the Commissioning Agent. The CD1 Design Review will include the review elements identified above.

h. Commissioning Design Review Log/Dr. Checks:

The Commissioning Agent should enter commissioning review comments on the Commissioning Design Review Comment Log and/or in the Dr. Checks System.

i. DD2 Design Review Meeting

The Commissioning Agent attends this meeting to discuss commissioning review comments with the A/E, VA, and Peer Reviewer.

j. DD2 Design Review Comment Follow-Up

The A/E should provide updated responses to the Commissioning Design Review comments based on the issues discussed during the design review meeting. The Commissioning Agent should review these updated responses to ensure they adequately address the results of the design review meeting.

5.15 Final Construction Documents

This is the final step in the design process and the Commissioning Design Review focuses on verifying that all previous design review comments have been adequately addressed in the final design documents.

a. Final Commissioning Plan

As the design reaches the Final Construction Documents Phase, all the major equipment and system decisions should be finalized, and any tweaks or minor changes can be inserted into the Final Commissioning Plan.

b. Final Commissioning Specifications Review and Back-Check

By this stage, all Commissioning Specifications should be completed. During the Final Construction Documents Phase, all Divisions and Sections should be reviewed and back-checked to ensure all required full language information and text have been included in the Final version.

c. Final Construction Document Review and Back-check

By this stage, all commissioning comments should be included in the Construction Documents. During the Final Construction Documents Phase, all drawings and related Construction Documents should be reviewed and back-checked to ensure all required Commissioning information has been included in the Final version and that the design conforms to the OPR.

d. Final Construction Document Review Comment Follow-Up

As with other Phases, this is the feedback (or back-check) step in the process to ensure the A/E team has addressed each comment and that the Construction Documents are revised as agreed.

e. Design Narrative Update:

The Commissioning Agent will update the Design Narrative to incorporate any design changes that impact commissioned systems. The update will also be updated to incorporate design information that impacts system operations and maintenance that will need to be included in the Systems Manual.

6 Bid and Pre-Construction Phase

6.1 Roles and Responsibilities of Commissioning Agent

The Commissioning Agent has the responsibility of supporting the A/E Team in confirming that the specification of Construction Phase Commissioning responsibilities for all commissioning team members is clearly defined. This includes providing clarifications that may be required both during the Pre-bid Meeting and during the bidding period.

6.2 Pre-Bid Meetings

The Commissioning Agent shall attend the Pre-Bid Meeting. At the request of the VA Contracting Officer, the VA Project Manager / Resident Engineer and/or the A/E, the Commissioning Agent will provide a brief explanation of the Commissioning Process and answer any questions that may arise during the Pre-Bid Meeting.

As required by the VA PM/RE, the Commissioning Agent shall develop clarification language for Pre-Bid Meeting notes and/or Contract Addendums in response to questions that may arise with regard to the Commissioning Process.

6.3 Bid RFI Review and Response

As required by VA PM/RE in response to written questions or requests for clarification, the Commissioning Agent shall develop clarification language for Contract Addendums with regard to the Commissioning Process.

7 Construction Phase

7.1 Commissioning Team

Construction Phase Commissioning is a collaborative effort between all parties to the construction project. The table below identifies the members of the expanded Commissioning Team during the Construction, Acceptance and Warranty Phases of a project. As part of the Commissioning Plan, the list of responsible parties noted below will be tailored to the project team and populated with names and contact information. It is critical that this information be kept current throughout the project. It is, likewise, important that the history of personnel responsible for commissioning tasks be retained in the project record.

The Commissioning Process includes record keeping methodologies that retain the input from all team members for the duration of the project. By clearly establishing the Commissioning Team and individual responsibilities, the process execution becomes easier, more effective and more accountable.

The table below identifies the members of the Commissioning Team during the Construction Phase. The Team members on the Commissioning Team should be updated as often as necessary to maintain the list up-to-date throughout the project.

Commissioning Team Construction Phase		
Designation	**Agency/Professional/Contactor**	**Description**
VA RE	Department of Veterans Affairs Resident Engineer(s)	Technical Representative of the VA Contracting Officer responsible for project delivery
VAMC-FM	VAMC Facilities Management and/or using agency	Representatives of the local VA Medical Center responsible for Facilities Operation & Maintenance, Construction Coordination and/or other VAMC departments.
A/E	Architect/Engineer Design Team	Representatives of the Architect and Engineering Design Team responsible for Construction Administration

Commissioning Team Construction Phase		
Designation	**Agency/Professional/Contactor**	**Description**
CxA	Commissioning Agent	Representatives of the independent 3rd Party Commissioning Contractor
Contractor	Prime Contractor	Representatives of the Prime Contractor responsible for project construction.
SC	Installing Sub-Contractors and Service Providers, to include but not necessarily be limited to	Representatives of the Fire Protection, Plumbing, HVAC, Electrical, Communications, Electronic Security 1st-Tier subcontractors responsible for installing systems and equipment
TAB	Test and Balance Agency	Representatives of the Test and Balance contractor responsible for air and water balance of HVAC systems
DDCC	Direct Digital Control System contractor	Representatives of the Control System contractor responsible for installing and programming the Direct Digital Control system
SpC	Specialty Contractors	Representatives of the Fire Alarm, Electronic Security System, and other specialty contractors responsible for installation and programming of special systems that interface with the DDC system, HVAC and/or Electrical systems. This can include independent 3rd-Party Test Agencies (e.g., NETA Qualified Testing Agents)

7.2 Roles and Responsibilities

The primary goals of Construction Phase Commissioning Process are

- to verify, demonstrate and document that the installed systems and components operate in accordance with the Owner's Project Requirements and the Construction Documents, and

- to verify that the Operations & Maintenance Team are effectively trained to sustain high performance operation of the installed systems. The following tables describe both the task associated with executing an effective commissioning process and the responsibilities of each commissioning team member in execution of each task. It is imperative that the Team Members be identified, and that the roles and responsibilities be clearly identified, as well as being tailored to each specific project.

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Pre Bid Meeting	Attend Pre Bid Meeting; provide overall description of Commissioning Process, provide clarifications for Commissioning Issues.	Meeting Notes for PM/RE Clarifications for Addendum if required
Construction Phase		
Pre Construction Meeting	Attend Pre Construction Meeting and be prepared to clarify the Commissioning Process for this project (e.g., discuss commissioning representative selection).	None
Commissioning Kick Off Meeting (Construction Phase) [The kickoff meeting should occur within 60 days of Notice to Proceed.]	Conduct a separate "Commissioning Kickoff Meeting" with the Construction Team Establish the purpose and proposed process for commissioning the project. Establish the individual roles of each participating commissioning team member. ATTENDEES: Commissioning Agent, A/E Design Team Representatives, Contractor's Commissioning Representative, Subcontractor's Commissioning Representatives, VA RE.	Meeting Minutes Revised Project Commissioning Plan (Include Names/Contact Information for selected Commissioning Team Members)
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should be incorporated into the contractor's project schedule to track all commissioning activities of the commissioning team.	Commissioning Duration Schedule (Schedule shall be periodically updated to reflect changes in the project schedule and/or scope.)

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Submittal & Shop Drawing Review	Review all pertinent project shop drawings necessary to support the Commissioning Process. Review of the shop drawings is for the purpose of developing appropriate Pre Functional Checklists and Systems Functional Performance Test Procedures. Submittals & Shop drawings shall be reviewed for commissionability, maintainability and for compliance to the Construction Documents. Note any issues identified in the Shop Drawing Review that might compromise the final commissioned system on the 'Commissioning Review Log' and submit comment to the Design Team and the RE contemporaneously with the A/E review for resolution. Comments shall be submitted in accordance with the contractual submittal review time. Comments shall be provided to the Design Team no less than 7 days prior to the Submittal Review Due Date provided that the Cx Agent has no less than 7 days to review the submittals. **ANY ISSUES IDENTIFIED IN THE SUBMITTAL REVIEW THAT MIGHT REQUIRE A CONTRACT CHANGE BUT IS NECESSARY TO MEET DESIGN INTENT SHOULD BE SPECIFICALLY REFERRED TO THE RE.**	Shop Drawing Cx Review List Shop Drawing Review Comments
Project Commissioning Plan	Based on the work completed in the items above, the Commissioning Plan for the project shall be periodically reviewed with the Commissioning Team and update to reflect changes in project scope or schedule and with project personnel.	Revised Project Commissioning Plan

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Site Observations	During the course of construction, the Commissioning Agent will visit the site to observe the progress of construction with respect to the systems being commissioned. The focus of the observations will to verify that systems being installed comply with the Construction Documents and can be successfully configured, operated and maintained. In addition, site observations visits will be scheduled to include • Witnessing factory or contractor equipment/system start up activities; • Verification of Completed Pre Functional Checklists • Verification that the Contractor and his subcontractors are completing and documenting Pre-Test procedures required by the specifications. • Clarification and technical support for understanding and resolving Commissioning Issues.	Site Observation Reports Updated Commissioning Issues Log
Commissioning Team Meetings	The Commissioning Agent will hold regular commissioning team meetings to review progress of the commissioning effort and reinforce individual responsibilities. The team will review schedule, construction sequence, and completed work (PFT and FPT's) and outstanding issues on the Commissioning Issues Log. Commissioning Team Meetings may be held at the jobsite or be teleconference depending upon the status of construction. While it is imperative that many of the Commissioning Team Meetings be held in person, during early construction phases, some meetings may be more cost effectively conducted remotely. Scheduling and location of meetings shall occur by consultation between the Commissioning Agent and the RE.	Commissioning Meeting Minutes Updated Commissioning Issues Log

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Develop Pre-Functional Checklists (PFC's)	The Commissioning Agent will complete all Pre Functional Checklists (PFC) for the project and distribute to all Cx Team members for review and comment. A completed PFC indicates the system and its related equipment is ready for Systems Functional Performance Testing. The requirements for Pre Functional Checklists shall be coordinated with the start up requirements specified for each commissioned system. The PFC's shall be constructed to leverage the specified contractor and vendor start activities to avoid unnecessary duplication.	Pre Functional Checklists (PFC's)
Develop Systems Functional Performance Test (FPT's) Procedures	Based on construction documents and approved submittals, the Commissioning Agent will prepare Systems Functional Performance Test Procedures (FPT's) for systems to be commissioned. Completed FPT's will be distributed to all appropriate members of the Commissioning Team for review and comment. Final FPT's will be issued once comments are reviewed and incorporated into final documents as appropriate.	Systems Functional Performance Test Procedures (FPT's)
Review Operations & Maintenance Manuals	The Commissioning Agent shall review Operations and Maintenance Manuals submitted by contractors for general conformance with specifications and VA's requirements, including: If provided with the manuals, Review Preventive Maintenance Schedules provided as part of the O&M Manuals for completeness. Verify that data is provided in a manner consistent with VA process for managing Preventive Maintenance tasks. Review of O&M Manuals will include a review of system and component warranties to confirm conformance with contract requirements and adequate documentation of warranty contact information and VA obligations. Review of O&M Manuals shall be completed in accordance with the Submittal Review schedule requirements.	Updated Commissioning Issues Log

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Review Contractor Equipment Startup Checklists, TAB Reports and PFC's	The Commissioning Agent will review all contractor prepared Equipment Startup Checklists, TAB Reports and PFC's to confirm that the systems are have been subject to appropriate Quality Control and Start Up procedures prior to initiation of Functional Performance Testing. Incomplete work, inadequate preparation and deficiencies will note noted and tracked on the Commissioning Issues Log.	Commissioning Issues Log

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
TAB Verification	The Commissioning Agent shall work with the TAB Contractor to verify that all Testing and Balancing work is conducted in strict accordance with the specified Procedural Standards for Testing, Adjusting and Balancing by either NEBB or AABC. The Commissioning Agent shall execute the following tasks: • Review the TAB Agenda provided by the TAB Contractor to verify that it is complete, thorough and in compliance with the specification and Procedural Standards requirements. • On the project site, the CA shall review the calibration certificates for the instrumentation being used by the TAB Contractor during the execution of TAB activities to confirm that the instrumentation meets the requirements of the spec and the appropriate Procedural Standard. • The CA shall periodically visit the project site and review the TAB documentation for method, reasonable values, and compliance with the specification, Procedural Standard and TAB Agenda. • Upon completion of the TAB activities, the CA shall visit the project site with the TAB Contractor and the RE. The TAB Contractor shall demonstrate readings selected by the CA that demonstrate that the system performance is consistent with the submitted values on the TAB report. Readings shall include Air Handling Unit total flows, static pressure control values, select outlet flows, building, and space pressures selected by the CA as critical system operating values.	TAB Agenda Review Comments TAB Agenda Review Meeting Minutes Field Observation Reports of TAB Inspections Summary Report of TAB Verification Readings

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Acceptance Phase		
Systems Functional Performance Testing	The Commissioning Agent will oversee, facilitate, and document all FPT testing. Execution of FPT's shall be executed in accordance with the Functional Testing Procedures published by the Commissioning Agent. All systems tested in accordance with the FPT's shall be operated by the contractors in accordance with the approved FPT. Contractors shall retain responsibility for the installed systems during and after functional testing until substantial completion or final acceptance as determined by the VA. The Commissioning Agent, in collaboration with the control contractor shall include long term trends (greater than 7 days) of integrated system performance once all systems have been commissioned. The Commissioning Agent shall provide analysis of these trends to confirm that the installed systems are stable and reliable	Executed Functional Performance Tests and support documentation. Long Term Trend Data and Analysis
Prepare Systems Manuals	The Commissioning Agent shall work with the design team, contractor and VA to develop Systems Manuals. Manuals will contain system design, operations and sequence information that describes the design intent, operational features and appropriate operational practices necessary to sustain the system operation in accordance with the Design Narrative and the VA's overall objectives for the facility. Systems Manual will include sections for each major system included in the commissioning process.	Project Systems Manual

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Training Plan Review	The Commissioning Agent shall collaborate with the Prime Contractor and installing subcontractors to develop effective contractor and manufacturer training plans and agendas for general conformance with specifications and VA's requirements. Observe training for quality of training and for general conformance with the training plan and agenda. The CA shall observe contractor and vendor training for critical systems. The Contractor shall provide and the CA shall maintain all attendance records and associated agendas and presentations for all training sessions. Attendance records shall be written original sign in sheets for each training session.	Compiled Training Plan Individual Training Agendas Training Attendance Sign In Sheets
Systems Training	The Commissioning Agent will conduct training sessions to provide systems-level training for O&M personnel. Training will include: • Review of system design, capacity, and equipment selection • Review of system operating sequences • Review of interconnection with other systems • Review of Emergency operating procedures • Review of the Project Systems Manual and its Use • Student Evaluation forms The number, duration and scope of the Systems Training sessions shall be determined by the specific requirements of the project. The training provided by the CA does not in any way relieve the Contractor from any specified training obligations.	Systems Training Presentations (electronic)

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Final Commissioning Report	The Commissioning Agent shall compile a comprehensive commissioning report documenting all commissioning activities, including but not limited to the following: • Executive Summary • Commissioning Scope of Work • Test methods and results • Outstanding commissioning issues • Comprehensive Commissioning Issues Log, including resolved items and a description of their resolution, • Commissioning plan, • Field Observation Reports, Status reports and other field activity documentation, • Submittal and O&M manual reviews • Training record • Completed Pre Functional Checklists • Completed Functional Performance Test protocols and support documentation • Other support documentation developed as part of the execution of the project Construction Phase Commissioning Process	Final Commissioning Report

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Warranty Phase		
Deferred and/or Seasonal Testing	The Commissioning Agent shall witness and document Systems Functional Performance Testing that was deferred to allow systems to be tested in appropriate seasonal conditions. Testing will be conducted in accordance with Systems Functional Performance Test Procedures. Testing support will be required from the installing contractors, EMCS Vendor and VA. Requirement for seasonal testing will be incorporated into the project specifications. As part of the Seasonal Testing Effort, the Commissioning Agent shall review systems operations with the onsite operations team and reinforce training and best operating practices of the operations team.	Executed Functional Performance Test and Support Documents Commissioning Issues Log
Warranty Period Site Visits	The Commissioning Agent shall make quarterly visits to the project site to reinforce training, evaluate performance of the installed systems and provide technical support to the operating team to sustain commissioned performance of the systems.	Warranty Site Visit Reports

Commissioning Team Task/Deliverables Description Pre Bid/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Post-Occupancy Inspection	Return to the project approximately 10 months after substantial completion to review the building operation with the facility occupants and O&M staff, and to discuss outstanding issues related to commissioning. Provide suggestions for improvements to systems operation including, • Measurement & Verification Issues, • Re-Commissioning Tasks, and • Improvements in Preventive Maintenance or Operational Strategies Assist facility staff in developing warranty issues, documents and requests for service to remedy outstanding problems. As part of the Post Occupancy Inspection, the Commissioning Agent shall analyze the energy consumption records from the project site (both utility and system generated reports) and provide the team with an analysis of actual system energy performance versus predicted performance. To the extent possible, deficiencies in performance shall be analyzed to provide an understanding of the systems, components or operating strategies that may be operating outside predicted parameters.	Post Occupancy Field Visit Report Commissioning Issues Log Warranty Issues Report Systems Energy Review Report
Final Commissioning Report Amendment	Amend Final Commissioning Report to document the Warranty Phase commissioning activities.	Final Report Amendment

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Pre Bid Meeting	Facilitate the Pre Bid Meeting	Attend Pre Bid Meeting Provide Clarifications regarding Commissioning as required	Attend the Pre Bid Meeting	Attend the Pre Bid Meeting Incorporate Commissioning Agent Clarifications into Pre Bid Meeting Notes/Addendum	Attend Pre Bid Seek Clarifications as required to include Commissioning in Proposal
Commissioning Kick Off Meeting	Facilitate the Kick Off Meeting Provide VA Schedule Requirements and Milestones Review Meeting Minutes & Comment	Prepare and disseminate Agenda Lead Kick Off Meeting Produce Meeting Minutes and Incorporate Comments	Identify Cx Team Members Review Meeting Minutes & Comment	Identify Cx Team Members Review Meeting Minutes & Comment	Identify Cx Team Members (including SC, TAB, DDCC, SpC) Review Meeting Minutes & Comment

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Construction Phase					
Duration Schedule for Commissioning Activities	Review Commissioning Agent Duration Schedule and Comment as Appropriate	Refine Commissioning Duration Schedule provided with the specification to include Commissioning Activities, Estimated Duration for each Activity and Conditions Required for Activity Execution	Review Commissioning Agent Duration Schedule and Comment as Appropriate Schedule VAMC Personnel to support Commissioning Process as appropriate	Review Commissioning Agent Duration Schedule and Comment as Appropriate	Review Commissioning Agent Duration Schedule and Comment as Appropriate Incorporate Commissioning Activities into Project CPM Schedule. Confirm with Commissioning Agent
Submittal & Shop Drawing Review	Facilitate Delivery of Shop Drawings to Commissioning Agent Review and approve submittals and shop drawings after review by A/E and Commissioning Agent	Provide a list of Required Shop Drawings to CM/GC Review required Shop Drawings in parallel with A/E Team. Deliver Comments to A/E Team as part of Submittal Review Process	None	Review Commissioning Agent Comments Incorporate into A/E Comments as Appropriate Communicate with Commissioning Agent where Cx comments are deemed inappropriate.	Deliver appropriate Shop Drawings to Commissioning Agent when provided to A/E Team. Submittal deliverable must be in contract -Agent address /Section 01340 -in specs?

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Review RFI'S ASI'S and other Contract Documents	Distribute to CxA	Review documents to identify impacts on Commissioning Process. Review to identify any conflicts with the project OPR.	None	In addition to other contract responsibilities, review and respond to CxA comments.	In addition to other contract responsibilities, review and respond to CxA comments.
Project Commissioning Plan	Distribute Design Phase Cx Plan Review Cx Plan & Comment/Approve	Update Project Commissioning Plan to include specific individuals and team members. Update as required for changes in project schedule or work scope as appropriate.	Review Cx Plan & Comment	Review Cx Plan & Comment	Review Cx Plan & Comment Support Construction Team adherence to Cx Plan

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Site Observations	Review Site Visit Reports and Commissioning Issues Logs and Comment as appropriate. Forward Site Visits Report to Contractor and A/E Facilitate resolution of Commissioning Issues Log Items as expeditiously as possible.	Visit the Project Site on a regular scheduled basis as agreed upon with the VA RE. Submit Site Visit Report to RE. Update and deliver Commissioning Issues Log	Review Site Visit Report & Comment as Appropriate	Review Site Visit Report & Comment as Appropriate Assist the Commissioning Agent in resolving all Design related Commissioning Issues.	Forward Site Visit Report to all Subcontractors, Commissioning Representatives and other appropriate construction team personnel. Review Site Visit Report & Comment as Appropriate Assist the Commissioning Agent in resolving all commissioning Issues.
Commissioning Team Meetings	Review Meeting Minutes & Comment	Prepare and disseminate Agenda for regular periodic Cx Team Meetings Lead Cx Team Meetings Produce Meeting Minutes and Incorporate Comments	VAMC Cx Team Members Attend Review Meeting Minutes & Comment	A/E Cx Team Members Attend Review Meeting Minutes & Comment	Cx Team Members (including SC, TAB, DDC, SpC) Attend Review Meeting Minutes & Comment

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Develop Pre Functional Checklists (PFC's)	Review & Comment as appropriate	Develop Pre Functional Checklists. (PFC's) Provide to Contractor for comment. Disseminate final PFC's for use by Construction Team.	Review & Comment as appropriate	Review & Comment as appropriate	Review & Comment – All Cx Team Members. Incorporate PFC requirements into start up schedules and processes.
Develop Functional Performance Test (FPT's) Procedures	Review & Comment as appropriate	Develop Functional Performance Tests (FPT's). Provide to Contractor team for comment. Disseminate final FPT's for use by Construction Team.	Review & Comment as appropriate	Review & Comment as appropriate	Review & Comment – All Cx Team Members. Incorporate FPT requirements into project and personnel schedules.

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Review Contractor Equipment Startup Checklists, TAB Reports and PFC's	Review & Comment as appropriate	Review & Comment on result s of Start Up testing, TAB results and PFC documentation. Field Verify a sampling of PFC's to confirm compliance with PFC requirements. Evaluate readiness for Functional Performance Testing	Review & Comment as appropriate	Review & Comment as appropriate	Provide Factory and Contractor Start Up documentation in accordance with Specifications and PFC's to VA PM/RE, Commissioning Agent and A/E Team for review & comment. Correct any deficiencies or deviations noted on the Commissioning Issues Log and report corrective action.
Review Operations & Maintenance Manuals	Review & Comment on Operations and Maintenance Manuals.	Review & Comment on Operations and Maintenance Manuals. Incorporate into Systems Training as appropriate.	Review & Comment on Operations and Maintenance Manuals.	Review & Comment on Operations and Maintenance Manuals.	Complete & Submit Operations and Maintenance Manuals prior to equipment start up and execution of Pre Functional Checklists. Correct issues identified with O&M Manuals identified on the Commissioning Issues Log.
Acceptance Phase					

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Systems Functional Performance Testing	Facilitate execution of the Functional Performance Testing as required. Review Commissioning Agent Issues Log & Provide Feedback as appropriate Facilitate Resolution of Commissioning Issues Log and reporting requirements between the Commissioning Agent and the Construction team.	In collaboration with the Contractor Commissioning Team, direct the execution of the Functional Performance Testing. Identify issues and deficiencies in system operation and performance on the Commissioning Issues Log. Retest systems as appropriate to demonstrate compliance with the Contract Documents and the Commissioning Plan.	Participate with the Commissioning Agent as agreed upon to support the commissioning process and facilitate training of the Operations Team. Review & Comment on Commissioning Issues Log as appropriate.	Review & Comment on the Commissioning Issues Log as appropriate.	Provide Qualified Technicians and Professionals to operate the installed systems and components as required by the Functional Performance Testing and any retesting required by the Commissioning Agent. Provide documentation of test results from installed systems as required by the FPT's. Correct issues and deficiencies identified on the Commissioning Issues Log and report methods and results of corrective actions to the Commissioning Agent.

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Prepare Systems Manuals	Review Systems Manual & Approve	Utilizing the accumulated information and data, prepare a Systems Manual for the Operations Team. Review submitted data and note any issues or deficiencies on the Commissioning Issues Log. Deliver Systems Manual to the Cx Team for Review and Comment.	Review Systems Manual & Comment	Provide systems diagrams and other appropriate data to the Commissioning Agent in electronic format for development of Systems Manual. Review Systems Manual & Comment	Provide data, including record drawings and submittal data for all commissioned systems. Correct any deficiencies and issues identified with the submitted data. Review Systems Manual & Comment

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Training Plan Review	Facilitate Development of Training Agendas and Training Schedules. Review Training Plan & Comment	Facilitate development of Training Agendas. Collaborate with CM/GC/SC and VAMC teams to schedule training activities. Review and Approve all CM/GC/SC training agendas. Note any issues or deficiencies in Agendas on the Commissioning Issues Log.	Review Training Plan & Comment Schedule Appropriate Operations Personnel in accordance with the training schedule.	Review Training Plan & Comment	Develop training agendas in accordance with Project Specifications and submit to Commissioning Agent for review. Coordinate training schedule with Commissioning Agent and other Cx Team members. Schedule and execute training in accordance with training schedule and agendas.

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Systems Training	Review & Approve Systems Training Agenda Facilitate Systems Training in accordance with the Agenda and Schedule	Develop Systems Training Sessions in accordance with the Commissioning Plan. Sessions shall include the use of the Operations and Maintenance Manual and a 'Systems Manual' developed for the VAMC operations Team. Deliver Systems Training in accordance with the approved Systems Training Agenda.	Schedule key O&M Personnel to attend Systems Training Sessions.	Review & Comment on Systems Training Agenda.	Review & Comment on Systems Training Agenda.
Final Commissioning Report	Review & Approve Final Commissioning Plan.	Create and submit Final Commissioning Report in accordance with the Commissioning Plan and other contract requirements.	Review & Comment on Final Commissioning Plan	Review & Comment on Final Commissioning Report	None

Commissioning Team Roles and Responsibilities Construction Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Lessons Learned Review Meeting	Facilitate Lessons Learned Meeting Review & Comment on Meeting Minutes	Distribute the Agenda for the Lessons Learned Meeting. Lead the Lessons Learned Meeting. Complete and distribute Meeting Minutes. Incorporate comments as appropriate.	Attend & Contribute to Meeting. Review & Comment on Meeting Minutes	Attend & Contribute to Meeting. Review & Comment on Meeting Minutes	Attend & Contribute to Meeting. Review & Comment on Meeting Minutes

Commissioning Team Roles and Responsibilities Warranty Phase					
Project Phase/ Cx Task	**Commissioning Team Member Responsibilities**				
	VA RE	**Commissioning Agent**	**VAMC**	**A/E Team**	**Contractor**
Deferred and/or Seasonal Testing	Facilitate Seasonal Testing with all appropriate parties. Review Commissioning Agent Issues Log & facilitate issues resolution. Facilitate Resolution of identified Commissioning Issues.	Schedule & Execute Seasonal Testing in Accordance with Functional Performance Testing Protocols. Maintain & Distribute Warranty Phase Commissioning Issues Logs. Facilitate and record resolution to identified Issues and Deficiencies recorded on Commissioning Issues Log.	Provide O&M Personnel to support seasonal testing in accordance with the Commissioning Plan. Review Commissioning Agent Issues Log & Comment Operations Team will operate systems under the deferred season testing protocols.	Review & Comment on Seasonal Testing. Provide and report resolution of any issue identified as a Design Issue.	Contractor will be invited to participate in the execution of seasonal testing and assist in resolution of issues and deficiencies identified. Record resolution for each issues based on A/E Response

Post-Occupancy Warranty Checkup	Facilitate Post Occupancy Warranty Check Up Meetings. Review and approve Final Commissioning Report Amendment.	Meet with the VAMC Operations Team. Interview team members to evaluate system performance and identify any issues with operation of the commissioned systems. Evaluate system performance through a review of operating performance data and warranty phase (re-commissioning) tests as identified in the Commissioning Plan and Systems Manual. Develop a Warranty Report identifying any outstanding warranty issues for VAMC use in resolving warranty issues on the project.	Provide O&M personnel to participate with the Commissioning Agent in the Post Occupancy Warranty Check up. Identify any outstanding or persistent warranty issues to the Commissioning Agent.	A/E Team will be invited to participate at their discretion. Review & Comment on Seasonal Testing. Provide and report resolution of any issue identified as a Design Issue.	Contractor will be invited to participate at his discretion. Assist in resolution of issues and deficiencies identified. Assist in facilitating execution of all warranty obligations identified.
Final Commissioning Report Amendment	Review & Approve Final Commissioning Report Amendment.	Create and submit Final Commissioning Report Amendment in accordance with the Commissioning Plan and other contract requirements.	Review & Comment on Final Commissioning Report Amendment	Review & Comment on Final Commissioning Report	None

7.3 Construction Phase Commissioning Kickoff Meeting

The Commissioning Agent shall prepare and facilitate a Construction Phase Kickoff Meeting with the Contractor and all key subcontractors, TAB Agency and DDC Contractor. The VA Project Manager and Resident Engineers and representatives of the A/E Team with construction responsibilities should also attend. This meeting shall occur within 60 days of Contract Award or Notice to Proceed as directed by the RE. All subcontractors shall be identified. Each subcontractor shall appoint a Commissioning Team Representative who shall attend the meeting.

The meeting should include but not necessarily be limited to the following topics:

a. Review the Commissioning Process & the Project Commissioning Plan
b. Review Project Performance Objectives & Verification Strategies
c. Review Process Documentation Requirements
d. Identify Commissioning Team Members
e. Discuss Project Communication Protocols
f. Discuss Project and Commissioning Schedules, including Commissioning Team Meeting Schedules
g. Discuss Shop Drawing/Submittal Review Process
h. The Commissioning Agent shall deliver Meeting Minutes of the Kickoff Meeting to all the VA-RE and the Contractor for distribution to all other Commissioning Team members.

7.4 Construction Commissioning Plan

The Construction Commissioning Plan is a living document that should updated throughout the construction phase of the project to document current members of the Commissioning Team, to update the communications protocols that may be agreed upon from time to time and to reflect changes in either project or commissioning scope that may occur from time to time.

The Construction Commissioning Plan should reflect the execution strategy for the project and include all commissioning activities, commissioning duration schedules and schedule updates, commissioning documentation requirements, including a specific list of Site Visit Report, Pre-Functional Checklists, System Functional Performance Test Procedures, and other support documents that are required to demonstrate successful completion of the project. As such, the Construction Commissioning Plan should be reviewed at each Commissioning Team Meeting and updated as required to keep the project on track.

7.5 Construction Schedule Facilitation and Integration

The objective of the Commissioning Process is to integrate commissioning tasks into the project construction schedule. The majority of commissioning activities should be completed as part of the normal construction schedule and finalized prior to the scheduled construction completion date. To this end, it is imperative that the Commissioning Agent and the Contractor collaborate to integrate commissioning activities into the Contractor's overall construction schedule.

The Commissioning Plan will identify critical commissioning activities and associated construction/start up tasks that must precede these activities to allow for successful execution of these tasks. In order to coordinate these activities with the construction schedule, a Commissioning Duration Schedule should be provided by the Commissioning Agent to the VA RE and the Contractor to provide a rational basis for integration of commissioning into the construction schedule. The Commissioning Duration Schedule should include the following information:

a. Description of Commissioning Activity
b. Prerequisite Construction Tasks Required to Execute the Cx Activity
c. Elapsed Time Duration of Each Activity
d. Documentation Associated with Each Task/Document Responsibility

Once the duration schedule is delivered to the Contractor, the Commissioning Agent will collaborate with the Contractor to integrate all commissioning activities into the fixed duration construction schedule in accordance with VA requirements for scheduling the project.

Often, Contractors elect to construct projects in a particular sequence that may facilitate accelerated turn-over of parts of the project to the VA ahead of other portions of the facility. Contractors very often think and schedule this sequential construction and turn-over based on "bricks and mortar", "finishes" and other general construction tasks without sufficient thought towards coordination of HVAC, electric, plumbing and other specialty trades into the schedule.

The Commissioning Agent can provide valuable technical expertise and experience to assist the Contractor with planning the construction process to accomplish the following goals:

a. Schedule construction of 'prototype areas' so that critical construction details and construction methods can be evaluated and documented for construction trades.
b. Schedule and complete construction so that systems testing can begin in portions of the project as early as reasonably practicable to facilitate early identification and resolution of systems level issues.

c. Schedule construction collaboratively with subcontractors to encourage the most time efficient construction of all trades and the most cost effective use of construction labor on the project.

This methodology often allows the construction team to incorporate reasonable time into the schedule for the specialty trade contractors to complete their work in a manner and facilitates the transition from construction to occupancy.

7.6 Construction Phase Meetings

Construction Phase meetings requiring the participation of the Commissioning Agent must be clearly and specifically identified and quantified in the project specifications.

a. Construction Progress Meetings:

While these regularly-scheduled meetings are well-stipulated in other VA documents, it is unlikely the Commissioning Agent needs to attend all of the construction phase meetings. The Commissioning Plan should identify the frequency during the construction process when the Commissioning Agent will attend these meetings. The primary purpose for the Commissioning Agent attending these meetings is to review outstanding commissioning issues that warrant attention by the Contractor or the VA RE. These meetings also allow the Commissioning Agent to be informed of construction progress, construction schedule updates, RFI status, Change Orders, and other directives that could impact the commissioning process.

b. Commissioning Team Meetings:

Commissioning tasks and requirements are clearly different and separate from other construction phase activities. The Commissioning Agent will be required to plan and lead these meetings. Issues addressed at Commissioning Progress Meetings will be specific to the commissioning process and will be items that enhance the success of project commissioning. The Commissioning Plan should address when, during the construction process, these meetings should begin and how often they should be held. The VA RE, Contractor, installing contractors, DDCC, TAB and specialty contractors should attend these meetings. Commissioning meetings are often scheduled immediately prior to, or immediately following, sub-contractor meetings conducted by the Contractor. The Commissioning Progress Meetings are used to plan and coordinate commissioning activities and to review system/equipment installation. These meetings also provide an opportunity for the sub-contractors to discuss technical or coordination issues regarding systems and equipment installation.

As a minimum, the following issues should be on the Commissioning Team Meeting Agenda. Additional issues should be added as required to maintain the schedule and progress of the commissioning process.

- Commissioning Plan Review
- Review Documentation Requirements/Outstanding Documentation Issues
- Review Current Commissioning Issues Log/Document Resolved Issues
- Review Project & Commissioning Schedule
    - Progress to Date
    - Upcoming 30 Day Schedule
    - Schedule Inspections/Tests as Appropriate

7.7 Commissioning Construction Observation Visits

The Commissioning Agent will schedule periodic visits to the construction site to observe construction progress and verify systems/equipment installation. The Commissioning Agent has an overall understanding of the plans, specifications, VA's requirements, construction procedures, and systems operational demands. The Commissioning Agent's role is to confirm that the installed systems are installed in accordance with the intent of the project documents and are maintainable and commissionable.

These site visits are not a substitute for the contractor's Quality Control inspections, nor are they a substitute for any required inspections by the VA RE. Rather, they supplement other reviews performed by the RE and the A/E design team. The construction evaluation visits are intended to identify issues early in the process to allow the Contractor to devote sufficient time and resources to correct the situation. Early identification also provides an opportunity for the Contractor and the installing contractors to prevent recurrence of the issue on similar equipment or systems.

Installation observations are a systematic set of procedures intended to identify whether individual system components have been installed properly. This process occurs during both the Construction Site Visits and at equipment startup. The contractor will be required to complete the Pre Functional Checklists and provide any supporting documentation to demonstrate proper component and system installation and start up. The Commissioning Agent uses the Pre-Functional Checklists and Equipment Startup Checklists as a guide to ensure consistency in the observations. During the Construction Observation Visits, the Commissioning Agent will validate that the completed Pre Functional Checklists have been properly completed. This process supplements the Contractors' Quality Control program to ensure that relatively minor issues (e.g. an improperly wired sensor, a control valve installed backwards, etc.) are discovered and corrected prior to Systems Functional Performance Testing.

The Commissioning Agent should have the experience to recognize potential conflicts between the various trades involved in equipment and systems installation. By identifying potential conflicts early, it allows the Contractor to resolve the coordination issues without the need for extensive (and expensive) re-work. The Commissioning Agent should identify coordination issues that will impact the facility Operations & Maintenance staff (for example, piping and conduit installation may limit or block adequate maintenance access to key components).

The Commissioning Agent, thru a comprehensive series of Construction Observation Visits and Commissioning Team Meetings will provide a resource for the Contractor and A/E Team to support the identification and resolution of construction issues and conflicts. The Commissioning Agent's specific objective is to facilitate the construction of systems that will perform as intended and can be operated and maintained over the life of the facility.

The frequency and duration of the visits will be established based on construction progress. For new construction projects, Project Commissioning will always begin with a Commissioning Kick-Off Meeting within 60 days of contract award. After the Kick-Off Meeting, it is imperative that the Commissioning Agent continue to be engaged with the construction team to build effective relationships that promote proactive and collaborative quality process for delivery of the construction project. For any project, the RE and the CxA should schedule meetings with the following issues in mind:

a. If the early stages of project construction do not involve significant construction of commissioned systems, Construction Site Observations should occur no less than once per quarter.

b. In the interim between Construction Site Observations, the CxA should maintain contact with the project thru remote Commissioning Team Meetings (teleconference and/or Web Based Meetings).

c. Once the construction of commissioned systems commences, Site Observations Visits should occur no less than monthly.

d. When the installation of commissioned systems reaches approximately 50% in any single area of the project, the frequency of Site Observations Visits should increase to bi-weekly or weekly visits. Note that the Commissioning Agent will be engaged with the construction team in verifying Pre Functional Checklists as well as conducted observations of construction progress.

e. During Testing and Balancing Activities, the Commissioning Agent should visit the project no less than weekly to observe progress of the TAB work and support the TAB Contractor's efforts to deliver an effective facility.

f. Once Systems Functional Performance Testing has commenced, the Commissioning Agent will typically be on site regularly enough that separate site visits are not required.

The objective of the Commissioning Agent during site observations visits is to verify that the construction team is adequately preparing systems for functional testing. The Commissioning Agent should validate completion of the Pre-Functional Checklists by the Contractor. The Commissioning Agent and the Contractor should also review the data needed from the Contractor to provide input for the COBIE system. This data should be incorporated into the Pre-Functional Checklists.

Construction Site visits will be documented using a Site Visit Observation Reports that outlines the purpose of the visit, the Commissioning Agent representative conducting the visit, others (RE, Contractor, installing contractors, etc) present or contacted during the visit and general observations of the work underway, quality of workmanship, and other general issues that should be brought to the attention of the VA RE and/or Contractor. If any significant issues are identified, they will be described and highlighted in the field report. The issue will also be entered on the Commissioning Master Issues Log and tracked until the issue is resolved. A significant issue is anything that impacts system operations or maintenance, safety, compliance with construction drawings or specifications, compliance with industry standards, and/or will impact the construction schedule.

Site Visit Observation Reports are submitted to the VA RE for distribution to the Contractor and A/E Team.

7.8 RFI's, Change Directives, Change Orders

The Commissioning Agent will review RFI's for their potential impact on the commissioning process. Also, the Commissioning Agent should review all VA-issued Change Directives or Change Orders that affect construction and may, therefore, impact the commissioning process and systems manual documentation. The Commissioning Agent should be included on the distribution list for RFIs, Change Directive, Change Orders and other correspondence that affects the commissioned systems. The Commissioning Agent also attends selected Construction Progress Meetings where this information is reviewed. This provides the opportunity for the Commissioning Agent to become familiar with each issue and to identify the specific information need to update the Functional Test Plans, systems manuals, and other commissioning documents.

The Commissioning Agent will also issue RFIs when necessary to obtain clarification or direction from the VA RE or A/E. These will usually request clarification or change to systems operating sequences or other issues that impact system/equipment operations, maintenance or functional testing.

In each case, the Commissioning Agent should note any issues identified with the documents noted above either on the Commissioning Issues Log or, if an issue is specific to the VA decision making process, in separate correspondence to the VA RE. Resolution of these issues should, whenever

appropriate, be reflected in the Design Narrative and the Construction Commissioning Plan.

7.9 Submittal Review

Submittals and shop drawings must be reviewed and commented upon by the Commissioning Agent. Not all submittals require Commissioning Agent review, but those submittals that have an impact on commissioned systems, energy, and Operations & Maintenance must be reviewed by the Commissioning Agent. Generally, all submittals required by Division 21, 22, 23, 26, 27, 28, and 31 should be sent to the Commissioning Agent. The Commissioning Plan should include a matrix identifying each submittal to be reviewed by the Commissioning Agent. The Commissioning Agent should review the submittals concurrently with the A/E review. Commissioning Agent review comments are provided to the A/E to be incorporated into the A/E review response that is submitted to the VA RE for submittal approval.

The Commissioning Agent review of the submittals is not a substitute for the A/E review, rather it supplements their review. The A/E still retains the overall responsibility for recommending approval/disapproval of the submittal. The VA RE retains overall authority to approve or disapprove submittals and shop drawings. The Commissioning Agent review will focus on Operations & Maintenance issues, determination that sufficient components and instrumentation is included with the equipment to allow the system to be tested and commissioned, and that the sequences of operation are sufficiently detailed to facilitate preparing the Systems Functional Performance Test Procedures.

The Commissioning Agent will specifically evaluate the contractors' submittals for the following:

- Conformance with the VA's construction documents
- Fulfilling operation and maintenance requirements
- Facilitating Systems Functional Performance Testing

Submittal review comments will be documented using the Commissioning Issues Log.

7.10 Construction Phase Controls Conference

Once design is complete, construction is underway, and DDC submittals have been reviewed, the Commissioning Team should meet with the DDC vendor to conduct a detailed review of the DDC submittal. The primary purpose of this review is to verify the DDC vendor, the A/E, the Commissioning Agent, and the VAMC FM fully understand how the DDC will be installed and programmed to properly control the HVAC and other systems to meet the VAMC and construction document requirements.

The DDC Sequences of Operations are a critical component that controls all aspects of system operation and performance. Often the DDC submittal includes Sequences of Operations that are merely copied from the plans and specifications. The submittals are often prepared by the sales engineer and the system programmer has not had the opportunity to evaluate how the sequences will be implemented. Early understanding of the sequences by the DDC programmer and the VAMC FM staff is vital to successful facility turnover and operations. The primary purpose of the meeting is to provide a forum for all parties to discuss systems operations and to facilitate the preparation of the DDC programming and graphics. The meeting allows the programmer to discuss the intent with the A/E design team, and for the VAMC FM staff to understand the reasoning behind the sequences. It also provides the opportunity for the programmer to conduct a detailed review of the sequences and to identify any potential issues before

7.11 Pre-Functional Checklists

The commissioning process includes the need to verify that systems and equipment is properly installed and started up prior to functional testing. The Commissioning Agent will prepare Pre-Functional Checklists that will provide a means for the Contractor and installing contractors to notify the Commissioning Agent and VA RE that each commissioned system and the equipment components are properly installed and ready for testing.

The Commissioning Agent will prepare preliminary checklists to describe the equipment installation requirements. The checklist will include provisions to verify that the major components are installed; connections to piping and ductwork are complete; vibration/noise control is installed; proper seismic or other restraint is complete; gauges, sensors, dampers, actuators, and DDC components; electrical connections; control connections; DDC programming; interface to other systems (i.e. fire alarm); TAB; manufacturers' startup; and/or 3rd party testing is complete.

These checklists will be submitted to the VA RE and distributed by the RE to the Contractor, and the A/E design team office for review and comment. The Commissioning Agent will revise the checklists as necessary to incorporate review comments. Upon final approval, the checklists will be issued to the Contractor to be completed prior to testing. The Pre Functional Checklists will also include spaces for the Contractor and installing contractors to certify that installation is complete and the system/equipment is ready for functional testing. This certification can also be used by the VA RE as an indication of the percentage of completion for use while reviewing payment applications.

The checklists will also include spaces to record data that will be needed for the COBIE and/or CMMS systems. This includes manufacturer, model, serial number, and similar as-installed data. The TAB contractor will also be

required to provide final TAB data and readings that will be incorporated into the survivable data entered into the COBIE system.

The Commissioning Agent will spot check the completed checklists and field-verify that the checklists accurately portray the actual installation. This will be done using sampling techniques that will initially select a representative sample of checklists. If the field verification indicates a significant portion of the sample does not accurately portray the system installation, or that system installation is not complete, the Commissioning Agent will select a larger sample to be field verified. When this larger sample indicates a significant variation between the document and the actual field conditions, the entire lot of checklists will be returned to the Contractor and installing contractors for re-submission.

7.12 Preliminary Systems Functional Performance Test Procedures

Each system and component to be commissioned shall undergo a final Systems Functional Performance Testing. The Commissioning Agent shall prepare (write) a Systems Functional Test Procedure that mimics the sequence of operation for each system and component. The Functional Test shall act as a checklist to verify that each step of the sequence was implemented by the control system as described in the contract documents. The Commissioning Agent shall also ultimately witness and document the Systems Functional Performance Tests performed by the Contractor.

The Systems Functional Performance Test Procedures will include system/equipment installation verification steps. These will be similar to the information provided in the System Readiness Checklists and includes information provided by the Contractor and installing contractors. The Commissioning Agent will verify the information and that the system/equipment is properly installed prior to beginning the testing.

The first steps of the functional testing following verification of installation will test the basic operation of the system component equipment and any associated safety shutdowns. These steps will include verifying that the system/equipment can be started/stopped using local controls, via the DDC controls and via any remote controls (i.e. Emergency Operations Center shutdown, Fire Alarm system shutdown, Fire Control Center control of start/stop for smoke evacuation systems). Safety shutdowns, such as High Duct Static, motor overload, high temperature, etc will also be verified.

When the system/equipment has successfully completed the initial static checks, the system operation in normal steady-state operation will be verified in all operating modes (i.e. occupied, unoccupied, night setback, manual, etc.). These steps will verify that the system properly responds to the input signals to maintain the required system output. For example, these steps will

verify that an AHU will maintain the proper discharge air temperature in response to variations in return air temperature, chilled water temperature, hot water temperature, etc.

The next section of the testing will verify that the system will properly respond to step-changes imposed on the system. For example, the test will verify that the VAV terminal unit and/or AHU system will properly respond when the room temperature setpoint is changed. Another example would be to verify that the OR AHU and Air Terminals will properly respond when the OR staff activates the “low temperature” mode or other special conditions.

Finally, the system operation is verified under emergency conditions. This verifies that the system will properly react to the failure of a critical component, to loss of power, or to manual override. For example, if a chilled water system includes a standby secondary pump, the test will simulate the failure of the operating pump and verify that the system will recognize the failure, indicate the proper alarm, and automatically start the standby pump, and that the standby pump will assume all operating requirements of the prime pump. Another example would be to simulate a power failure to the system and verify that the system will operate on backup power. This test would also verify that the system will return to normal operation with normal power is restored.

8 Acceptance and Testing Phase

8.1 Construction Meetings

As with the Construction Phase, Acceptance and Testing Phase meetings requiring the participation of the Commissioning Agent must be clearly and specifically identified and quantified in the construction documents.

a. Construction Progress Meetings:

   While these regularly-scheduled meetings are well-stipulated in other VA documents, it is unlikely the Commissioning Agent needs to attend all of the construction phase meetings. The Commissioning Plan should identify the critical steps during the construction process that warrant meeting attendance by the Commissioning Agent. The primary purpose for the Commissioning Agent attending these meetings is to review outstanding commissioning issues that warrant attention by the Contractor or the VA PM/RE. These meetings also allow the Commissioning Agent to be informed of construction progress, construction schedule updates, RFI status, Change Orders, and other directives that could impact the commissioning process

b. Commissioning Progress Meetings:

   Commissioning tasks and requirements are clearly different and separate from other acceptance and testing phase activities. The Commissioning Agent will be required to attend all commissioning related meetings and will also be required to plan and even lead these meetings. Issues addressed at Commissioning Progress Meetings will be specific to the Commissioning process and will be items that enhance the success of project commissioning. The Construction Commissioning Plan will identify the required number and content/context of all Commissioning Progress Meetings for the project. The Commissioning Progress Meetings will also focus on planning, preparing for, and coordinating System Functional Performance Testing.

8.2 Commissioning Construction Evaluation Visits

As with the Construction Phase, Acceptance and Testing Phase Construction Evaluation visits requiring the participation of the Commissioning Agent must be clearly and specifically identified and quantified in the Commissioning Plan. It is expected that the frequency of these visits will increase as the systems installation near completion. These visits will have the same purpose as those conducted during the Construction Phase, with increasing emphasis on preparations for systems functional performance testing.

8.3 Equipment/System Start Up Observation and Review

As construction and system/equipment installation progresses, various items will be ready for startup. Specific sections of the construction specifications require that the installing contractor will engage the services of a qualified manufacturers' representative to conduct an equipment startup. The installing contractor should schedule these startups with Contractor, VA RE, A/E, and Commissioning Agent in addition to scheduling with the manufacturers' representative. Sufficient notice should be provided to allow coordinating the startup with other scheduled activities.

The VA RE and the Commissioning Agent will determine which equipment startups should be witnessed by the Commissioning Agent. Not all startups need to be witnessed by the Commissioning Agent, but critical equipment such as chillers, cooling towers, air handlers, generators, boilers, etc. should be witnessed by the Commissioning Agent. Often the manufacturer's startup includes verification of start/stop, equipment safety shutdown, and other testing that is included in the initial sections of the Systems Functional Performance Test Procedures. When the Commissioning Agent witnesses the manufacturers' startup verification of these items, it provides the opportunity to document successful completion of those Systems Functional Performance Test steps without having to duplicate them later. This is especially important when verification of the safety shutdown involves temporary adjustments to the equipment controls that should only be made by qualified manufacturer's representatives. The intent is to streamline the process and not require that the manufacturers' representative and the Commissioning Agent return to the site multiple times.

In the case of multiple installations of the same or similar equipment provided by the same manufacturer that involves several visits by the manufacturer's representative, it may not be necessary for the Commissioning Agent to witness each startup. At the discretion of the VA RE and Commissioning Agent, it may be sufficient for the Commissioning Agent to verify the startup procedure is correctly performed and then the Commissioning Agent can review startup documentation for subsequent startup. For example, the project may include many AHUs provided by the same manufacturer. The construction sequence may entail installing and starting the AHUs in one section of the facility followed by additional AHUs installed in other portions of the building later in the construction. In this case, the Commissioning Agent should witness the startup of the first AHUs, but can review the startup documentation for subsequent AHU startups.

8.4 Pre-Functional Checklist Verification

As discussed earlier in the Pre-Functional Checklist section, the Commissioning Agent will spot check completed checklists submitted by the Contractor and installing contractors. The intent of this verification is to

determine that all steps necessary to install the systems/equipment have been properly completed and the equipment is functional and the systems are ready to be tested.

8.5 Systems Functional Testing (Season 1)

Systems Functional Performance Testing occurs once all system components are installed, energized, programmed, balanced, and otherwise ready for operation under part- and full-load conditions. Testing should include each process in the sequence of operation under central and packaged equipment control, including startup, shutdown, capacity modulation, emergency and failure modes, alarms, and interlocks to other equipment or systems. The Contractor indicates the system is ready for functional testing by submitting the completed Pre-Functional Checklist.

Testing is directed by the Commissioning Agent using the approved Functional Test Procedures. As discussed earlier, the Systems Functional Test Procedure is a detailed step-by-step “script” that begins with verification of the system installation and basic start/stop and safety shutdown verification. As the actual functional testing starts, the system is placed in the specified initial condition. The test proceeds to test individual components and equipment under steady state conditions. As the performance of individual components and equipment is successfully demonstrated, the testing progresses to test sub-systems and finally the entire system under steady state conditions is all operating modes.

When steady state operation has been successfully demonstrated, the system, sub-systems, and components/equipment are tested for response to step changes. These steps are designed to subject the system to anticipated extreme operating conditions such as full load, minimum load, temporary overload, and other situations that could be encountered. Often, this testing places the system in conditions that are rarely, if ever, seen under normal operations. The intent is to verify that the systems will safely and properly react to these extreme conditions without damaging the system or causing other unintended consequences. It is imperative that the test procedures adequately identify the risks involved and do not subject the system to dangerous or damaging situations. Therefore, the Contractor, installing contractor, manufacturers’ representatives, and the A/E must review the Systems Functional Performance Test procedures to identify potential situations that could damage the equipment and or cause other harm or injury.

System Functional Performance Testing continues by simulating anticipated failure conditions and evaluating system response to these failures. Normally, the Systems Functional Performance Test Procedures will be written to subject the system to single failure situations – multiple failures are not normally included in the testing. In the event that multiple failures are

reasonably expected, these can be included in the testing. Examples of single failure situations would include failure of one pump in a multi-pump system; failure of a single chiller in a multi-chiller system, etc. Examples of multiple failures would include failure of a single pump in a multi-pump system and simultaneous or subsequent failure of one chiller in multi-chiller system when the pumps and the chillers are part of a single chilled water system. In these cases, the Commissioning Agent can assist in developing contingency plans to be used by the VAMC FM for manually configuring and/or manually operating the system with multiple failures.

Systems Functional Performance Testing uses the DDC system to control the systems. The DDC system normally includes trending and alarm capabilities. The Commissioning Agent should use the DDC trend capabilities to record system responses to test conditions. As part of the analysis of the test results, the Commissioning Agent should carefully review DDC trend logs and other data gathered during testing to ensure the system performance is consistent with the construction documents. Systems Functional Performance Testing should also include verification that the proper alarms and alarm priorities are indicated when the alarm conditions are present.

Evaluation of results is the final step. At each point in the process of installation inspections and system performance testing, the Commissioning Agent should evaluate whether the installed systems meet the criteria as set forth in the construction documents. Any issues or observations are reported to the VA PM/RE and the Contractor on Field Reports and the Master Commissioning Issues Log. The team should work collaboratively to find and implement an appropriate solution.

In projects being constructed in regions that have multiple operating seasons (i.e. heating season and cooling season), the construction schedule does not normally allow testing system operations in both seasonal modes. These systems will require additional testing under Season 2 conditions. For example, in a project where initial system testing is conducted during the cooling season, the cooling season become Season 1. Season 2 testing will be conducted during the heating season. Therefore, the Season 2 testing will generally be scheduled during the Warranty Phase of the project, approximately 6 months after initial testing, when environmental conditions are conducive to the alternate season testing.

Functional testing requires support from many Construction Team members. The Commissioning Agent witnesses and documents the testing while the Contractor, installing contactor and the DDC vendor operate and manipulate the systems. Since testing often identifies minor issues that can easily be corrected by minor adjustment or repair, other supporting contractors should be readily available to assist the testing, adjustment and/or repairs. In the case of HVAC system testing, the HVAC contractor and the DDC contractor are required to be present and to conduct the test. The electrical contractor,

TAB contractor, and other subcontractors do not need to be present at the test, but should be onsite and be readily available if needed.

It is also recommended that the VAMC FM staff be present during functional testing. The rigor of the testing is such that it provides an excellent opportunity for the O&M staff to see the systems in full operation and to witness the system response to the abnormal operating conditions. The systems are operated under conditions that the O&M staff may not witness in day-to-day operations for many years. It is very valuable for them to see and hear how the system reacts to these extreme situations. For example, the noise level in the system may rise considerably when operating at full load or temporary overload. The O&M staff needs to know that this is normal and to recognize it as a symptom of a system reacting normally to the extreme condition. This also allows the O&M staff to learn to differentiate between normal, abnormal and dangerous noises, vibrations, reading, or other indications of impending problems.

System failures, observations, and other issues are often identified during testing. The Commissioning Agent is a technical resource that can provide assistance and direction towards identifying the root cause of the problem. Together with the installing contractor, DDC vendor and TAB contractor, the Commissioning Agent can often identify possible causes and recommended corrective measures. Where these measures can be readily identified and the corrective action can be completed by readily available personnel and material, the functional testing can be temporarily be interrupted to complete the corrective action. If the corrective action cannot be completed in a reasonable time (usually 15 – 20 minutes), testing can continue with other portions of the test that are not impacted by the problem. If the problem is severe enough that, if in the opinion of the Commissioning Agent, functional testing cannot continue in a meaningful manner with a reasonable probability of a partially successful completion, the Commissioning Agent will recommend that testing be halted. Final direction to halt testing is at the sole discretion of the VA RE. If testing can proceed on other systems, those tests can be conducted. If no other testing or commissioning tasks can be completed, the Commissioning Agent will leave the site. Resumption of functional testing will be scheduled at a time and date mutually acceptable to all parties involved in the testing.

The results of functional testing are documented on the Systems Functional Performance Test Procedure. The Commissioning Agent will also prepare a Field Report to document the testing activities and any significant issues found during testing. Significant issues will also be entered on the Master Commissioning Issues Log.

8.6 Operations and Maintenance Manuals

The Contractor is required to submit O&M Manuals for systems and equipment as identified in the specifications. These manuals should be submitted at within 90 days of approval of all related shop drawings. Early delivery of Operations and Maintenance Manuals allows both the Commissioning Agent and the Construction Team to validate the accuracy of these manuals and utilize them as an effective training tool during the turn over phase of the project.

The Commissioning Agent has the experience and knowledge to assist in review of the O&M Manuals. The submittal process is expanded into multiple submittals throughout the construction phase. The requirements for each submittal are designed to coordinate with the point in the construction process when the contractor obtains the required information.

The first submittal may include the binder(s) with a Table of Contents and divider tabs for each section of the manual. This submittal includes the approved equipment submittal information and basic equipment manuals available from the manufacturer. This O&M submittal is due shortly after Equipment Submittal/Shop Drawing approval.

The second O&M submittal may expand on the first submittal by including data sheets for each item of equipment installed on the project. Generally this data will include make, model, size, equipment identification, serial number, installed location, and other item-specific information.

The final O&M submittal expand the earlier submittals by including scheduled maintenance information, recommended critical spare parts information, and contact information for local suppliers.

Coordination of the O&M Manual Submittal process should be considered and clearly described in the Project Specifications.

8.7 Systems Manual

The Commissioning Agent, with the assistance of the Contractor and the A/E team, will develop a Systems Manual that gives operating staff the information needed to understand and optimally operate the commissioned systems. The Systems Manual is provided in addition to the O&M Manuals submitted by the contractors. The Systems Manual generally focuses on operating, rather than maintaining, the equipment. It also focuses on the interactions between systems.

The Systems Manual should include the following for each commissioned system:

- Final version of the Design Narrative
- Single-Line Diagrams, Flow Diagrams

- As-built sequences of operations, control drawings, and original setpoints
- Operating instructions for integrated building systems
- Recommended schedule of maintenance requirements and frequency, if not already included in the O&M Manuals.
- Recommended schedule for re-testing of commissioned systems with blank test forms from the original commissioning plan
- Recommended schedule of calibrating sensors and actuators

8.8 Training Verification

Successful and sustained operation of building systems relies on experienced and trained operating personnel. To this end, the construction specifications require that the Contractor and/or the Manufacturers' Representative provide training to operating personnel.

The Commissioning Agent is in a unique position to evaluate the training needs for operating personnel. These needs can then be translated into training requirements that the contractors must address in the training plans they develop. Common topics that should be included in the training plans are as follows:

- General purpose of the system (design narrative)
- Use of O&M Manuals
- Review of Control Drawings and schematics
- Startup, normal operation, shutdown, unoccupied operation, seasonal changeover, manual operation, control setup and programming, troubleshooting and alarms.
- Interactions with other systems
- Adjustments and optimizing methods for energy conservation
- Health and safety issues
- Special Maintenance and replacement sources
- Occupant interaction issues
- System response to different operating conditions

8.9 Commissioning Issues Follow Up and Resolution

Throughout the construction commissioning process, issues will be identified that need to be evaluated and resolved. There are several vehicles available

to the Commissioning Agent to assist with documenting and tracking these issues. These include:

- Field Reports
- Commissioning Issues Log
- Systems Functional Performance Test Procedures
- Commissioning Requests for Information (Cx RFI)

Opportunities to follow-up on outstanding issues include Construction Progress Meetings, Commissioning Progress Meetings, emails, face-to-face meetings, phone calls, and informal discussions with the VA RE, A/E, Contractor, DDC vendor, TAB contractor, as well as others who may have information relevant to the issue.

The Commissioning Agent has the expertise, experience and overall knowledge of the system design to assist the project team with identifying root causes and recommending appropriate solutions. The recommended resolution of an issue may require review by the A/E team with final approval and direction by the VA RE. The Commissioning Agent will often recommend that the installing contractor, DDC vendor, TAB contractor or Contractor submit an RFI to the VA PM/RE and the A/E for review and approval. In some cases, the Commissioning Agent will submit a Commissioning RFI to request clarification from the A/E and VA RE.

Final approval of, and direction on, proposed resolutions rests with the VA RE who will issue the appropriate Change Order, Field Directive or other document. The Commissioning Agent should be included in the distribution for these approval documents so they can be included in revisions to the Design Narrative and the Systems Manual. The A/E and the Contractor may also need to document the issue resolution in the As-Built drawings, Sequences of Operation, and/or control schematics. If necessary, the Commissioning Agent will modify functional test procedures to address changes made during the issues resolution process.

8.10 Final Commissioning Report

The Commissioning Agent will prepare a comprehensive Commissioning Report that documents the commissioning activities and results. This report is prepared after installation inspections and systems functional testing activities have been completed, and the results have been tabulated and evaluated.

The Commissioning Report should include the following:

- Executive Summary of the process and the results of the commissioning program, including observations, conclusions, and any outstanding issues.
- Summary of the design review process

- Summary of the submittal review process
- Summary of the O&M Manual and Training processes.
- History of any system deficiencies identified and how they were resolved, including any outstanding issues or seasonal testing scheduled for later during the warranty phase.
- Systems performance test results and evaluation.
- Confirmation from the Commissioning Agent indicating whether individual systems meet the Owner's Project Requirements, design narrative and contract documents.

8.11 Lessons Learned Review Meeting

This is a meeting convened by the Commissioning Agent for the purpose of reviewing the project and the commissioning process. The meeting should be scheduled shortly after the Commissioning Report has been submitted and reviewed by the VA. Attendees at the meeting should include:

- VA PM and VA RE
- Commissioning Agent
- VAMC FM managers
- VAMC user agency representative
- VA CFM
- A/E
- Contractor
- VA Contracting Officer (optional)

This should be an open forum where all parties can address concerns, recommendations for improvement, and other issues aimed at improving the facility and the project delivery process.

Topics could include concerns and recommendations for improving the following:

- the design or design process
- the construction process
- facility performance
- energy performance
- building or systems operations
- building or systems maintenance

- the commissioning process

The results of this conference will be summarized by the Commissioning Agent and submitted to VA CFM and VA PM and VA RE for review and follow-up.

9 Warranty Phase

9.1 Systems Performance Monitoring

During the Warranty Phase, the Commissioning Agent, VA staff, and representatives of the A/E team and the Contractor's team shall verify on-going system performance by repeating selected Systems Functional Performance Tests and by reviewing energy bills and other performance-related documentation. The Commissioning Agent shall prepare a report to the VA stipulating any issues with on-going system performance and/or confirming that the systems are functioning as designed and intended.

9.2 Deferred Seasonal Testing

Functional Testing is performed on systems that could not be tested during the Acceptance Phase of the project due to seasonal load issues that prevent reasonable testing of a system or of integrated systems whose operation is dependent on seasonal building loads. Systems Functional Performance Testing will be executed in the opposite season to confirm successful operation of the integrated systems under building loads. These tests can also be required to demonstrate the performance of the occupied building where insufficient internal loads in the building prevented the Commissioning Agent from adequately challenging the systems during initial testing.

The Commissioning Agent will issue the following documentation:

- Warranty Phase Commissioning Issues Log for issues and deficiencies identified during Seasonal Testing. The Contractor should be obligated to resolve any identified issues and report resolution to the Commissioning Agent. Resolutions will be verified by the Commissioning Agent and documented on the Warranty Phase Commissioning Issues Log.
- Commissioning Field Observation Reports that document the seasonal testing results

9.3 Post-Occupancy Warranty Checkup

In order to support the VAMC Operations Team and the VA RE in the Post Occupancy Period and provide technical support for warranty enforcement, the Commissioning Agent will provide a Post Occupancy Inspection of the project at least once no later than 10 months after start of the Contractor's project warranty period. Visits should be scheduled quarterly to provide ongoing evaluation of system performance, training reinforcement/enhancement and warranty support. The objectives of the Post Occupancy Warranty Check Up shall be:

a. To evaluate system performance against commissioned performance thru execution of ‘re-commissioning’ testing and performance evaluation strategies;
b. To Evaluate staff operational methodologies and expertise;
c. To reinforce training delivered at the end of construction and to recommend additional staff training to enhance operational expertise; and,
d. To provide assistance and technical expertise in documenting outstanding warranty and latent defect issues that may be identified during this period.

During the Post Occupancy Check up, the Commissioning Agent should

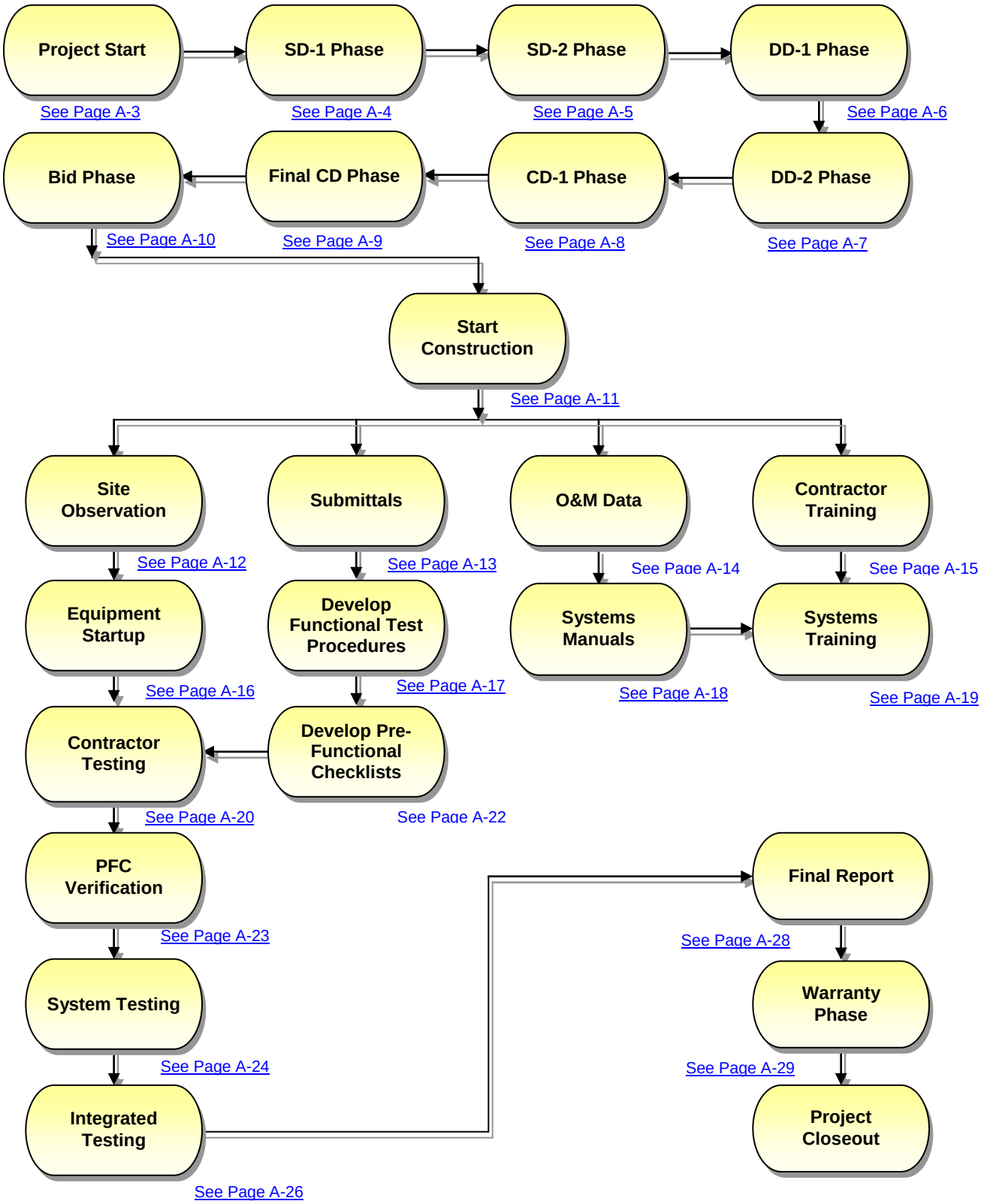
a. Meet with the VAMC Operations Team. Interview team members to evaluate system performance to identify any issues with operation of the commissioned systems and to reinforce good operational practices.
b. Evaluate system performance through a review of operating performance data and warranty phase (re-commissioning) tests as identified in the Commissioning Plan and Systems Manual.
c. Develop a Warranty Report identifying any outstanding warranty issues for VAMC use in resolving warranty issues on the project.

9.4 Final Commissioning Report Post Occupancy Addendum

Once the Post Occupancy Site Visit is complete, the Commissioning Agent will issue a final addendum to the Commissioning Report that documents all Warranty Phase efforts including Seasonal Testing, additional training efforts, post occupancy system performance evaluations and Warranty Reporting. The Addendum should be issued in a manner that allows the VAMC to incorporate the information into their working copy of the Final Commissioning Report.

Appendix A – Commissioning Process Flowcharts

The following pages contain flowcharts that graphically depict the VA Commissioning Process as described in this Manual.


Project Start
See Page A-3
SD-1 Phase
See Page A-4
SD-2 Phase
See Page A-5
DD-1 Phase
See Page A-6
DD-2 Phase
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CD-1 Phase
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Final CD Phase
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Bid Phase
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Start Construction
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Site Observation
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Submittals
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O&M Data
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Contractor Training
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Equipment Startup
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Develop Functional Test Procedures
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Systems Manuals
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Systems Training
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Contractor Testing
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Develop Pre-Functional Checklists
See Page A-22
PFC Verification
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System Testing
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Integrated Testing
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Final Report
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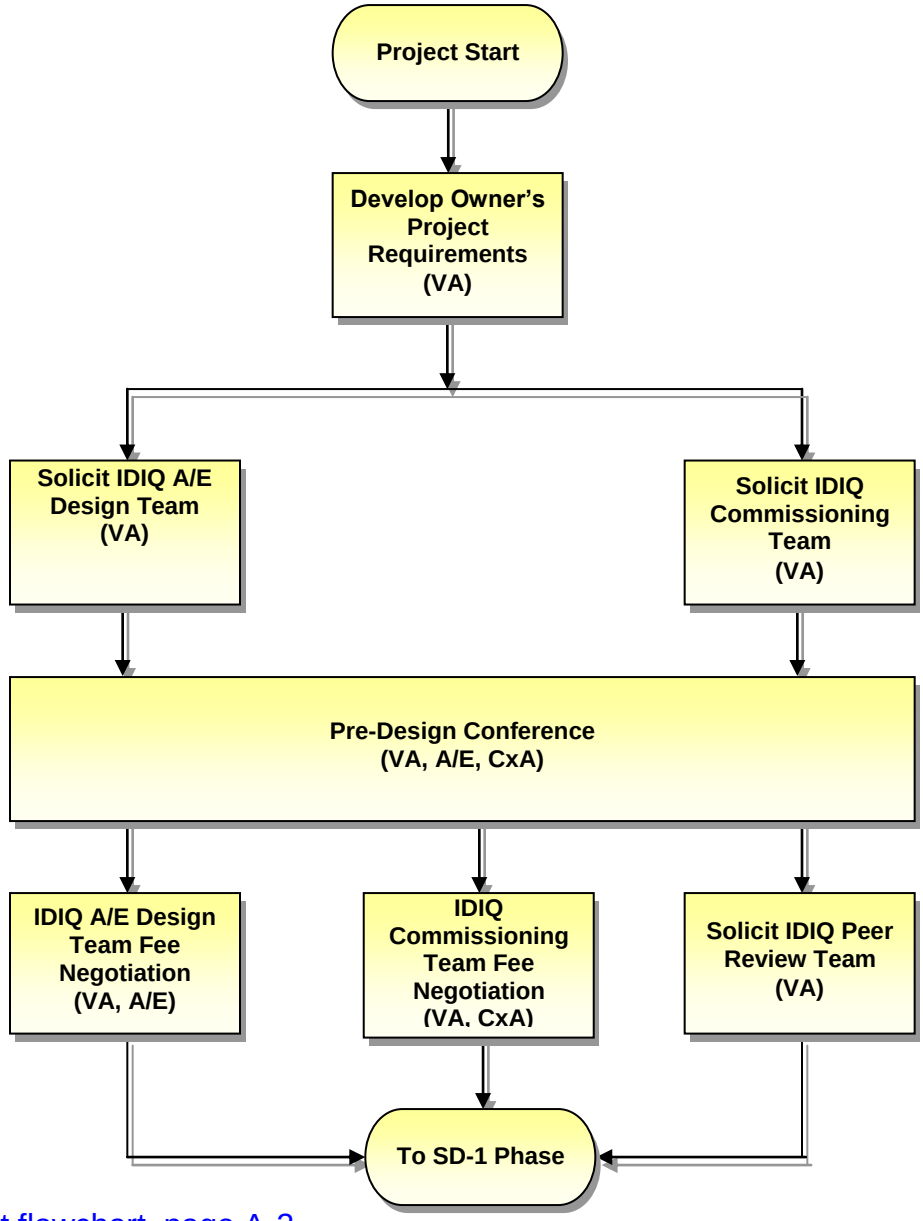
Warranty Phase
See Page A-29
Project Closeout



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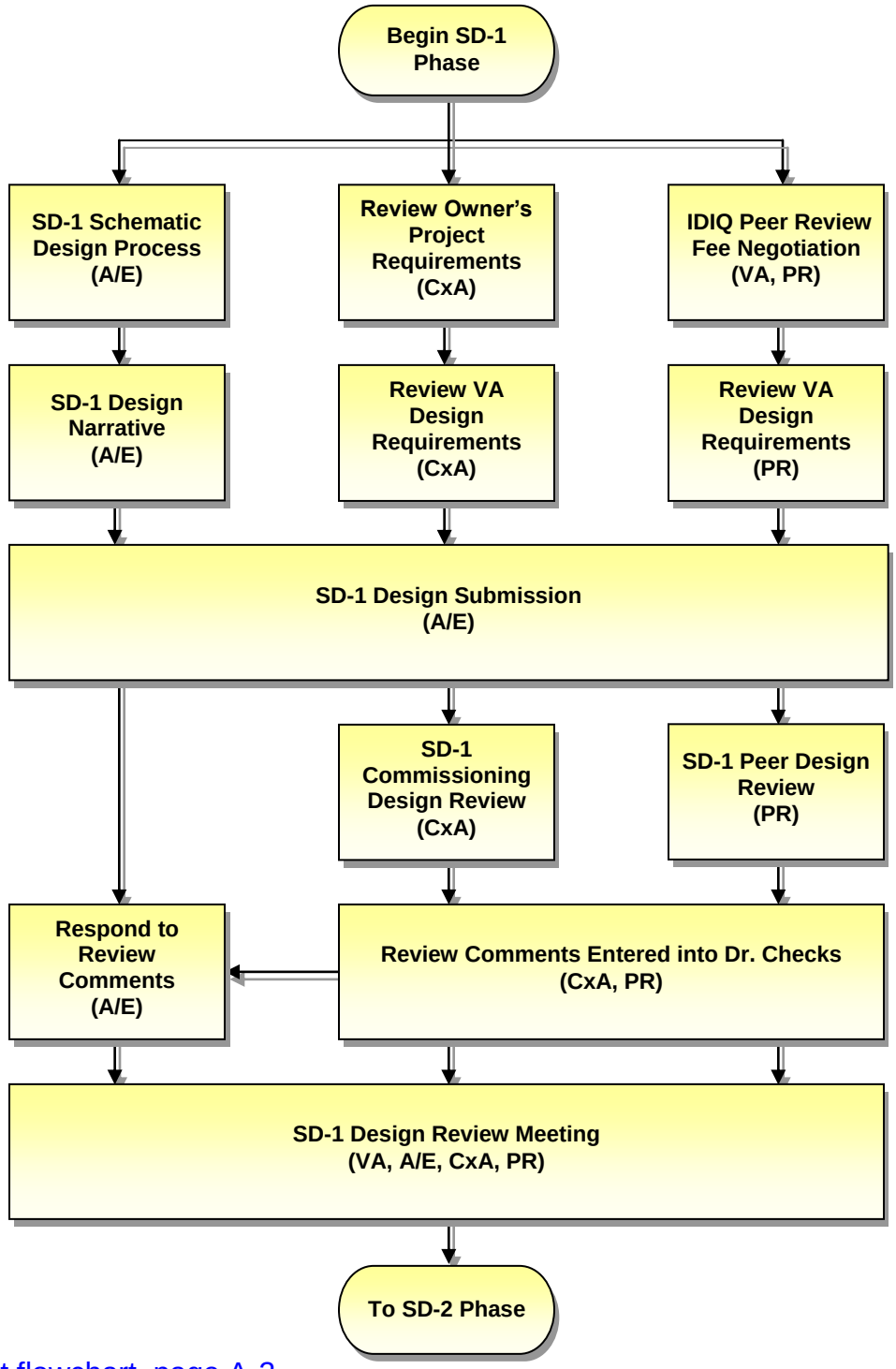

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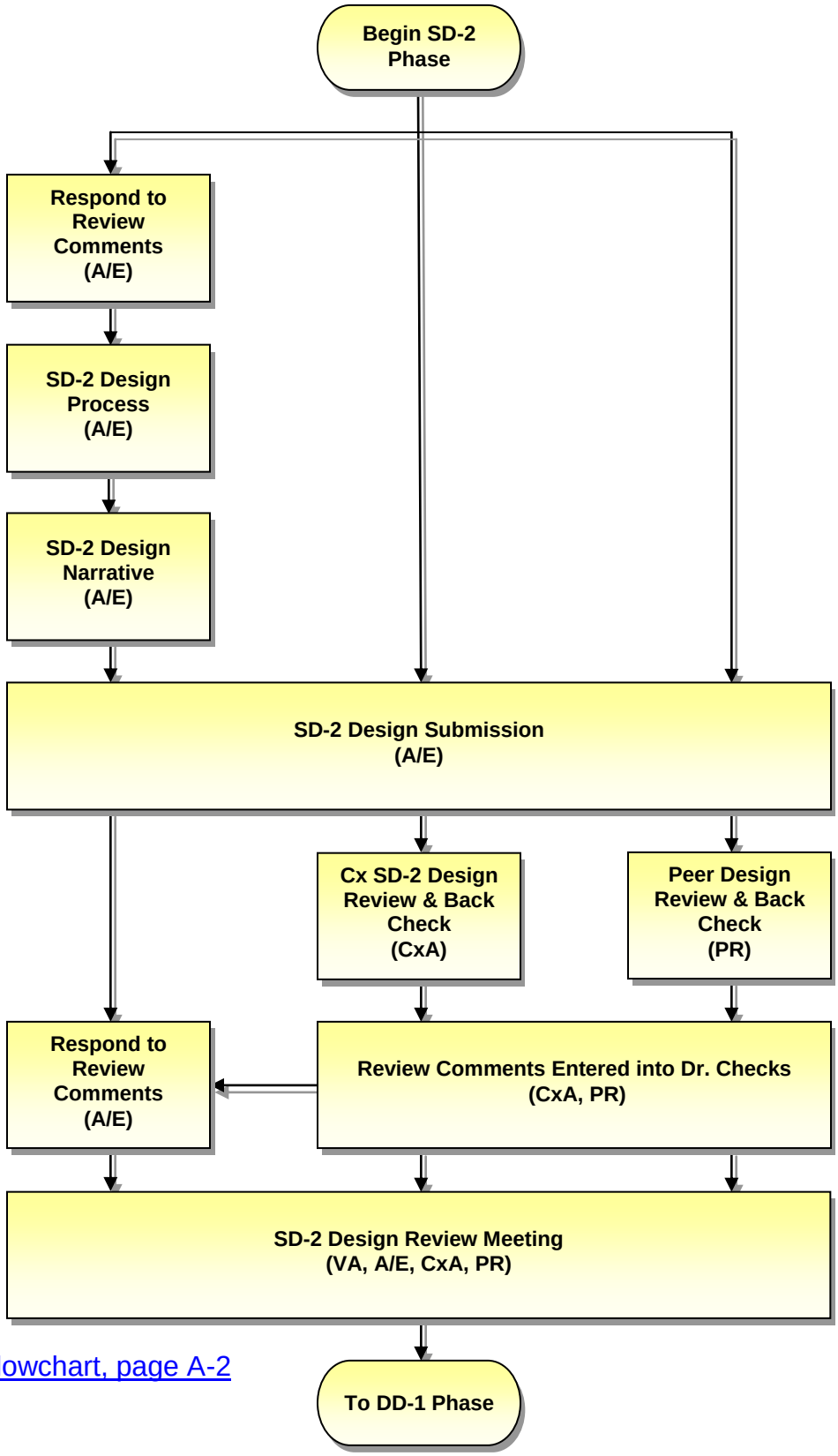

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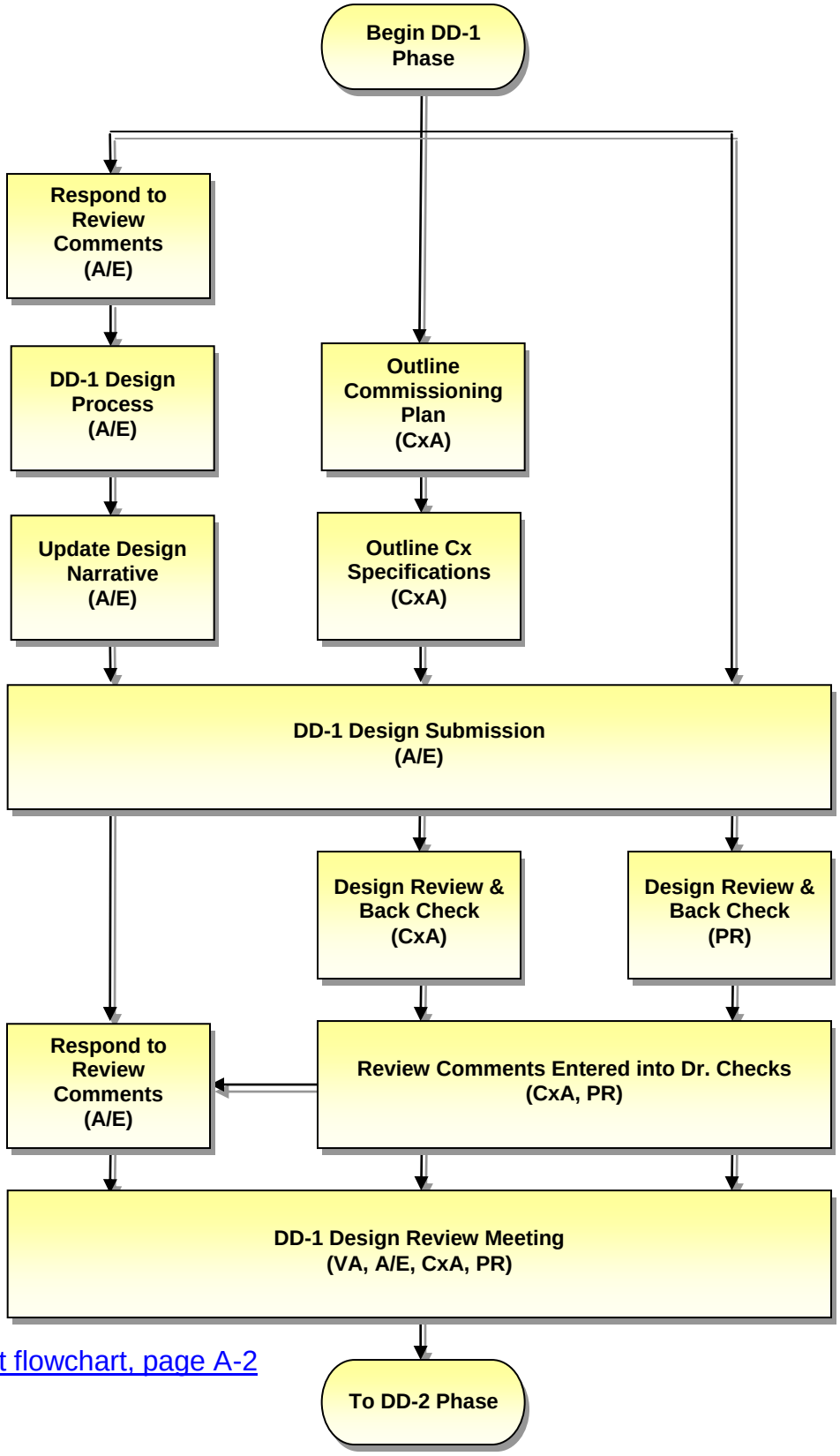

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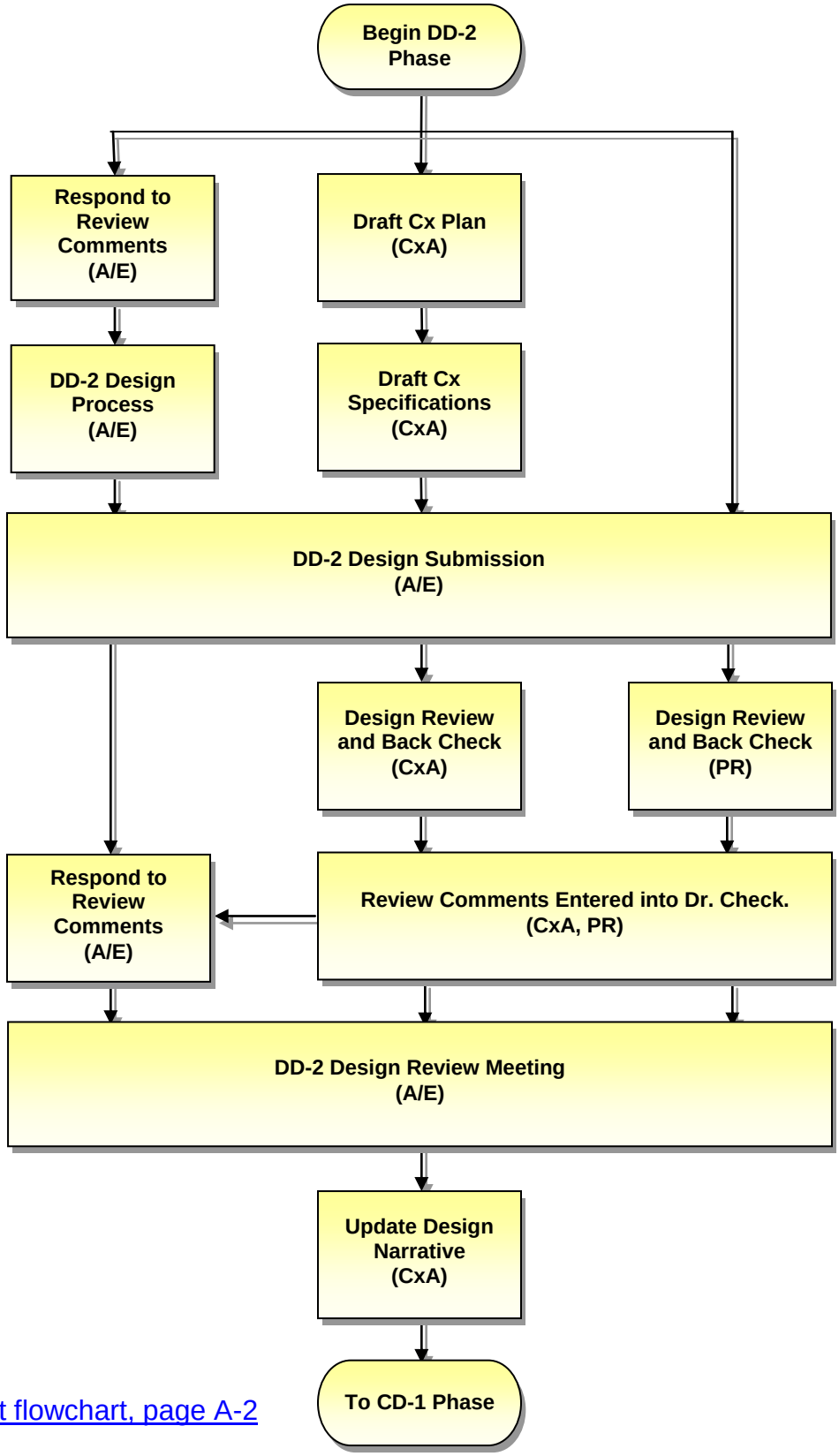

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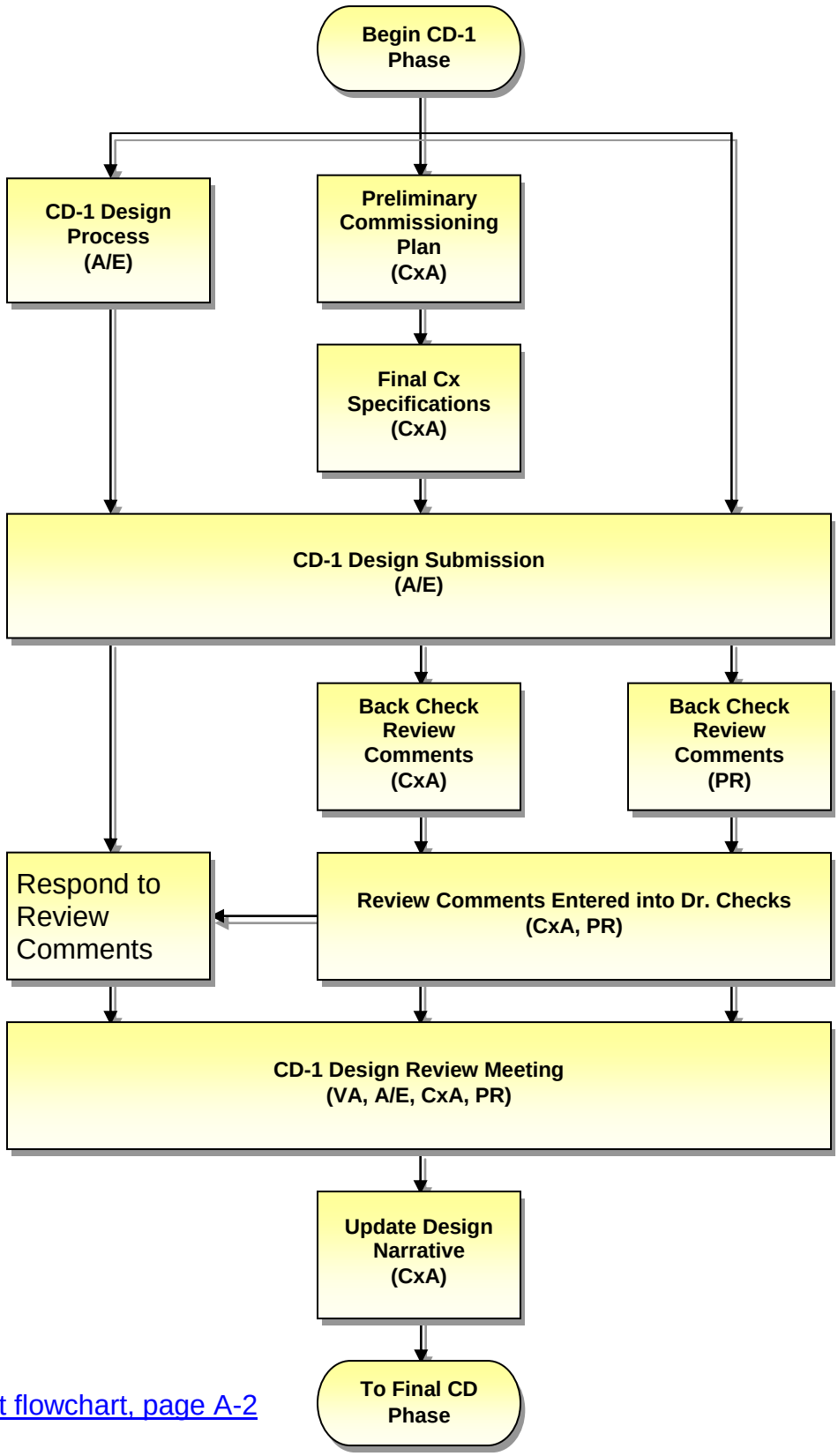

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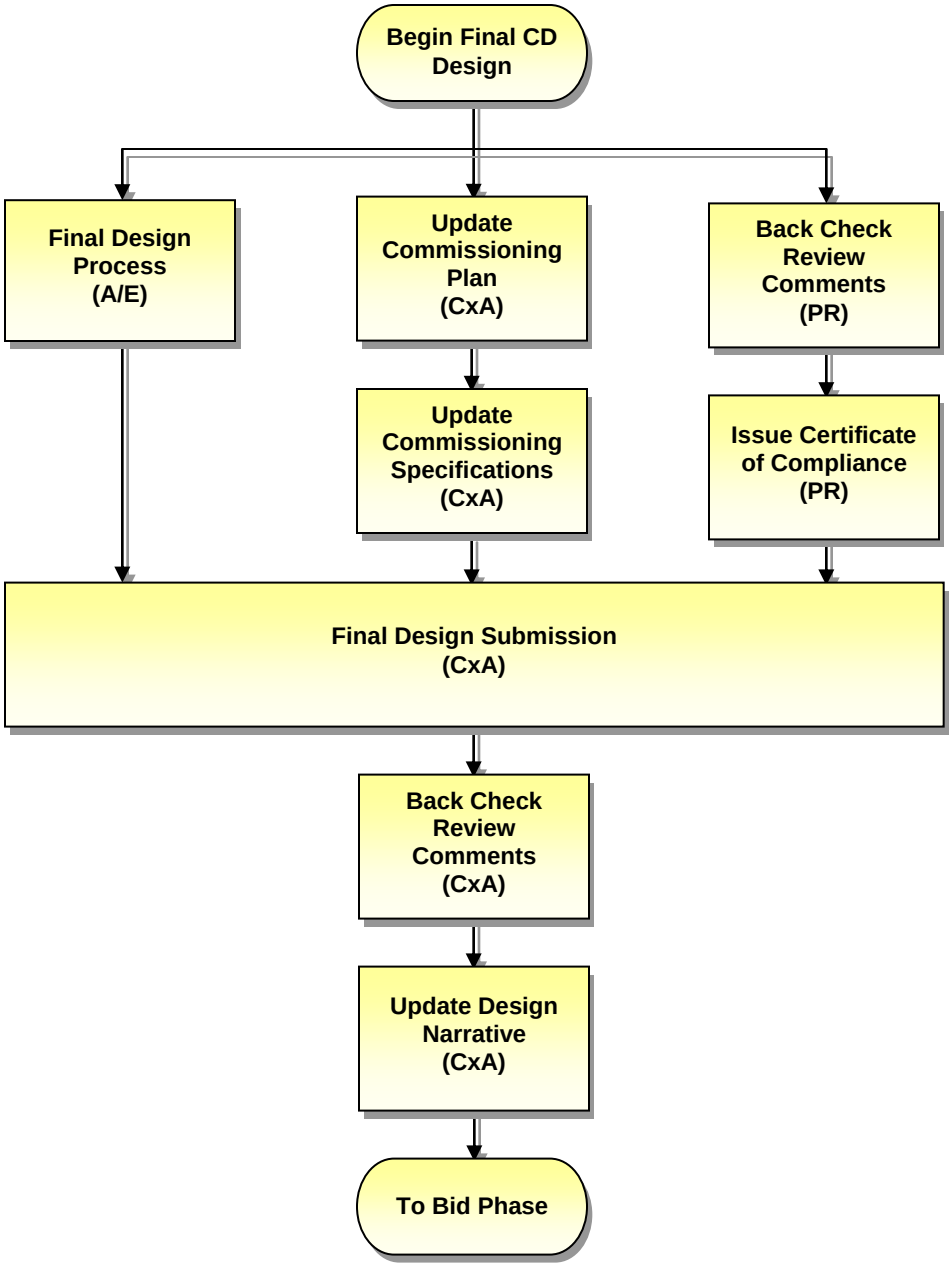

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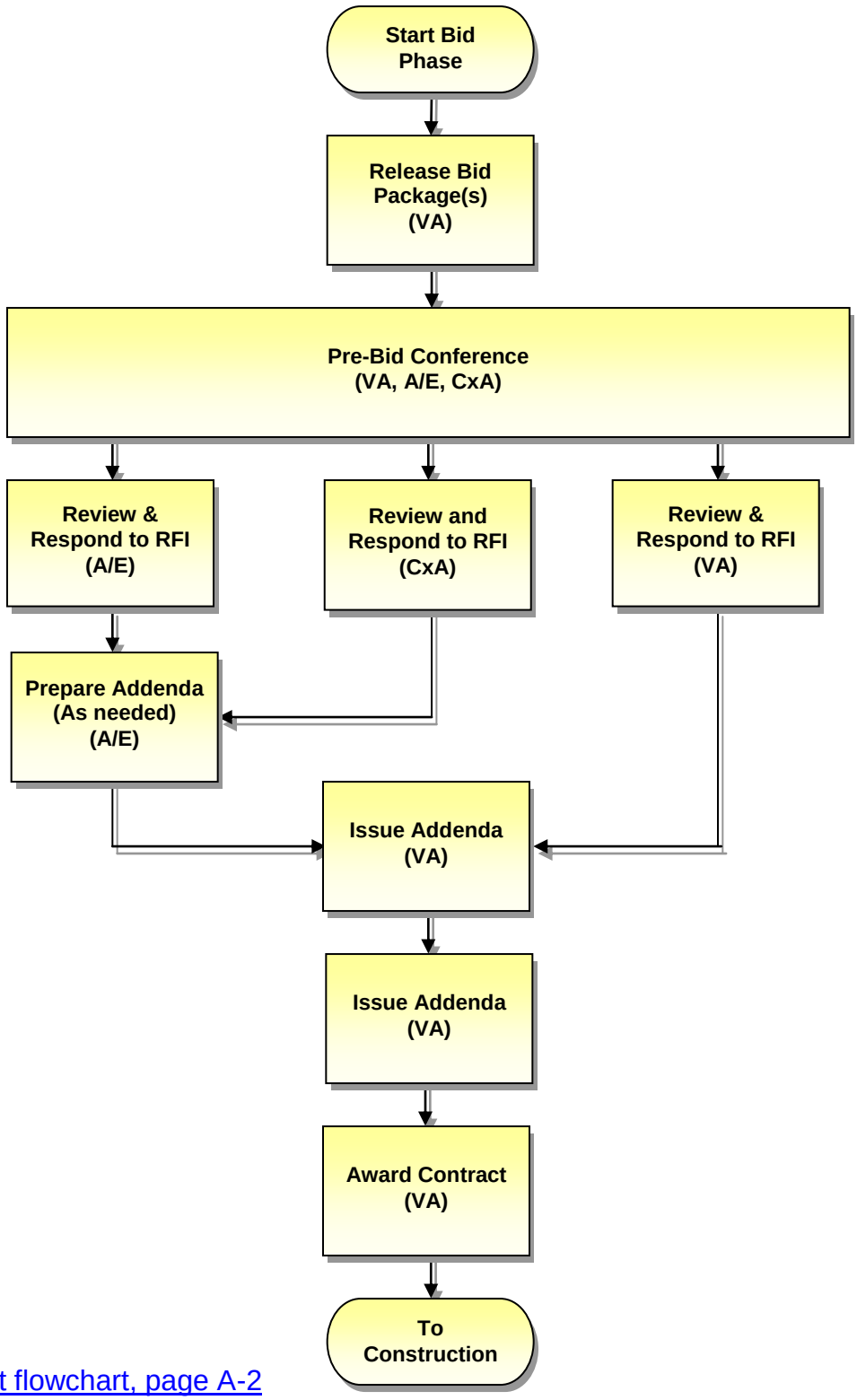

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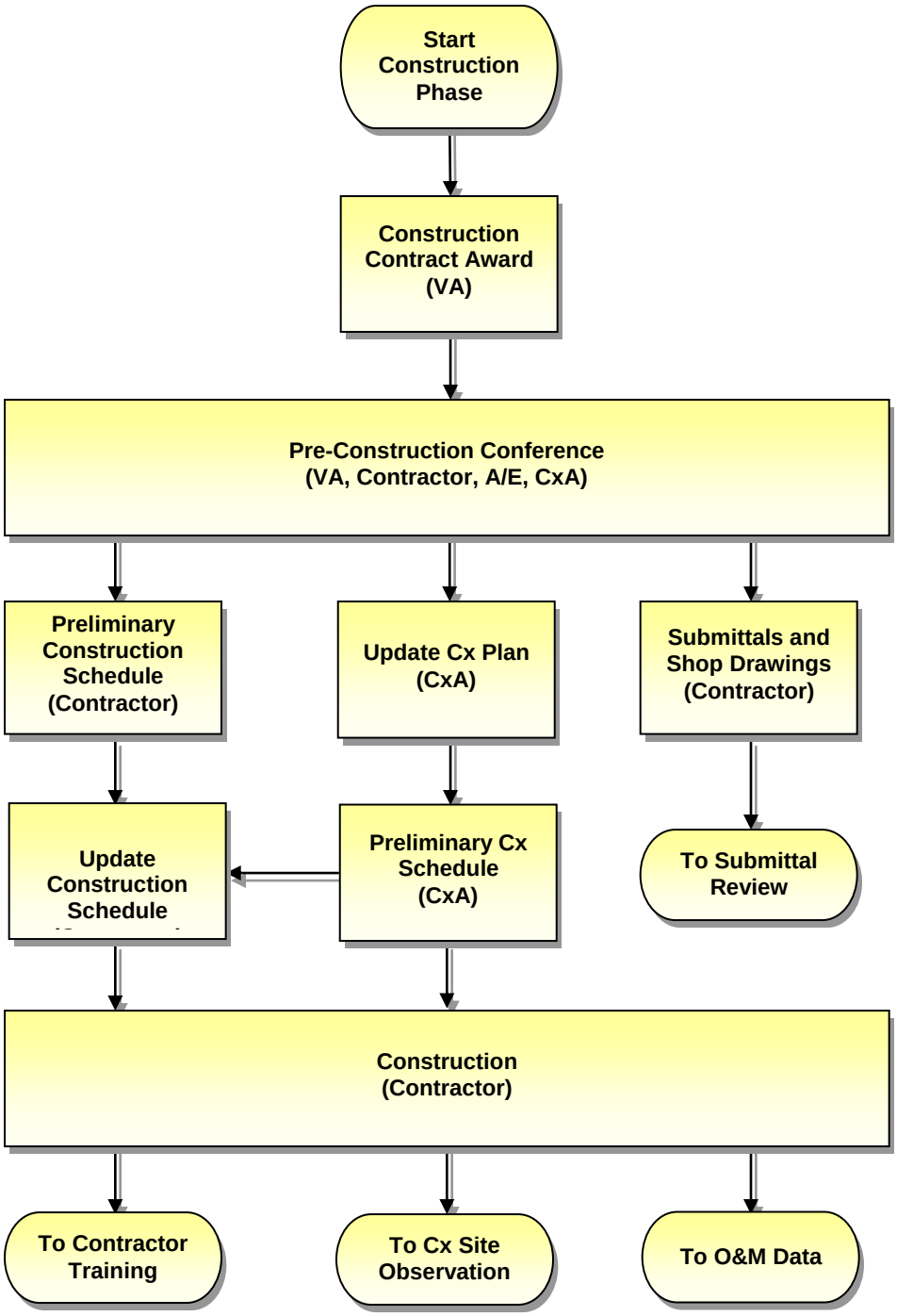

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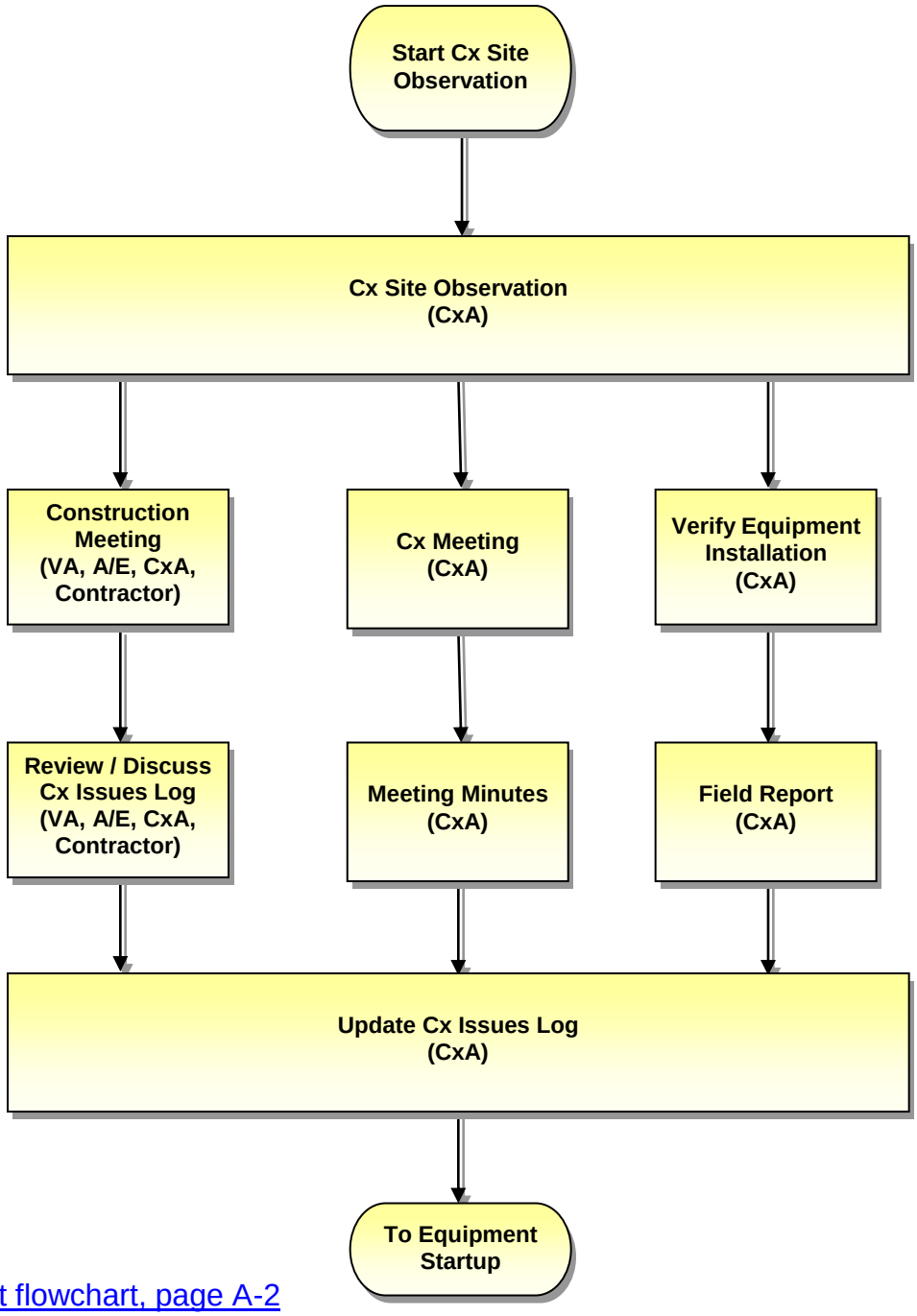

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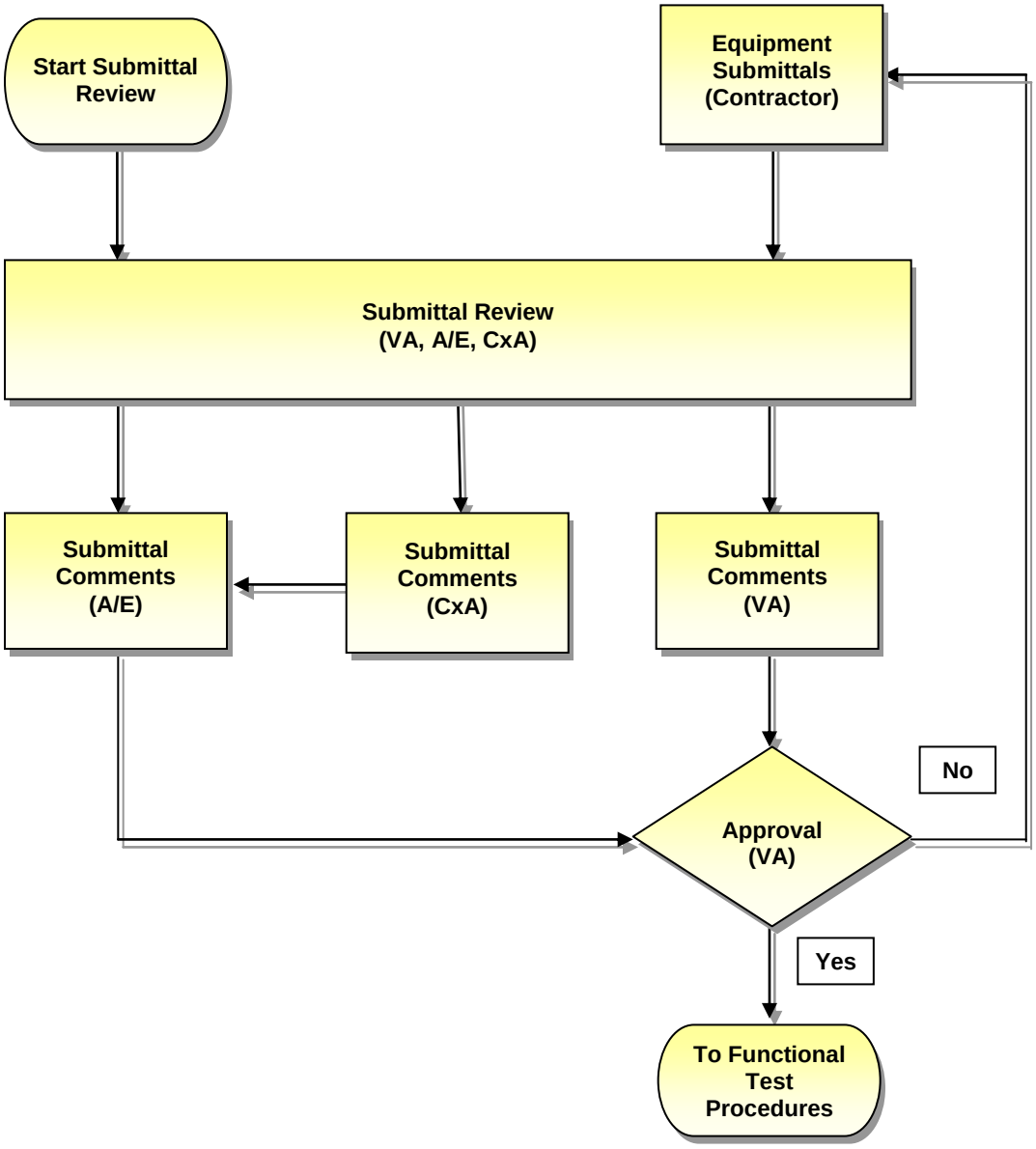

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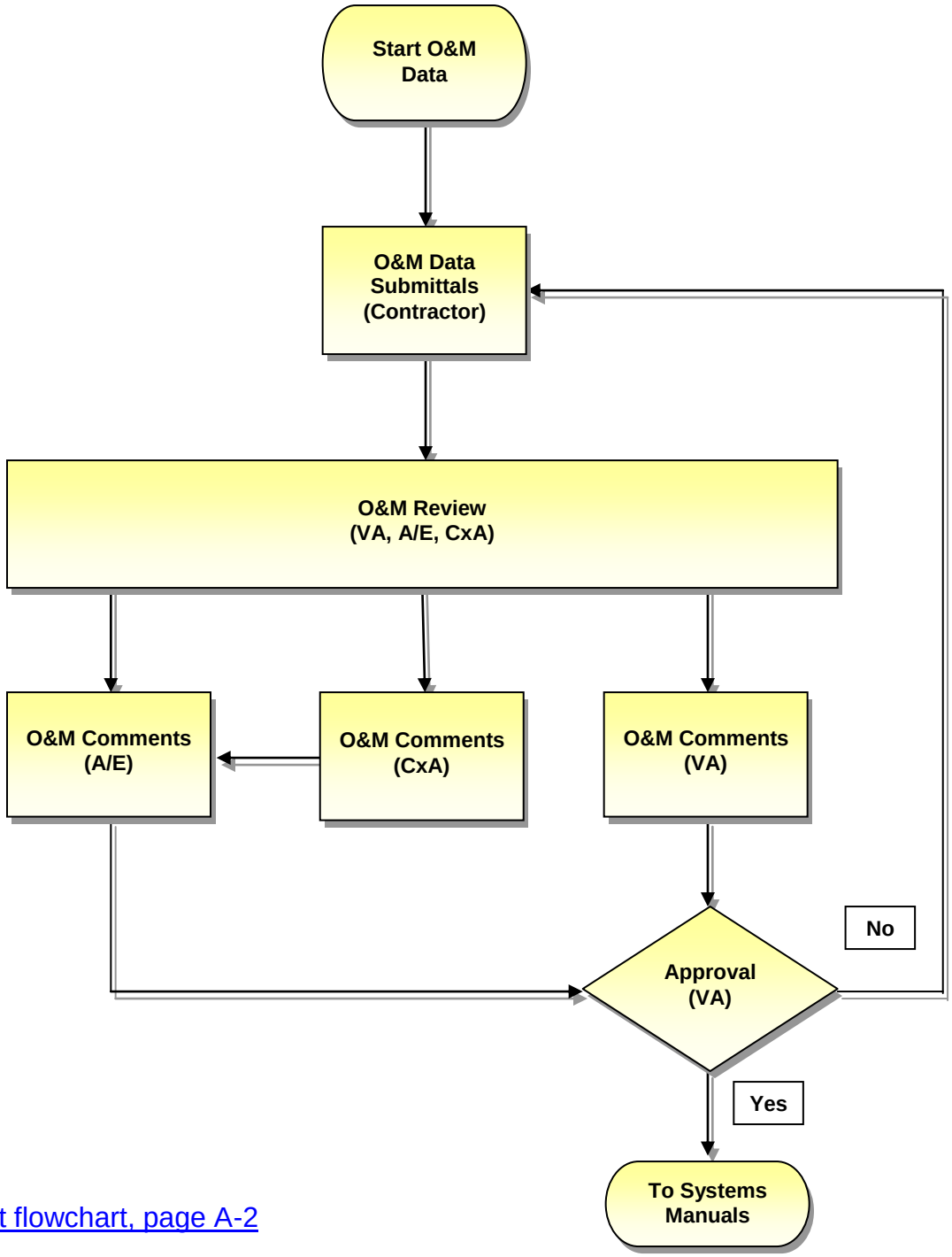

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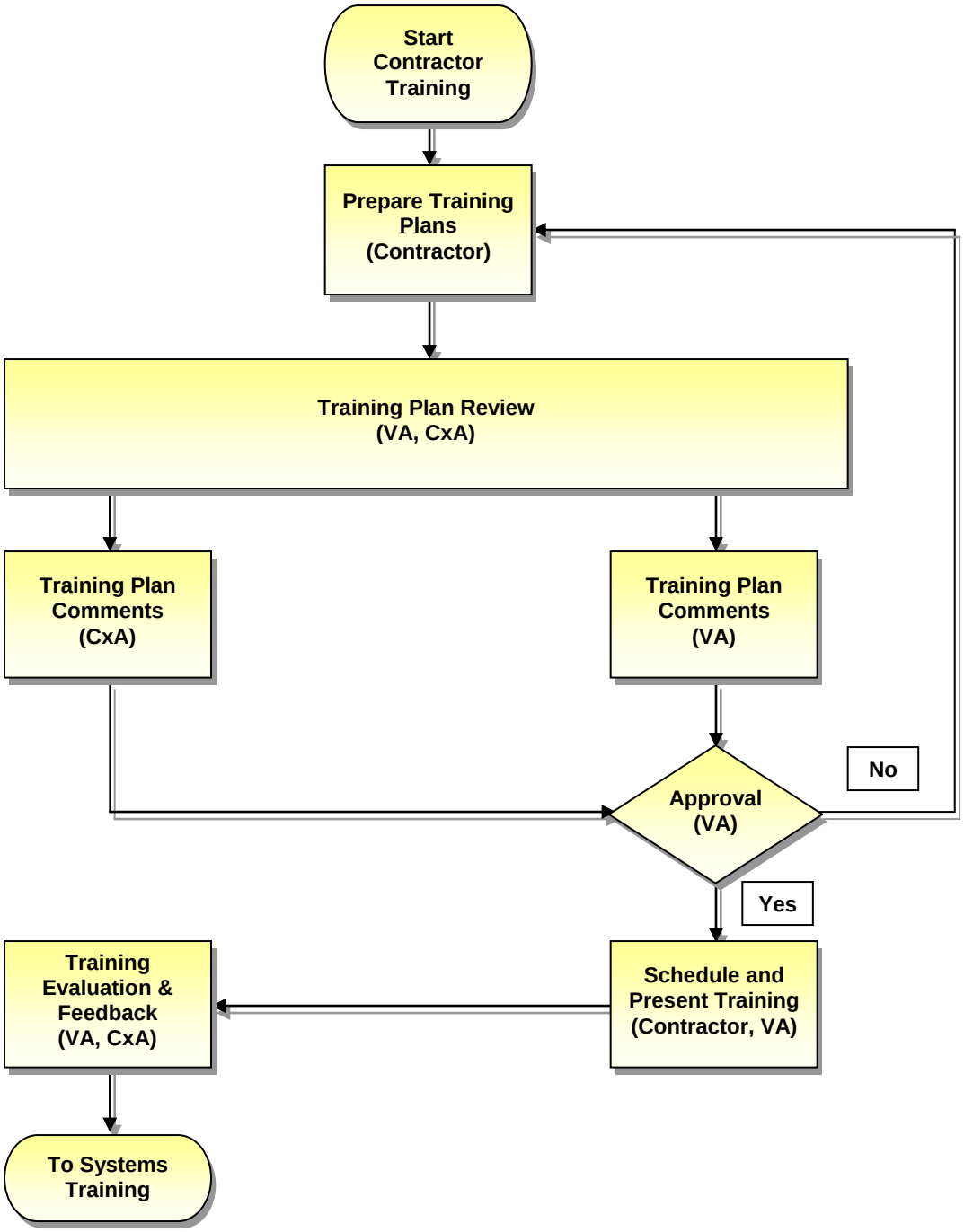

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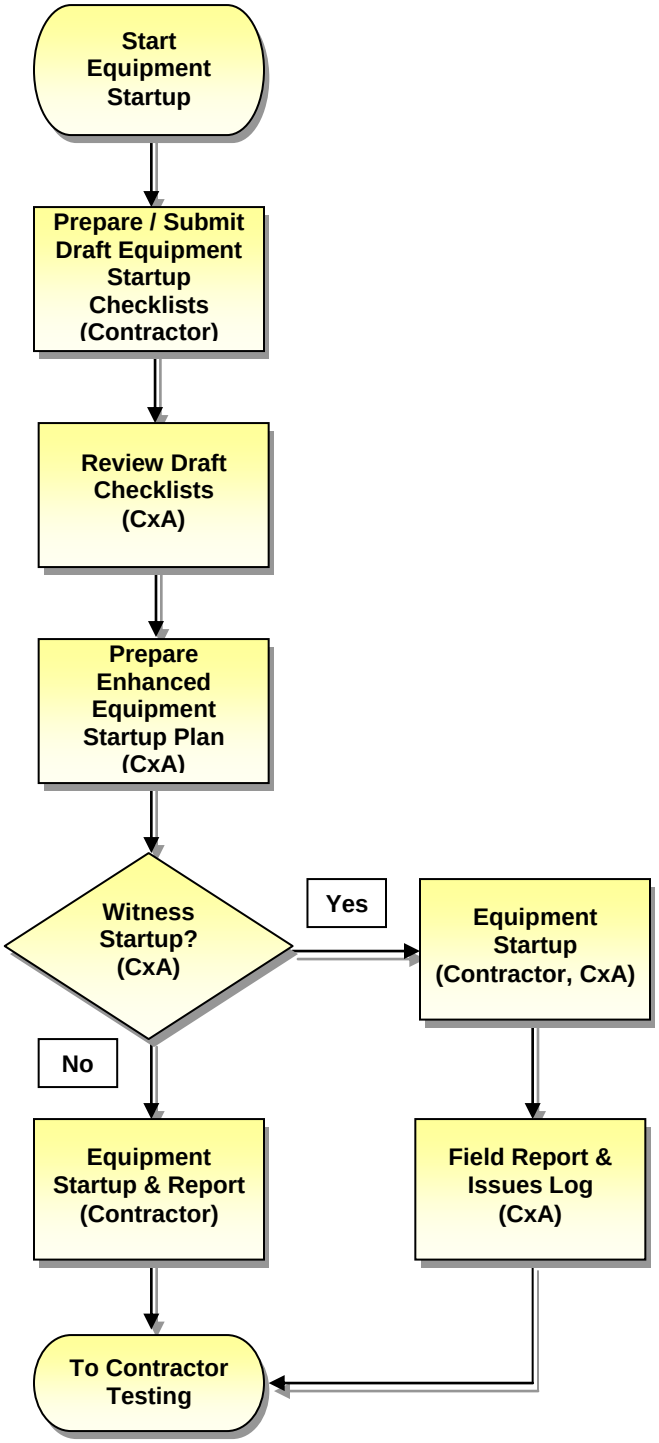

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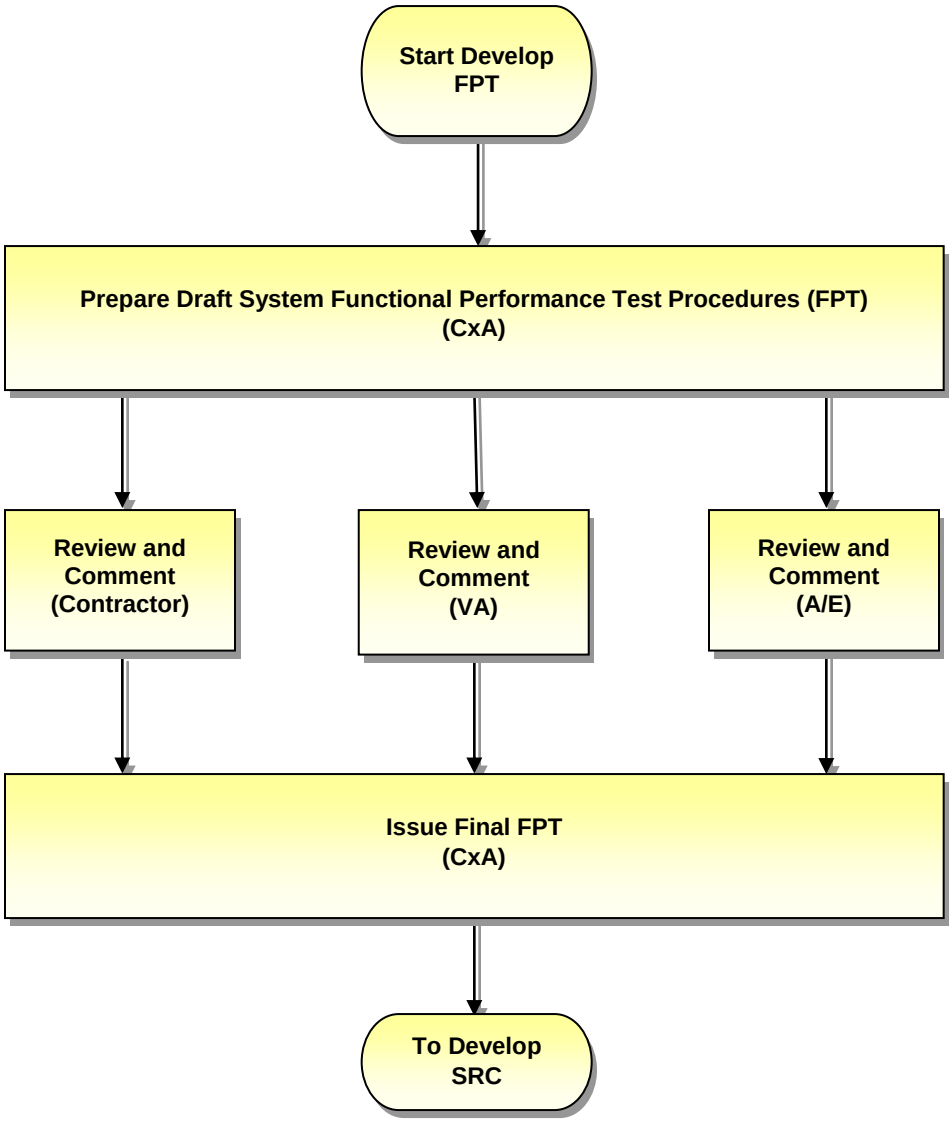

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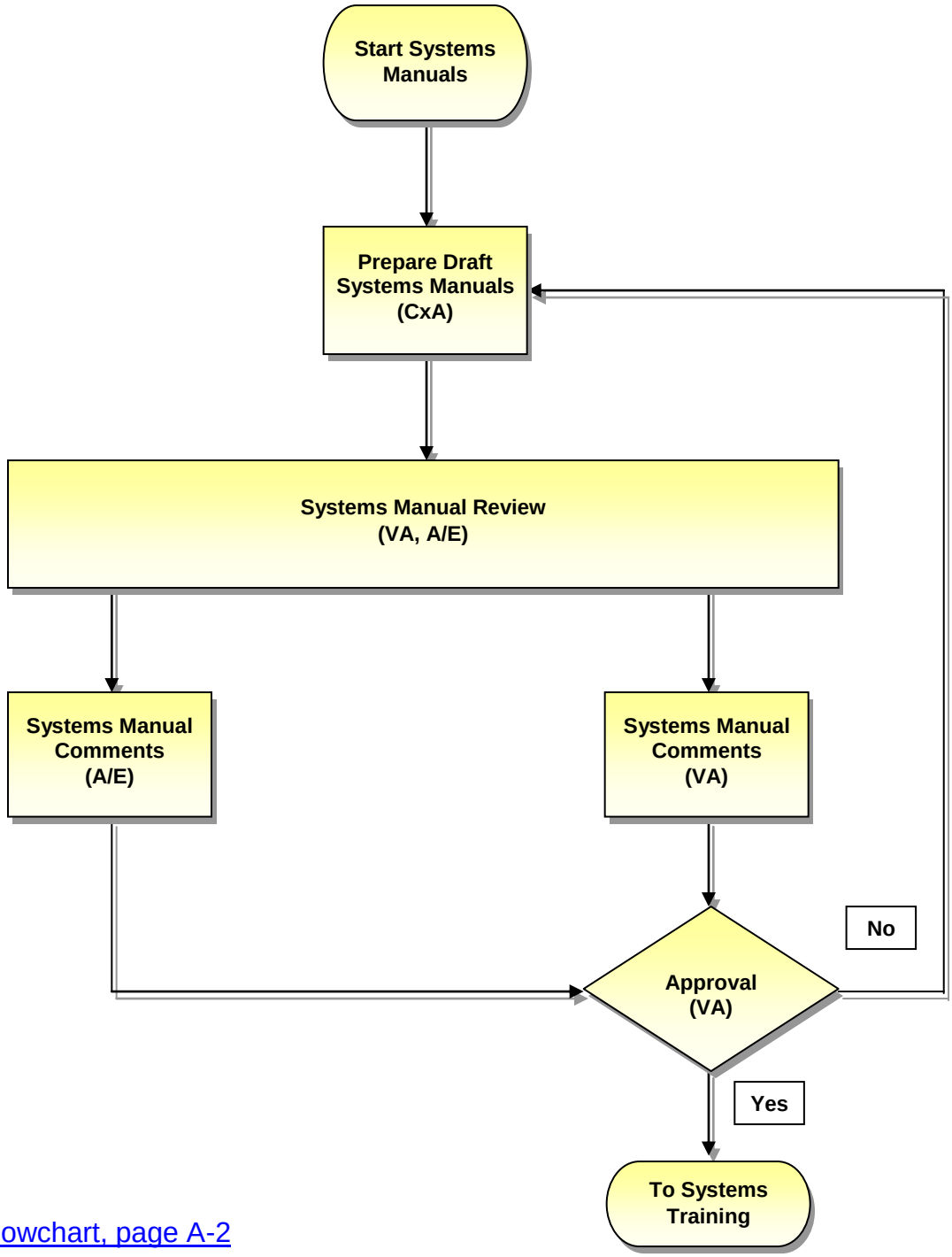

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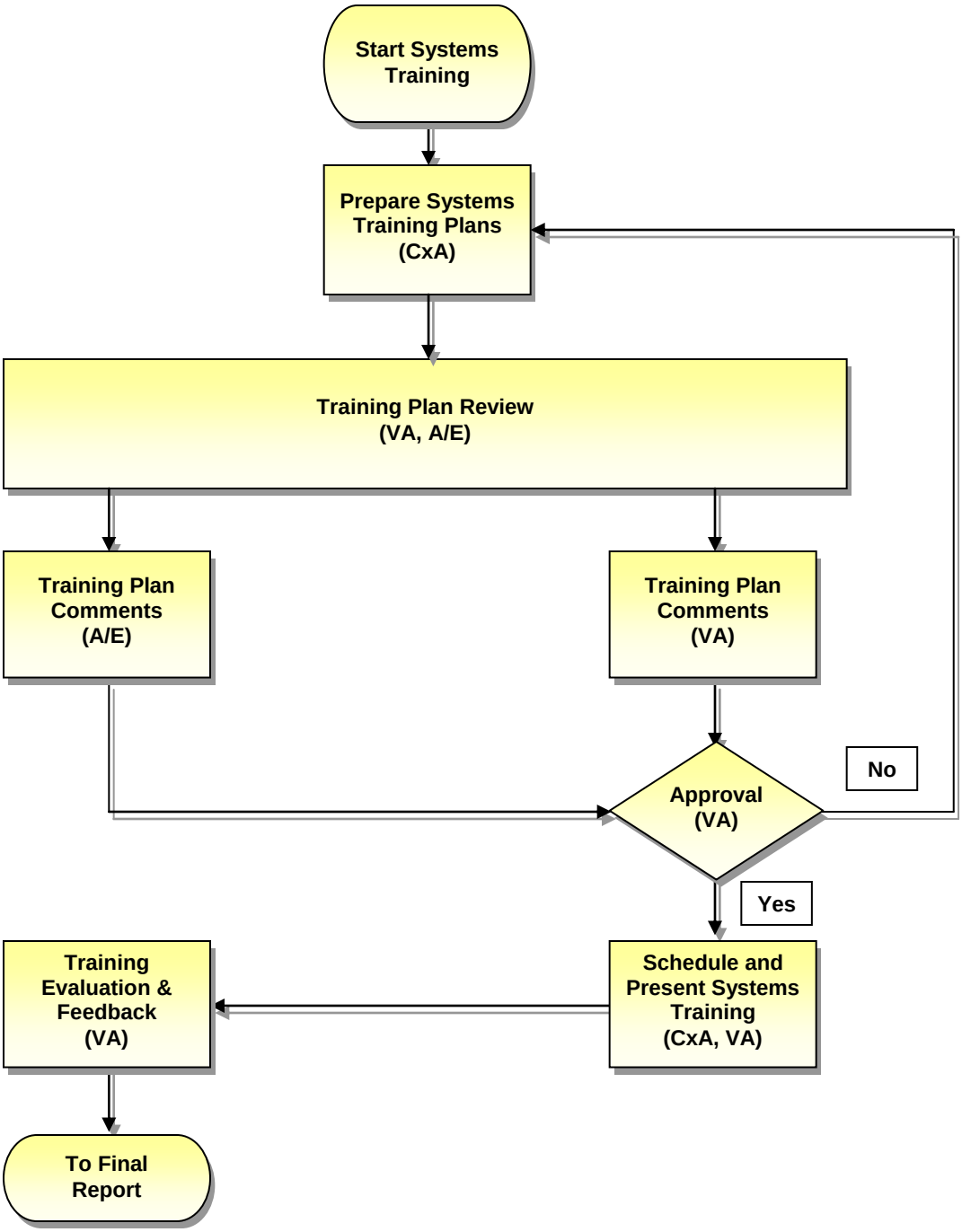

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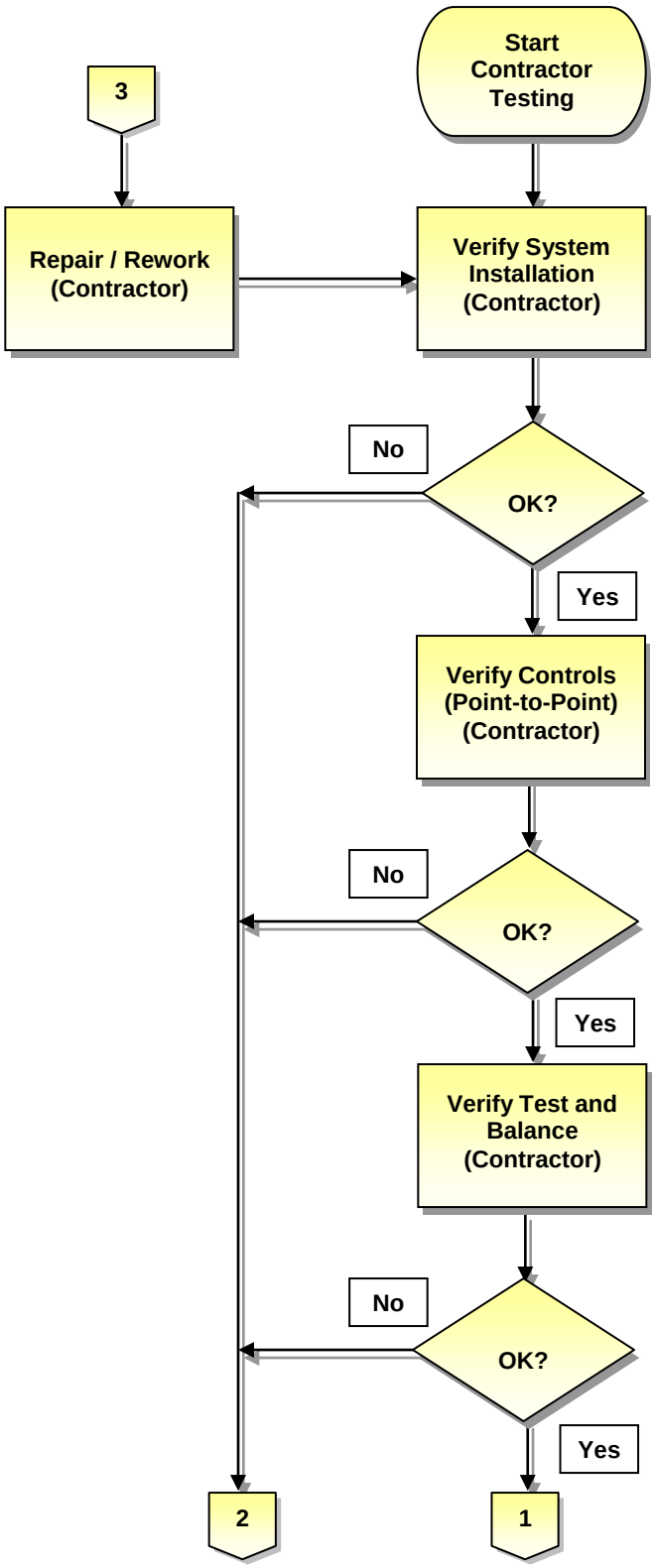

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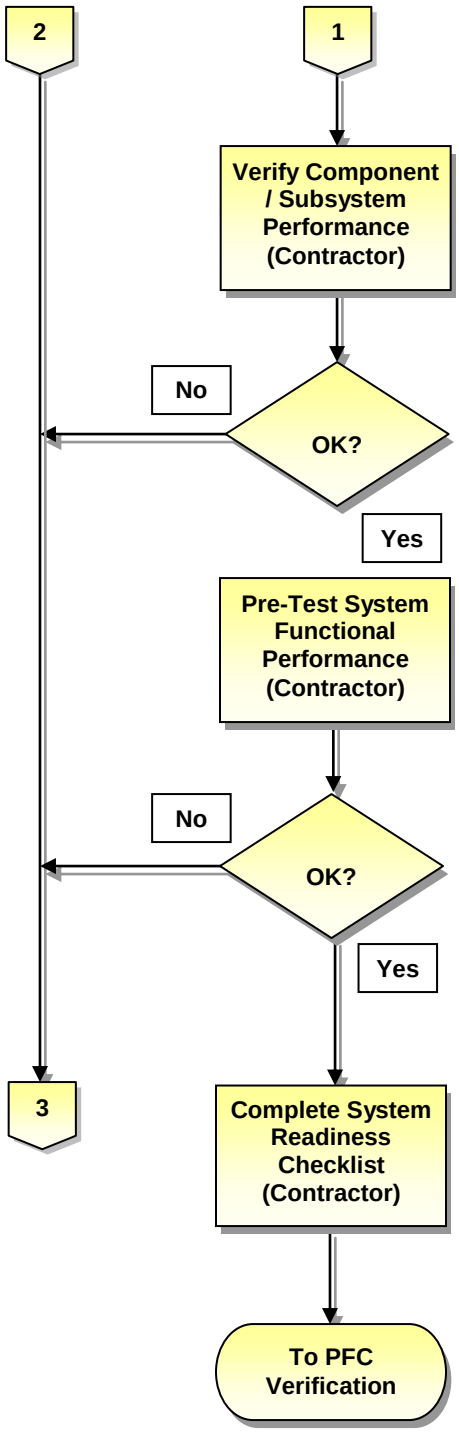

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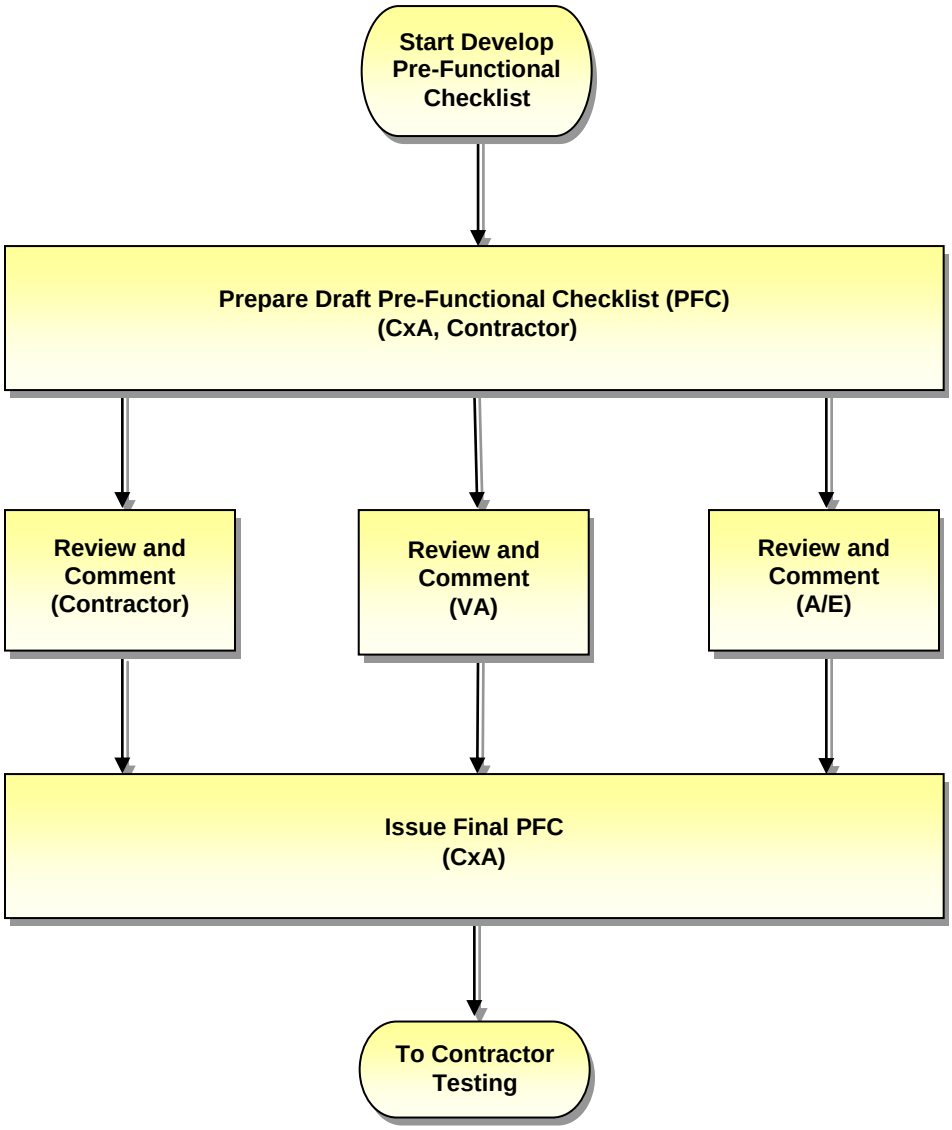

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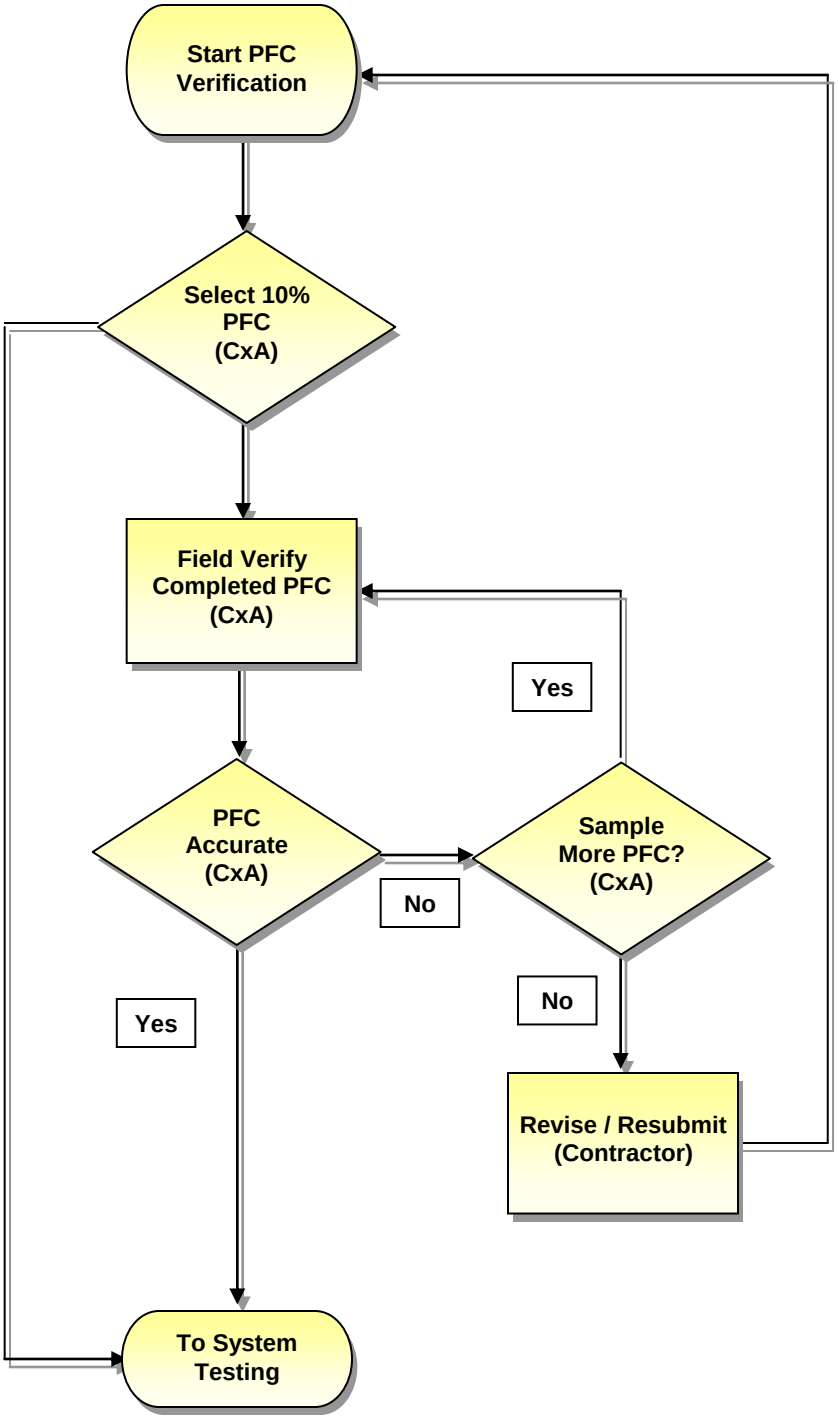

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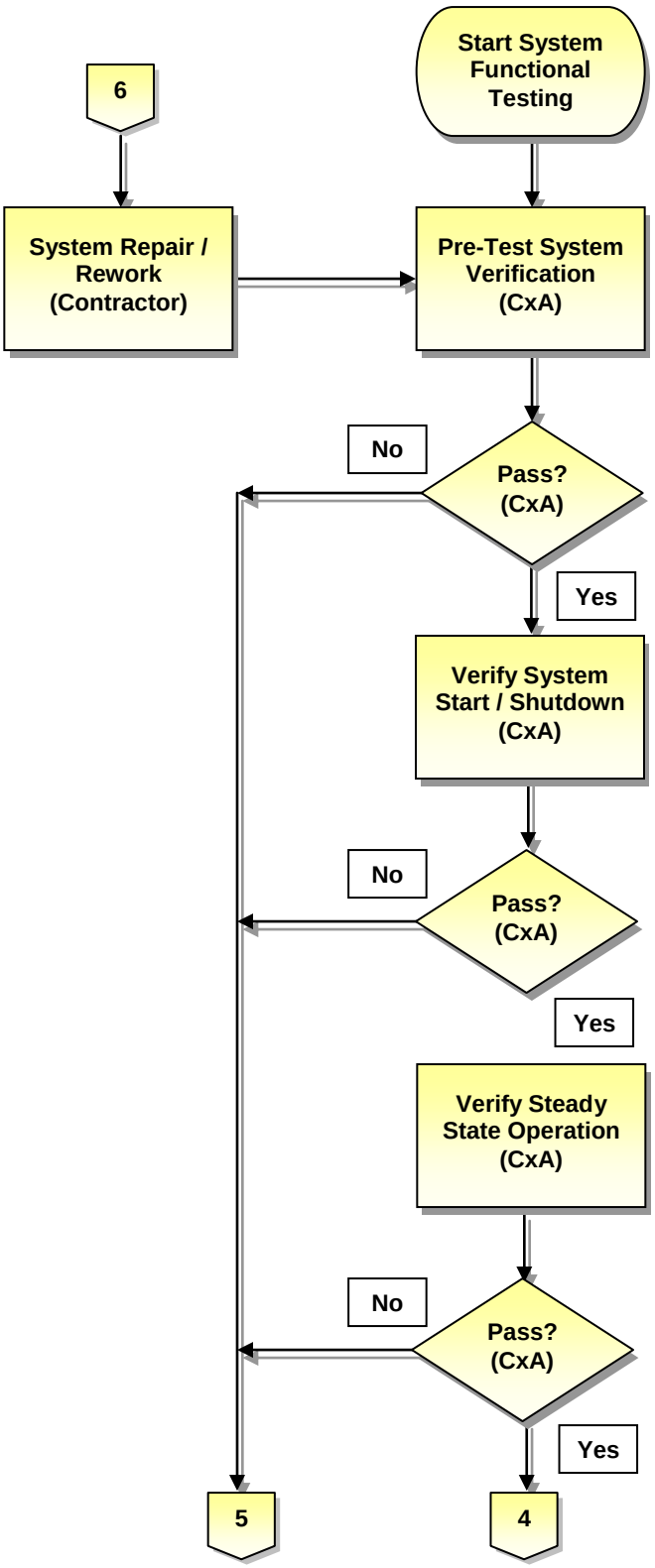

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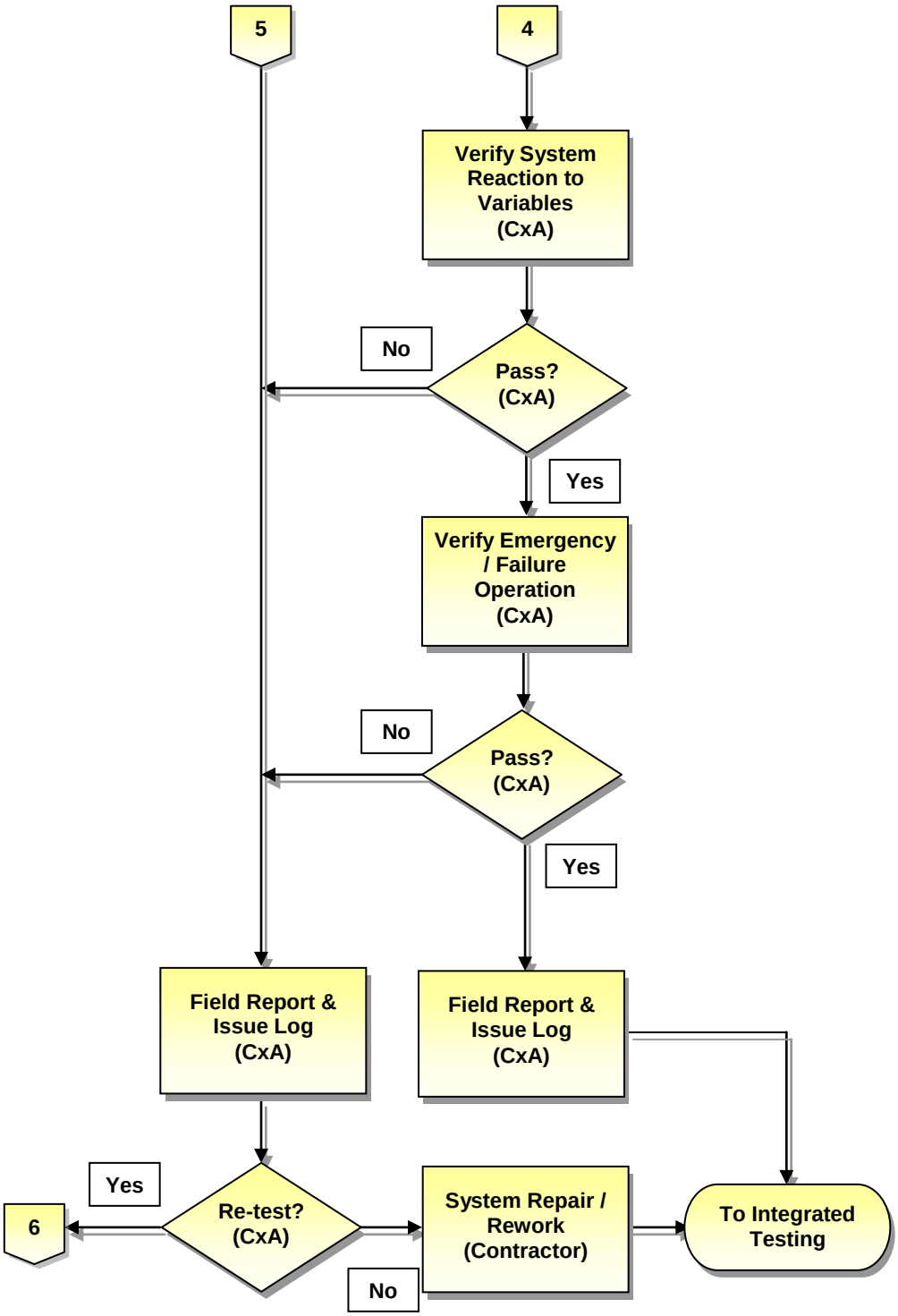

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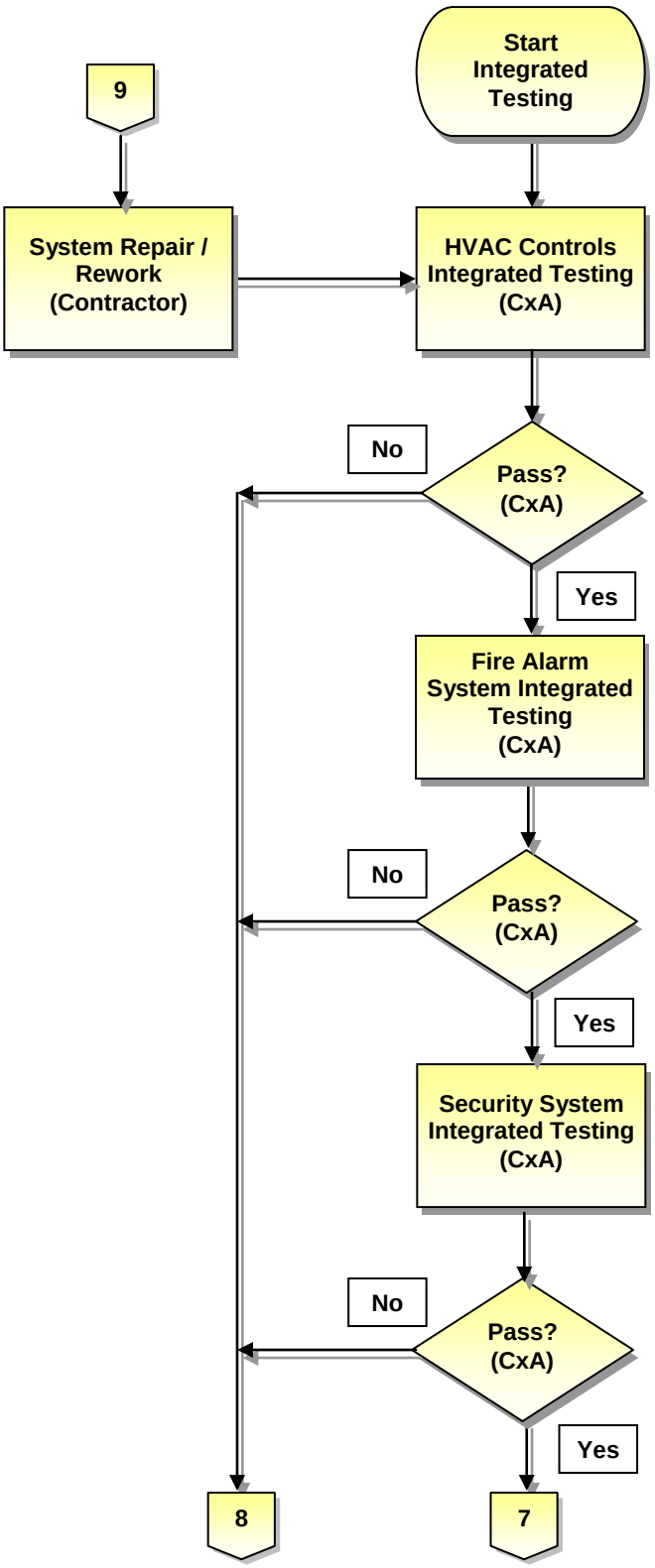

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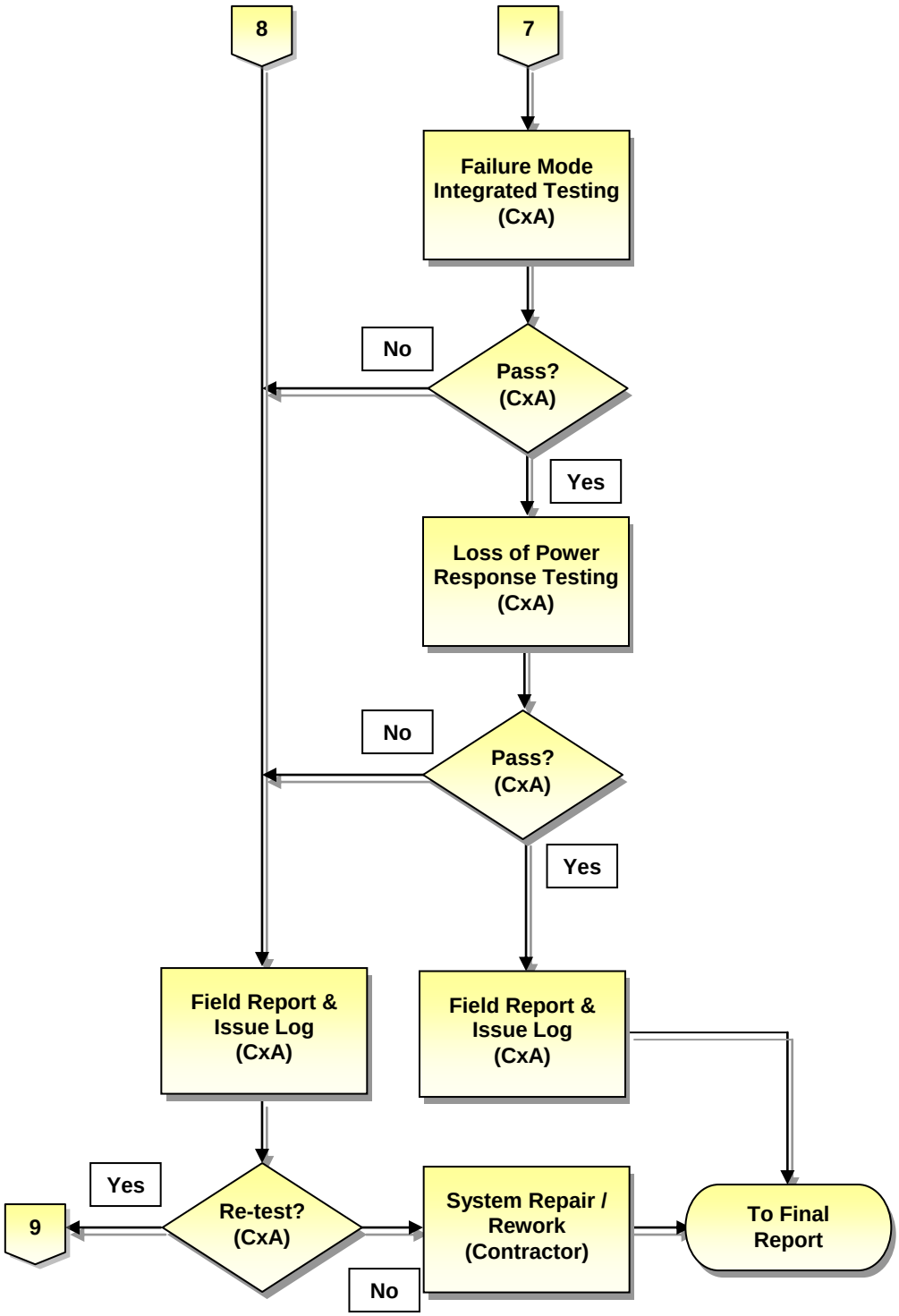

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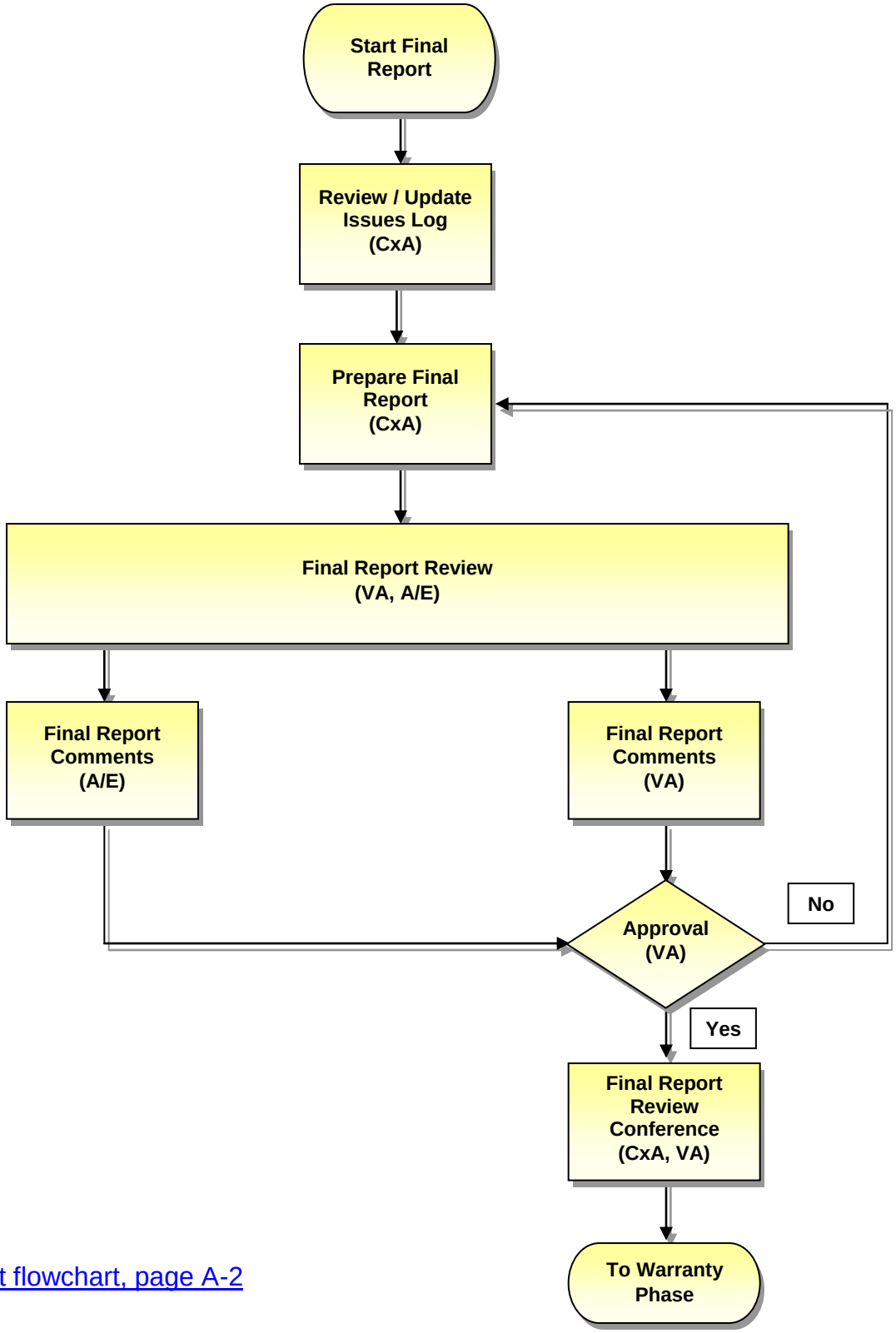

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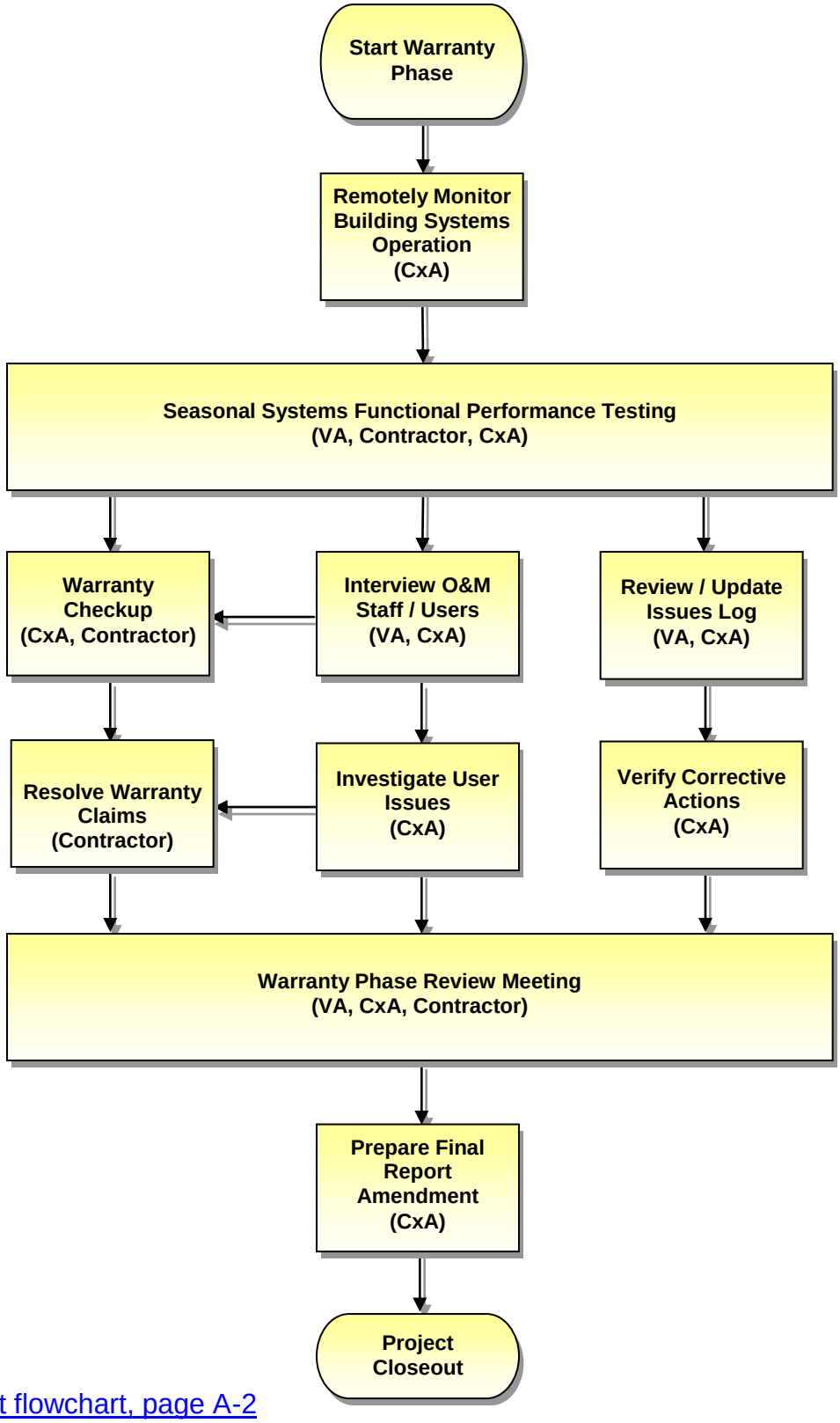

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Appendix B – Sample Commissioning Agent Scope of Work

The Commissioning Agent shall provide all labor, materials and instrumentation required to complete the scope of work outlined in this section. Commissioning activities shall include all appropriate work tasks necessary to complete Whole Building Commissioning for the systems listed below under "Systems to be Commissioned."

SYSTEMS TO BE COMMISSIONED

The following systems shall be included in the Commissioning Scope of Work.

[Editors Note: Edit the Systems to be Commissioned table below to conform with the scope of the project to be commissioned and the budget allocated for Commissioning Activities. Remember that it is the intention of the Department of Veterans Affairs to provide Whole Building Commissioning on every project. The list of commissioned systems must be tailored to the systems to be installed on your project.]

Systems To Be Commissioned	
System	**Description**
Building Exterior Closure	
Exterior Walls	Air and Vapor Infiltration, Water Leakage, Thermal Value
Roofing	Air and Vapor Infiltration, Water Leakage, Thermal Value, Positive Drainage of Storm Water
Windows, Doors, Louvers and Other Penetrations	Air and Vapor Infiltration, Water Leakage, Thermal Value
Specialties	
Patient Bed Service Walls	Medical gas certification and cross check, electrical connections
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]

Systems To Be Commissioned	
System	**Description**
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]
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
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	

Systems To Be Commissioned	
System	**Description**
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.
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
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	
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

Systems To Be Commissioned	
System	**Description**
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	
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

Systems To Be Commissioned	
System	**Description**
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.
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
Renewable Energy Systems	Photovoltaic Electrical Systems, Wind Turbines
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

SCOPE OF WORK

The Commissioning Agent shall include all tasks and provide all deliverables to complete the scope of work outlined below:

[Editors Note: Edit the table below to conform to the scope of the project to be commissioned and the budget allocated for Commissioning Activities. Remember that it is the intention of the Department of Veterans Affairs to provide Whole Building Commissioning on every project. The list of task should be tailored to the project execution method and schedule for your specific project.]

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Pre-Design Commissioning Kickoff Meeting	Conduct Pre-Design Commissioning Kickoff Meeting with the VA and the Design Team. Establish the purpose and proposed process for commissioning the project. Establish the individual roles of each participating commissioning team member.	Draft Commissioning Plan Meeting Minutes
SD1 PHASE		
Design Submission Review	Complete a thorough review of the SD1 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the Owner's Project Requirements (OPR). Documents provided to the Commissioning Agent should include, SD1 Design Narrative and other submittal documents required by PG 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Review and Reconcile the Project Design Narrative. Narrative should incorporate OPR requirements from VA Standards and other Project Contracts. Design Narrative should describe designer's response to the project requirements. Design Narrative can include both the Owner's Project Requirements (OPR) and the Basis of Design (BOD) information. Likewise separate documents can be developed and retained in the project record.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Commissioning Plan	Develop the Project Commissioning Plan that outlines process requirements, deliverables, roles, responsibilities, schedule and milestones. Provide a copy of the Commissioning Plan to the A/E. The A/E will incorporate the Commissioning Plan into the Design Narrative as described in PG 18-15	Project Commissioning Plan
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Design Review Meeting	Attend and participate in SD1 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log. (Note that resolution of some issues may be deferred to later design stages.)
SD2 PHASE		
Design Submission Review	Complete a thorough review of the SD2 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. Documents provided to the Commissioning Agent should include, SD2 Design Narrative, calculations, room locations and preliminary layouts and other submittal documents required by PGA 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Review the updated Project Design Narrative. The Design Narrative should incorporate OPR requirements from VA Standards and other Project Contracts. Design Narrative should describe designer's response to the project requirements.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Commissioning Plan	Update the Project Commissioning Plan. Provide a copy of the Commissioning Plan to the A/E. The A/E will incorporate the Commissioning Plan into the Design Narrative as described in PG 18-15	Updated Project Commissioning Plan
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Commissioning Specifications	Provide Outline Commissioning Specifications Sections utilizing the VA Master Construction Specification. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Outline Commissioning Specifications Specification Coordination Matrix for Commissioning Agent/A/E coordination.

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Design Review Meeting	Attend and participate in SD2 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log Note that resolution of some issues may be deferred to later design stages.
Design Phase Issue Log Resolution	Update the Commissioning Issues Log by recording resolutions to identified Commissioning Issues.	Revised Design Phase Commissioning Issue Log
DD1 PHASE		
Design Submission Review	Complete a thorough review of the DD1 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. Documents provided to the Commissioning Agent should include: DD1 Updated Design Narrative, calculations, equipment schedules, system and control schematic diagrams and appropriate schematics and other submittal documents required by PG 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Review the updated Project Design Narrative. The Design Narrative should be updated to reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Commissioning Plan	Update the Project Commissioning Plan, including any revisions to Commissioning Team Members, Schedules and other modifications required by the progress of the project. Include a Draft Construction Phase Commissioning Plan, including systems to be commissioned, an outline of construction phase roles and responsibilities, and an outline of required system documentation requirements. Provide a copy of the Commissioning Plan to the A/E. The A/E will incorporate the Commissioning Plan into the Design Narrative as described in PG 18-15	Updated Project Commissioning Plan

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Commissioning Specifications	Provide Draft Commissioning Specifications Sections utilizing the VA Master Construction Specification. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Draft Commissioning Specifications Specification Coordination Matrix for Commissioning Agent/A/E coordination.
Design Review Meeting	Attend and participate in DD1 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log. (Note that resolution of some issues may be deferred to later design stages.)
Design Phase Issue Log Resolution	Update the Commissioning Issues Log by recording resolutions to identified Commissioning Issues.	Revised Design Phase Commissioning Issue Log
DD2 PHASE		
Design Submission Review	Complete a thorough review of the DD2 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. Documents provided to the Commissioning Agent should include: DD2 Updated Design Narrative, calculations, equipment schedules, system and control schematic diagrams, floor plans and appropriate schematics and other submittal documents required by PG 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Design Narrative	Commissioning Agent to update, review and reconcile the Project Design Narrative. The Design Narrative should reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Commissioning Plan	Update the Project Commissioning Plan, including any revisions to Commissioning Team Members, Schedules and other modifications required by the progress of the project. Update the Construction Phase elements of the Commissioning Plan, including systems to be commissioned, an outline of construction phase roles and responsibilities, and an outline of required system documentation requirements. Include the updated Commissioning Plan in the revised Design Narrative	Updated Project Commissioning Plan
Commissioning Specifications	Provide Preliminary Commissioning Specifications Sections utilizing the VA Master Construction Specification. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Preliminary Commissioning Specifications Specification Coordination Matrix for Commissioning Agent/A/E coordination.
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Design Review Meeting	Attend and participate in DD2 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log. (Note that resolution of some issues may be deferred to later design stages.)
Design Phase Issue Log Resolution	Update the Commissioning Issues Log by recording resolutions to identified Commissioning Issues.	Revised Design Phase Commissioning Issue Log

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
CD1 PHASE		
Design Submission Review	Complete a thorough review of the CD1 submittal documents and submitted criteria to establish the systems to be designed and installed in compliance with the OPR. Documents provided to the Commissioning Agent should include: calculations, equipment schedules, system and control schematic diagrams, floor plans and appropriate schematics and other submittal documents required by PG 18-15, as well as other pertinent documents.	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Commissioning Agent to update, review and reconcile the Project Design Narrative. The Design Narrative should be updated to reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements.	Revised Design Narrative
Commissioning Plan	Update the Project Commissioning Plan, including any revisions to Commissioning Team Members, Schedules and other modifications required by the progress of the project. Update the Construction Phase Commissioning Plan, including systems to be commissioned, an outline of construction phase roles and responsibilities, and an outline of required system documentation requirements. Include the updated Commissioning Plan in the revised Design Narrative	Updated Project Commissioning Plan
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Commissioning Specifications	Provide Final Commissioning Specifications Sections utilizing the VA Master Construction Specification. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Final Project Commissioning Specifications Specification Coordination Matrix for Commissioning Agent/A/E coordination.
Design Review Meeting	Attend and participate in CD1 Design Review Meeting. Provide clarifications for identified Commissioning Issues as appropriate. Incorporate other comments or issues identified at Review Meeting that impact project commissioning into Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log. (Note that resolution of some issues may be deferred to later design stages.)
Design Phase Issue Log Resolution	Update the Commissioning Issues Log by recording resolutions to identified Commissioning Issues.	Revised Design Phase Commissioning Issue Log
FINAL DESIGN DOCUMENTS		
Design Final Design Submission Review	Review Final Design Submission for resolution of Outstanding Commissioning Issues	Design Phase Commissioning Issues Log (Incorporate into Dr Checks for Project Tracking – Retain for Design Phase Cx Report)
Design Narrative	Commissioning Agent to provide a Final Design Narrative to Include all modifications and/or deviations from CD1 Design Narrative. The Design Narrative should be updated to reflect the evolution of the project design and note all significant deviations from prior version for ease of review and reconciliation. Design Narrative should describe designer's response to the project requirements. Where appropriate, provide documentation of approved deviations from design standards and reasoning for same.	Revised Design Narrative
Commissioning Plan	Update & Submit Project Commissioning Plan Include the updated Commissioning Plan in the revised Design Narrative	Project Commissioning Plan

Commissioning Team Task/Deliverables Description Design Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should include both Design and Construction Phase Activities. The Duration Schedule should provide sufficient detail to comply with the AE Team CPM scheduling requirements as outlined in PG 18-15.	Commissioning Duration Schedule – Incorporate into Commissioning Plan
Commissioning Specification	Provide updated Final Cx Specifications. Specifications shall be submitted in accordance with the requirements of PG 18-15.	Updated Project Commissioning Specifications
Design Phase Issue Log Resolution	Record resolutions to Cx Issues on the Design Phase Commissioning Issues Log.	Revised Design Phase Commissioning Issue Log

Commissioning Team Task/Deliverables Description Pre Construction/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Pre Bid Meeting	Attend Pre Bid Meeting; provide overall description of Commissioning Process, provide clarifications for Commissioning Issues.	Meeting Notes for PM/RE Clarifications for Addendum if required
Commissioning Kick Off Meeting (Construction Phase)	Conduct an “”Kickoff Meeting” with the Construction Team (includes A/E participants). Establish the purpose and proposed process for commissioning the project. Establish the individual roles of each participating commissioning team member.	Meeting Minutes Revised Project Commissioning Plan (Include Names/Contact Information for selected Commissioning Team Members)
Construction Phase		

Commissioning Team Task/Deliverables Description Pre Construction/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Duration Schedule for Commissioning Activities	Based on the Project Commissioning Plan, prepare a duration schedule for the commissioning activities required by the commissioning plan. This duration schedule should be incorporated into the contractor's project schedule to track all commissioning activities of the commissioning team.	Commissioning Duration Schedule (Schedule shall be periodically updated to reflect changes in the project schedule and/or scope.)
Submittal & Shop Drawing Review	Review all pertinent project shop drawings necessary to support the Commissioning Process. Review of the shop drawings is for the purpose of developing appropriate Pre Functional Checklists and Functional Test Procedures. Submittals & Shop drawings shall be reviewed for commissionability, maintainability and for compliance to the Design Intent Documents. Note any issues identified in the Shop Drawing Review that might compromise the final commissioned system on the 'Commissioning Review Log' and submit comment to the Design Team contemporaneously with their review for resolution.	Shop Drawing Cx Review List Shop Drawing Review Comments
Project Commissioning Plan	Based on the work completed in the items above, the Commissioning Plan for the project shall be periodically reviewed with the Commissioning Team and update to reflect changes in project scope or schedule and with project personnel.	Revised Project Commissioning Plan
Site Observations	During the course of construction, the Commissioning Agent will visit the site to inspect the progress of construction with respect to the systems being commissioned. The focus of the observations will to verify that systems being installed comply with the Design Narrative and can be successfully configured, operated and maintained. In addition, site observations visits will be scheduled to include: • Witnessing factory or contractor equipment/system start up activities; • Verification of Completed Pre Functional Checklists • Clarification and technical support for understanding and resolving Commissioning Issues.	Site Observation Reports Updated Commissioning Issues Log

Commissioning Team Task/Deliverables Description Pre Construction/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Commissioning Team Meetings	The Commissioning Agent will hold regular commissioning team meetings to review progress of the commissioning effort and reinforce individual responsibilities. The team will review schedule, construction sequence, and completed work (PFT and FPT's) and outstanding issues on the Commissioning Issues Log.	Commissioning Meeting Minutes Updated Commissioning Issues Log
Develop Pre Functional Checklists (PFC's)	The Commissioning Agent will complete all Pre Functional Checklists (PFC) for the project and distribute to all Cx Team members for review and comment. A completed PFC indicates the system or piece of equipment is ready to be started and FPT's performed.	Pre Functional Checklists (PFC's)
Develop Functional Performance Test (FPT's) Procedures	Based on construction documents and approved submittals, the Commissioning Agent will prepare Functional Performance Test Plans (FPT's) for systems to be commissioned. Completed FPT's will be distributed to all appropriate members of the Commissioning Team for review and comment. Final FPT's will be issued once comments are reviewed and incorporated into final documents as appropriate.	Functional Performance Test Plans (FPT's)
Review Operations & Maintenance Manuals	The Commissioning Agent shall review Operations and Maintenance Manuals submitted by contractors for general conformance with specifications and owner's requirements, including: Review Preventive Maintenance Schedules provided as part of the O&M Manuals for completeness. Verify that data is provided in a manner consistent with VA process for managing Preventive Maintenance tasks. Review of O&M Manuals will include a review of system and component warranties to confirm conformance with contract requirements and adequate documentation of warranty contact information and Owner obligations.	Updated Commissioning Issues Log

Commissioning Team Task/Deliverables Description Pre Construction/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Review Contractor Equipment Startup Checklists, TAB Reports and PFC's	The Commissioning Agent will review all contractor prepared Equipment Startup Checklists, TAB Reports and PFC's to confirm that the systems are have been subject to appropriate Quality Control and Start Up procedures prior to initiation of Functional Performance Testing. Incomplete work, inadequate preparation and deficiencies will note noted and tracked on the Commissioning Issues Log.	Commissioning Issues Log
Acceptance Phase		
Systems Functional Performance Testing	The Commissioning Agent will direct, facilitate, and document all FPT testing. Execution of FPT's shall be directed by the Commissioning Agent and performed by the contractors under the direction of the Commissioning Agent. Contractors shall retain responsibility for the installed systems until substantial completion or final acceptance as determined by the VA. The Commissioning Agent, in collaboration with the control contractor shall include long term trends (greater than 7 days) of integrated system performance once all systems have been commissioned. The Commissioning Agent shall provide analysis of these trends to confirm that the installed systems are stable and reliable	Executed Functional Performance Tests and support documentation. Long Term Trend Data and Analysis
Prepare Systems Manuals	The Commissioning Agent shall work with the design team, contractor and owner to develop Systems Operating Manuals. Manuals will contain system design, operations and sequence information that describes the design intent, operational features and appropriate operational practices necessary to sustain the system operation in accordance with the Design Narrative and the VA's overall objectives for the facility. Systems manual will include sections for each major discipline included in the commissioning process.	Project Systems Manual

Commissioning Team Task/Deliverables Description Pre Construction/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Training Plan Review	The Commissioning Agent shall coordinate with appropriate Prime Contractor and installing subcontractors to develop effective contractor and manufacturer training plans and agendas for general conformance with specifications and owner's requirements. Observe training for quality of training and for general conformance with the training plan and agenda.	Compiled Training Plan Individual Training Agendas
Systems Training	The Commissioning Agent will conduct training sessions to provide systems-level training for O&M personnel. Training will include: • Review of system design, capacity, and equipment selection • Review of system operating sequences • Review of interconnection with other systems • Review of Emergency operating procedures • Review of the Project Systems Manual and its Use • Student Evaluation forms The number, duration and scope of the Systems Training sessions shall be determined by the specific requirements of the project.	Systems Training Presentations (electronic)

Commissioning Team Task/Deliverables Description Pre Construction/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Final Commissioning Report	The Commissioning Agent shall compile a comprehensive commissioning report documenting all commissioning activities, including but not limited to the following: • Executive Summary • Commissioning Scope of Work • Test methods and results • Outstanding commissioning issues • Comprehensive Commissioning Issues Log, including resolved items and a description of their resolution, • Commissioning plan, • Field Observation Reports, Status reports and other field activity documentation, • Submittal and O&M manual reviews • Training record • Completed Pre Functional Checklists • Completed Functional Performance Test protocols and support documentation • Other support documentation developed as part of the execution of the project Construction Phase Commissioning Process	Final Commissioning Report
Warranty Phase		
Deferred and/or Seasonal Testing	The Commissioning Agent shall direct testing that was deferred to allow systems to be tested in appropriate seasonal conditions. Testing will be conducted in accordance with Functional Test Plans. Testing support will be required from the installing contractors, EMCS Vendor and owner. Requirement for seasonal testing will be incorporated into the project specifications.	Executed Functional Performance Test and Support Documents Commissioning Issues Log

Commissioning Team Task/Deliverables Description Pre Construction/Construction Phase		
Project Phase/ Cx Task	**Commissioning Task Description**	**Commissioning Deliverables**
Post-Occupancy Warranty Checkup	Return to the project approximately 10 months after substantial completion to review the building operation with the facility occupants and O&M staff, and to discuss outstanding issues related to commissioning. Provide suggestions for improvements to systems operation including: • Measurement & Verification Issues, • Re Commissioning Tasks, and • Improvements in Preventive Maintenance or Operational Strategies Assist facility staff in developing warranty claims, documents and requests for service to remedy outstanding problems.	Post Occupancy Field Visit Report Commissioning Issues Log Warranty Issues Report
Final Commissioning Report Amendment	Amend Final Commissioning Report to document the Warranty Phase commissioning activities.	Final Report Amendment

Appendix C - Sample Commissioning Agent Request for Qualifications

[Editors Note: The following is a sample Request for Qualifications (RFQ) for an Indefinite Delivery, Indefinite Quantity commissioning services contract. This sample document assumes the VA will solicit qualifications and award one or more commissioning agent contracts by the various VA VISNs, or by CFM via regional contracts with ordering officer authority given to the various VISNs. The RFQ should be modified and adapted as necessary to meet the specific needs of the VISN. It can also be adapted by VACO to request proposals for specific very large projects where Central Office oversight is desired.

The sample document requests qualifications from qualified commissioning firms. Award of an IDIQ contract will be qualifications-based without pricing for specific projects. Subsequent task orders will request firm fixed pricing via competition between the IDIQ firms. -

When the proposals have been evaluated, a short list of prospective firms can be established. These firms can be interviewed so the VA and the VISN can evaluate the firm and the key personnel face-to-face.

When evaluations have been completed, the VA or the VISN will award IDIQ contracts to two or more best qualified commissioning firms. As required for specific projects, the VA or VISN will compete commissioning services between the firms to provide commissioning services for the project.

The sample RFP that follows is too big for a synopsis and should be pared down for that. Using the entire format would be a good template for a solicitation. The acquisition of a Commissioning Agent may require development of an acquisition plan, source selection plan, etc. on the contracting side, and the sample RFP should be used for informational purposes only.]

SYNOPSIS:

I. GENERAL INFORMATION:

The U.S. Department of Veterans Affairs, VISN XX hereby solicits for Qualifications to provide Whole Building Commissioning Services on an Indefinite Delivery/Indefinite Quantity (ID/IQ) Contract basis to be procured in accordance with the Federal Acquisition Regulation Part 36. It is anticipated that these ID/IQ contracts will be negotiated and awarded in insert timeframe. The initial contract periods will consist of one base year with four (4) option years per contract. The amount of work will not exceed $ insert amount per year. Work will be issued by negotiated firm-fixed-price task orders not to exceed the maximum limit per task order.

II. REQUIRED SERVICES:

Whole Building Commissioning services for third-party commissioning are required for various VA facilities and infrastructure projects within the VA VISN XX area of responsibility which includes insert area description. The successful Commissioning Agent will support thru the Commissioning Process the design, construction, and post-acceptance phases of renovation, additions, or other projects with an estimated construction cost of $5,000,000 to $50,000,000 per project. These contracts may support medical-related facilities (to include, but not be limited to VA Hospitals, VA medical clinics, VA dental clinics, VA Community Living Centers, and VA laboratories) as well as a broad range of other types of VA facilities (to include, but not be limited to administration, training, education, maintenance, recreation, domiciliary, central energy plants, other supporting facilities). Projects for which commissioning services would be required may include new facility construction, additions to existing facilities, and/or renovation, alteration, maintenance, repair, or upgrades to existing facilities.

Commissioning Services will be provided in accordance with the Department of Veterans Affairs Commissioning Process Manual. Prospective proposers shall review the Whole Building Commissioning Process Manual available on the VA Technical Information Library at http://www.cfm.va.gov/til/. The facility systems to be supported by these contracts may include (but are not limited to): building water and sewer systems, air handling systems, chilled water systems, power plants, boiler plants, clean rooms, heating water and steam systems, renewable energy systems, condenser water systems, conveying systems, vacuum systems, medical gas systems, natural gas systems, medium voltage electrical systems, low voltage distribution systems, building communications (voice, data, nurse, call, patient monitoring, infant protection, mass notification), emergency power systems, fire alarm systems, fire sprinkler systems, security and access control systems, lighting control systems, lightning protection systems, emergency lighting systems, interfaces

between life safety systems, building automation and energy management control systems (including hardware and software, sequence of operations, and integration of factory controls with EMCS), building envelope air and moisture control, and envelope integrity (walls, roofs, etc.), kitchen and laundry equipment, elevators, refrigeration systems, fuel oil systems, and automated delivery systems.

Commissioning services may include (but may not be limited to):

Design Phase Commissioning Services:

1. Participate in a Pre-Design Meeting with VA Project Manager, A/E Design Team, and Peer Review Team
2. Review Owner's Project Requirements and VA Design Requirements
3. Conduct Commissioning Design Review of Schematic Design (SD1)
4. Participate in SD1 Design Review Conference
5. Review SD2 Design Narrative and SD2 Design Submission
6. Participate in SD2 Design Review Conference.
7. Prepare Outline Commissioning Specifications
8. Prepare Outline Commissioning Plan
9. Review DD1 Design Narrative and DD1 Design Submission
10. Participate in DD1 Design Review Conference
11. Prepare Draft Commissioning Plan
12. Prepare Draft Commissioning Specifications
13. Review DD2 Design Submission and DD2 Design Narrative
14. Participate in DD2 Design Review Conference
15. Update Design Narrative based on DD2 Design
16. Prepare Preliminary Commissioning Plan
17. Prepare Final Commissioning Specifications
18. Participate in a Design Phase Controls Meeting to discuss control strategies and system sequences of operations
19. Prepare Draft System Readiness Checklists
20. Prepare Draft System Functional Performance Test Protocols
21. Review CD1 Design Submission
22. Participate in CD1 Design Review Conference
23. Update Design Narrative based on CD-2 Design

24. Review Final Construction Documents to Back check Commissioning Design Review Comments
25. Update Design Narrative based on Final Construction Documents
26. Participate in Pre-Bid Conference to discuss Commissioning Process, review and respond to Requests for Information during Bid Phase.

Construction and Acceptance Phase Commissioning Services:

1. Participate in Pre-Construction Conference
2. Prepare Construction Commissioning Plan
3. Prepare Commissioning task duration schedule and predecessors.
4. Conduct Commissioning Construction Observations to verify equipment/system installation, attend construction progress meetings, conduct Commissioning Progress Meetings, witness contractor duct pressure testing, witness contractor piping testing, witness contractor duct and pipe cleaning/flushing process, assist in resolving commissioning issues, witness contractor equipment startup, witness TAB procedures, and/or witness contractor equipment/subsystem testing.
5. Review contractor submittals and/or shop drawings.
6. Participate in a Construction Phase Controls Meeting to discuss and optimize control strategies, controls programming, and optimizing sequences of operations.
7. Review TAB Plan
8. Prepare Final Systems Readiness Checklists
9. Prepare Final Systems Functional Performance Test Protocols.
10. Review O&M data
11. Review TAB Report
12. Review Contractor Training
13. Prepare Systems Manuals
14. Conduct Systems Training
15. Spot Check contractor-prepared System Readiness Checklists
16. Direct Systems Functional Performance Testing
17. Direct Integrated Systems Testing
18. Prepare Final Commissioning Report

19. Meet with VA Project Manager and Facilities Staff to review the Final Report and develop corrective action plan for outstanding commissioning issues and construction punch list items

Post-Occupancy Phase Commissioning Services:

1. Direct Deferred and Seasonal Systems Functional Performance Testing
2. Interview VA Project Manager, Users, and Facilities Operations & Maintenance Staff concerning facilities and systems operations.
3. Conduct systems inspections for potential warranty claims prior to expiration of contractor's warranties.
4. Review outstanding commissioning issues and verify corrective actions.
5. Prepare Amendment to Final Commissioning Plan.
6. Meet with VA Project Manager and Facilities Staff to review Amendment to Final Commissioning Report.

III. Selection Criteria:

The selection criteria listed below are in descending order of importance:

***SPECIALIZED EXPERIENCE & TECHNICAL COMPETENCE*:**

a. Firms shall demonstrate specific relevant experience in Whole Building Commissioning Services for a minimum of ten (10) projects completed in the past five years. Projects shall be similar in nature, application and project size. Firms must address and demonstrate the specialized experience and technical competence of the Commissioning Agent and proposed support team members in each discipline required to address the systems to be commissioned described in REQUIRED SERVICES above. For joint venture submittals and prime professionals with sub-consultant team members, each joint venture partner and/or each sub-consultant shall provide letters of commitment to the project team. The offeror agrees to assign to the contract those persons whose resumes, personnel data forms or personnel qualification statements were submitted. If personnel for whatever reason become unavailable for work under the contract for a continuous period exceeding 30 working days, or are expected to devote substantially less effort to the work than indicated in the proposal, the contractor shall propose a substitution of such personnel. All proposed substitutions shall be submitted, in writing, to the Contracting Officer at least 15 days prior to the proposed substitution. All proposed substitutes shall have qualifications equal to or higher than the qualifications of the person being replaced. Project descriptions should show explicit experience pertinent to this announcement.

PROFESSIONAL QUALIFICATIONS:

a. The Prime Commissioning Firm and Joint Venture Partners shall be certified by the National Environmental Balancing Bureau (NEBB), Associated Air Balance Council (AABC), the Testing Adjusting and Balancing Bureau (TABB), or other national or international certification agencies that provide specific firm and individual Commissioning Agent certifications.

b. The Senior Commissioning Agent shall be a Whole Building Commissioning Certified Professional with a current certification from National Environmental Balancing Bureau (NEBB), Associated Air Balance Council (AABC), the Testing Adjusting and Balancing Bureau (TABB), or other national or international certification agencies. The Senior Commissioning Agent's certification shall be from the same agency that provides the Firm's Certification. He/she shall have a minimum of five (5) years of experience in commissioning projects similar in size and scope of the projects described in REQUIRED SERVICES above.

c. The commissioning Firm, or proposed team, shall be familiar with construction practices, materials, standards, and design requirements.

d. Identify the qualifications of all key personnel in the following disciplines: Senior Commissioning Agent, Project Manager, Building Envelope Specialist, Electrical Engineering Commissioning Specialist, Mechanical Engineering Commissioning Specialist, and Communications/Security Engineering Commissioning Specialist. For each proposed professional acting as a key technical resource in specific discipline, provide resumes demonstrating specific experience in the services related to their discipline for each area described in, REQUIRED SERVICES, Section 2 of this announcement.

e. The qualifications evaluation will consider the breadth of education, training, certification, overall and relevant experience and longevity with the proposed Commissioning firm team for all proposed key personnel.

f. The Senior Commissioning Agent, Project Manager and Lead Field Personnel shall have either bachelor's degrees in their discipline or certifications from recognized national Commissioning Certification Organizations. Each key technical resources shall demonstrate a minimum of 5 similar projects commissioning systems in their discipline.

PAST PERFORMANCE:

a. The Commissioning Agent shall have relevant past performance on VA, DOD, GSA, and other contracts that can be demonstrated to be similar with respect to cost control, quality of work and compliance with performance schedules.

b. The Commissioning Agent shall have acted as the principal commissioning agent for healthcare construction projects over 200,000 square feet or for

healthcare alteration/renovation projects over $5,000,000. List up to five projects of comparable type, size, and complexity which were completed within the last 10 years. Provide information about each project: public or private client, completion date, project location, project description, construction cost, systems commissioned, and commissioning services provided. Provide contact information for an individual who can provide a reference for at least seven of the ten projects.

c. For the ten projects submitted in response to the above requirement, identify the key project personnel including Senior Commissioning Agent, project manager, electrical, mechanical communications and envelope Commissioning Specialist. Indicate if the key individual was an employee or a sub-consultant.

CAPACITY:

a. Demonstrate the Firm's or Joint Venture's ability (in terms of labor capacity, operational control and quality assurance) to perform projects with labor fee in the range of approximately $ insert amount (consistent with maximum contract/task order amount) for the required type in a one-year period. The evaluation will consider the availability of an adequate number of personnel in key disciplines, equipment availability, and demonstrated management procedures.

b. Firms shall demonstrate the capacity to execute multiple Task Orders simultaneously while dealing with existing work backlog.

ADDITIONAL QUALIFICATIONS OF THE COMMISSIONING TEAM MEMBERS:

a. Commissioning Team members shall extensive knowledge and experience in the operations and troubleshooting of HVAC and complex electrical systems.

b. Commissioning Team members shall have extensive knowledge and experience in open-protocol direct digital control (DDC) systems.

c. Commissioning Team members shall have extensive knowledge of testing, adjusting, and balancing (TAB) of HVAC systems. Experience in performing or managing the TAB process is desired.

d. Commissioning Team members shall have extensive experience in testing and commissioning building system envelopes and envelope assemblies.

e. Commissioning Team members shall have knowledge and experience in building operations and maintenance. Experience in developing and providing systems-level training for O&M personnel is desired.

f. Commissioning Team members shall have experience in developing, implementing, and/or optimizing system control strategy and sequences.

g. Commissioning Team members shall have extensive experience in writing commissioning specifications, commissioning plans, functional test

procedures, and coordinating commissioning tasks with the contractor's schedule.

SAMPLE WORK PRODUCT:

a. Submit examples of the following work products for a recently completed project that were prepared by proposed Commissioning Team members. Examples should be submitted in electronic PDF format on CD-ROM or DVD:

1. Commissioning Plan
2. Commissioning Specifications
3. Design Review Comments
4. Field Report for Commissioning Construction Observation Visit
5. Commissioning Issues Log
6. Systems Readiness Checklist completed by the contractor
7. Systems Functional Performance Test Procedure annotated to with testing results
8. Final Commissioning Report (Executive Summary)

IV. SUBMISSION REQUIREMENTS:

Firms that have the capability to perform this work are invited to submit two copies of their past performance information, technical expertise and personnel qualifications. Include information for the prime firm, and if applicable for all joint venture partners, and if applicable for the proposed team including consultants and subcontractors to the address below not later than insert date/time. -. Firms responding to this announcement after the closing date and time will not be considered.

Include the firm's point-of-contact, email address, and telephone number in the submittal. Joint Ventures must submit the following additional documentation of evidence of a Joint Venture entity: a) A copy of a legally binding Joint Venture agreement, and b) Identification of the party who can legally bind the Joint Venture. If the firm is teaming, and credit for any of the selection criteria is sought because of the qualifications of team members, then letters of commitment from team members are required and must be submitted.

The assessment of the offeror's past performance will be used as a means of evaluating the relative capability of the offeror to successfully meet the requirements of this RFP. The Government reserves the right to obtain information for use in the evaluation of past performance from any and all sources including sources outside of the Government. Offerors lacking

relevant past performance history will not be evaluated favorably or unfavorably for past performance. However, the proposal of an offeror with no relevant past performance history, while rated neutral in past performance, may not represent the most advantageous proposal to the Government and thus, may be an unsuccessful proposal when compared to the proposals of other offerors. The offeror must provide the information requested below for past performance evaluation or affirmatively state that it possesses no relevant, directly related, or similar past performance.

Offerors are to submit past performance information on up to ten projects (but a minimum of three) that best demonstrates the firm's and proposed team members' performance for commissioning projects similar in scope, size, and complexity. This includes awards, customer letters of commendation, etc., with points of contact and telephone numbers.

The Government will evaluate the quality of the offeror's technical qualifications. When evaluating technical qualifications the Government will consider highly qualified offerors to be those who have experience with commissioning services for medical facilities including new facility construction, additions to existing facilities, and/or renovation, alteration, maintenance, repair, or upgrades to existing facilities. The evaluation will take into account performance of key personnel regarding predecessor companies, if applicable. The offeror must provide the information requested below for technical qualifications evaluation or affirmatively state that it possesses no relevant, directly related, or similar qualifications. Any changes to key personnel will follow the requirements stated on Page C – 6. Offerors are to submit key personnel staffing that demonstrates technical qualifications in most engineering and architectural disciplines including as applicable: Project Executive, Project Manager, Building Envelope Specialist, Electrical Engineering, Mechanical Engineering, and Communications/Security Engineering. One or more of the professionals as key personnel in these disciplines shall have some experience in the services described in REQUIRED SERVICES, section 2 of this announcement. The Project Manager and lead field engineers shall have a bachelor's degree in mechanical engineering, a bachelor's degree in electrical engineering, and a bachelor's degree in architecture or approved equivalents. Field support staff may be non-engineers who have technical training and past field experience in commissioning, construction management, or building systems operation and maintenance. Also required is organizational structure for design teams demonstrating contractual arrangements and lines of authority among key personnel.

Appendix D - Sample Design Narrative

The attached documents are a sample Design for a large VA Medical Center project.

The Design Narrative is prepared by the A/E Design Team for the SD2 and DD1 submissions. It is then updated by the Commissioning Agent after the DD2, CD and Final Construction Documents have been submitted and reviewed. The updated Design Narrative reflects the design decisions and changes made for each submission. The Design Narrative is updated to reflect the Final Construction Documents becomes the basis for the initial Systems Manuals to be prepared by the Commissioning Agent for use by the VAMC Facilities Staff. See Program Guide 18-15 and other VA documents available on the VA Technical Information Library Website: http://www.cfm.va.gov/TIL/

Sample Design Narrative: Table of Contents	
Coversheet	Chapter 10 – Sanitary
Table of Contents	Chapter 11 – Site Development
Chapter 01 – Project Description	Chapter 12 – Space Planning
Chapter 02 – Architecture	Chapter 13 – Steam Distribution (Outside)
Chapter 03 – Automatic Transport	Chapter 14 – Steam Heat Generation
Chapter 04 – Critical Path Method	Chapter 15 – Structural Systems
Chapter 05 – Electrical	Chapter 16 – Building Systems Commissioning
Chapter 06 – Building & Life Safety Code Analysis	Chapter 17 – Project Quality Audits
Chapter 07 – HVAC	Chapter 18 – Sustainable Design
Chapter 08 – Interior Design	Chapter 19 – Food Service
Chapter 09 – Plumbing	

Appendix E – Sample Design Review Comment Log

The below document is a sample of a Commissioning Design Review Comment Log. This log demonstrates the types of comments usually made by the Commissioning Agent during a design review. In lieu of a Design Review Comment Log, the Commissioning Agent should enter their review comments into the Dr. Checks system.

Commissioning Design Review Comment Log											
Comment Number	C = Critical CO = Coordinate S = Suggestion I = Information	Comment Date	Reference			Commissioning Agent Comment	Design Team Response		Commissioning Backcheck		Status
			Type	Number	Discipline		Response Date	Comment	Backcheck Date	Comment	
Cx-001											
Cx-002											
Cx-003											
Cx-004											
Cx-005											
Cx-006											
Cx-007											
Cx-008											
Cx-009											
Cx-010											
Cx-011											
Cx-012											
Cx-013											
Cx-014											
Cx-015											
Cx-016											
Cx-017											
Cx-018											
Cx-019											
Cx-020											

Appendix F – Sample Commissioning Plan

The below document is a sample Commissioning Plan for a large healthcare project. This document demonstrates the topics that should be covered and the level of detail that is expected in a Commissioning Plan prepared by a Commissioning Agent.

COMMISSIONING PLAN

I. Introduction

A. The Department of Veterans Affairs (VA) is committed to commissioning new facilities and systems required for the reliable, safe, and secure operation of the [project name] in [project location]. This process will verify that systems are complete and functioning properly upon project completion and that the facilities maintenance staff has appropriate system documentation and training.

B. Commissioning consists of systematically documenting that specified components and systems have been installed and started up properly and then functionally tested to verify that systems are complete and functioning properly upon project completion and that the VAMC Facilities Management (FMD) staff has the appropriate system documentation and training. In addition, owner-personnel training will be verified and final project Operation & Maintenance (O&M) documents will be reviewed for completeness.

C. This document is intended to be a roadmap for the parties involved in the Commissioning process. The document will explain the systems to be commissioned, the process activities, the procedures to follow throughout the commissioning process, and the roles and responsibilities for each party involved. The commissioning activities will begin during the design phase of the project and proceed through the warranty period.

D. The team members for this project are committed to commissioning this facility and systems required for the reliable, safe, and secure operation of the Facility. This process is intended to verify that systems are properly installed, configured and operating in accordance with the requirements of the project and that operating personnel are adequately prepared to successfully operate the facility at project turnover.

E. For this project, the Department of Veterans Affairs establishes AE Design contracts for Design Phase and Construction Period Services. The Department also establishes a construction contract with a Prime Contractor to provide construction services. Both contracts are administered by a VA Contracting Officer and his/her designated representative. During the Design Phase, this representative is the Project Manager; during the construction phase, it is the Resident Engineer. On every project, the authority to modify any contract is strictly limited to the Contracting Officer and his/her designated representative.

F. In this structure, all communications on contractual issues are strictly limited to communications between the VA and these two prime contractors (AE Team and Prime Contractor). It is the practice of the VA to require that communication between other parties to the contracts (AE Sub-consultants, Subcontractors and Vendors) be routed through these two prime contractors and the VA.

G. Whole Building Commissioning is a process that relies upon high levels of communications and collaboration between all parties to the construction process. By its nature, the levels of communication and cooperation between the Commissioning Agent and all other parties to the construction process (Architects, Engineers, Subcontractors, Vendors, third party testing agencies, etc) is essential to the success of the Commissioning effort. In the absence of the relationships, cooperation and support created by this communication, the Commissioning Process will likely fail to achieve its ends.

H. With this fundamental conflict in mind, this Commissioning Plan has been developed to recognize that, in the execution of the Commissioning Process, the Commissioning Agent 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 his/her Designated Representative. Thus, all procedures outlined in this manual must be executed within the following limitations:

1. The Commissioning Agent may maintain a continuous open communication with the AE team, including sub-consultants, the Contractor and subcontractors and the Owner's team to facilitate a collaborative commissioning process subject to the specific limitations outlined below.
2. All communications shall be copied to the VA Project Manager (Design Phase) and Resident Engineer (Construction Phase).
3. All Communications shall include specific reference to these contract limitations (e.g., "All issues identified in this Commissioning Issues Log are subject to Paragraph 2.5: Contractual Relationships in the VA Commissioning Process Manual."
4. All information from the Commissioning Agent to any party to the project must be transmitted with the following clear limitations:
    a. No communications (verbal or written) will be deemed to constitute direction that modifies the terms of any contract between the Department of Veterans Affairs and any party to the construction project.

b. Commissioning Issues communicated in writing to the Contractor or AE Team and copied to the PM/RE are provided to all parties to the contract to expedite communication. All issues must be understood as the professional opinion of the Commissioning Agent and suggestions for issue resolution only until expressly approved as direction by the Project Manager or Resident Engineer.

c. In the event that any Commissioning Issues and suggested resolutions are deemed to require either an official interpretation of the construction documents or are determined to require a modification of the contract documents, Contracting Officer or designated COTR will issue an official directive to this effect.

d. All parties to the Commissioning Process shall be individually responsible for alerting the COTR of any issues that they deem to constitute a potential contract change prior to acting on these issues.

e. Authority for design and construction issues resolution rests solely with the Contracting Officer and his/her designated representative with appropriate technical guidance from the AE Team and/or Commissioning Agent.

I. Abbreviations

1. Operations and Maintenance (O&M)
2. VAMC Project Manager and/or Resident Engineer (PM/RE)
3. VAMC Facilities Management Department Staff (FMD)
4. Design Professionals (D)
5. Construction Manager (CPM)
6. Installation Contractors (CONTR)
7. Testing, Adjusting & Balancing Contractor (TAB)
8. Commissioning Agent (CxA)
9. Request for Information (RFI)
10. Architect's Supplemental Instructions (ASI)
11. Design Development Documents (DD)
12. Construction Documents (CD)
13. Commissioning (Cx)
14. Functional Performance Test (FPT)

15. Pre-Functional Checklist (PFC)
16. Corrective Action Notice (CAR)
17. Quality Control (QC)

II. Commissioning Goals

A. The Commissioning Agent has developed specific Commissioning Goals to emphasize the role commissioning will play in the design and construction processes:

- Meet or exceed VAMC Project Requirements
- Optimize Systems Operations
- System operation and performance verification
  - ✓ Performance Test results
  - ✓ Pre-Functional checklists
  - ✓ Equipment startup
- Documentation and Training for FMD Staff
  - ✓ Operating instructions and documentation
  - ✓ Operator equipment training
  - ✓ Operator systems training
- Integrate Testing Schedules into Construction Schedule
  - ✓ Coordination of trades
  - ✓ Coordination of DDC vendor tasks
  - ✓ Coordination of TAB vendor tasks
- Early identification and resolution of issues
- Clear and open communications

III. Project Description

A. [Provide a brief narrative description of the project, including overall project scope, goals, and systems.]

IV. Commissioning Scope

A. [Commissioning Agent name] will provide commissioning services to support the [project name] project. Commissioning activities will include the tasks and deliverables outlined below.

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Design	Review Owner's Project Requirements	Review VAMC Design Criteria and Owner's Project Requirement document prior to submission to LEED Facilitator.	Review comment log.
Design	Review Basis of Design Document	Review the Basis of Design Document prior to submission to the LEED Facilitator	Review comment log.
Design	Review Schematic design	Review Schematic Design for familiarization, general conformance with Owner's Project Requirements, Basis of Design and VA Design Criteria.	Review comment log.
Design	Review Design Development design	Review Design Development design for familiarization, general conformance with Owner's Project Requirements, Basis of Design and VAMC Design Criteria.	Review comment log.
Design	Commissioning Specifications	Prepare Commissioning Specification "Section 01 91 13 – General Commissioning Requirements" to be included in project manual.	Commissioning Specification

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
		Prepare Commissioning Specification for Division 07 – Thermal and Moisture Protection, Division 08 – Openings, Division 10 – Specialties, Division 11 – Equipment, Division 14 – Conveying Equipment, Division 21 – Fire Protection, Division 22 – Plumbing, Division 23 – HVAC, Division 26 – Electrical, Division 27 – Communications, Division 28 – Electronic Safety and Security, Division 33 – Utilities, and Division 34 - Transportation to provide detailed commissioning, operations & maintenance and training requirements for individual technical specification sections.	Commissioning Specifications
Design	Design Phase Controls Meeting	Meet with Owner, Architect, Mechanical/Electrical Design Engineer, and Owner's Controls Vendor to review Building Control Systems and Sequences of Operations. The focus of the meeting will be to obtain understanding of the interactions between systems and the control system in various operating modes. It is anticipated this meeting will be held in conjunction with a scheduled Owner/Architect design-phase meeting.	Meeting notes.
Design	Preliminary Commissioning Plan	Prepare Preliminary Commissioning Plan that describes the Commissioning Process, Commissioning Team with specific Roles and Responsibilities. The Commissioning Plan will include description of systems to be commissioned.	Preliminary Commissioning Plan
Design	Focused Design Document Review	Perform a focused review of a Design Document SD-1, SD-2, DD-1, DD-2, CD, and Final submissions.	Commissioning Design Review Log

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Design	Focused Construction Document Review	Perform a focused review of the final Construction Document submission. This review will include a back check of commissioning comments provided during previous reviews.	Commissioning Design Review Log
Design	Design Phase Meetings	Participate in selected Design Phase Owner/Architect/ meetings.	Meeting Notes.
Design	Focused Design Review Meetings	Attend selected meetings with Owner and Design Team to review the design and specific commissioning design review comments. It is assumed this meeting will be scheduled in conjunction with scheduled Owner/Architect meetings.	Meeting Notes.
Design	LEED Commissioning-related Document Review	Assist LEED Facilitator with final review of commissioning-related design-phase LEED templates and required documentation.	Brief Narrative Reports
Design	Develop Measurement & Verification (M&V) Plan	Coordinate with the design team and the LEED energy modeling consultant to develop an M&V Plan for the project. Coordinate with the design team to verify that appropriate instrumentation is included in the DDC or other systems to support the M&V Plan.	Draft M&V Plan Marked up drawings showing required M&V instrumentations.
Construction	Final Commissioning Plan	Based on the final construction documents, update the Preliminary Commissioning Plan to identify specific systems to be commissioned. The Final Commissioning Plan will also include specific individual roles and responsibilities and Preliminary Pre-Functional Checklists and Functional Test Plans for systems to be commissioned.	Final Commissioning Plan.

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Construction	Construction Commissioning Kick Off meeting	Conduct an initial commissioning meeting with all contractors and commissioning team members. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility in the construction, acceptance and warranties phases of the project. Review the individual roles and responsibilities of each participating commissioning team member as specified in the Construction Documents. Meeting will be scheduled for each construction package with a commissioning scope.	Meeting Notes
Construction	Duration Schedule for Commissioning Activities	Based on Final Commissioning Plan, prepare a duration schedule to show the duration, predecessors and successors for commissioning activities. This duration schedule will be provided to the Construction Manager to include commissioning activities in the project construction schedule. This will allow commissioning activities to be smoothly integrated into the overall construction process.	Duration schedule with commissioning activities, predecessors, successors and key milestones.
Construction	Submittal and Shop Drawing Review	Based on final construction documents, prepare a list of selected submittals and shop drawings for review by the Commissioning Agent.	Submittal Request Checklist.
Construction		Review selected submittals and shop drawings to support the commissioning process. Review will be for the purpose of developing appropriate Pre-Functional Checklists and Functional Test Plans. Reviews will focus on the ability to commission the systems, maintainability and general conformance to owner's requirements. Commissioning review of submittals and shop drawings does not replace the Design Team responsibility for approval.	Commissioning Submittal Review Log

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Construction	Controls Meeting	After receipt of the Controls Submittal, participate in or conduct a meeting with the Owner's representatives, Control Vendor, TAB contractor, Mechanical/Electrical Design team, mechanical sub-contractor and electrical sub-contractor to review the Controls Submittal and mechanical/electrical systems to be installed. Focus will be on how the selected sequences of operation interact with the mechanical/electrical systems and how well they meet the owner's requirements.	Meeting Notes Marked up Controls Submittal and Sequence of Operations. Commissioning Issues Log to track action items.
Construction	Pre-Functional Checklists	Prepare Pre-Functional Checklists for systems, components and/or equipment to be commissioned. These Pre-Functional Checklists will be used to document completion of system, component and/or equipment installation and to determine system readiness for functional testing. Pre-Functional Checklists should be completed by the installing contractors to document the installation process. Completed Pre-Functional Checklists are to be submitted to the commissioning agent a minimum of seven days prior to testing. Completed Systems Readiness Checklists will be spot checked by the commissioning agent to verify systems are ready for testing.	Draft Pre-Functional Checklists for owner and contractor review. Final Pre-Functional Checklists for use by contractors and/or CxA.

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Construction	Review Contractor Equipment Startup Checklists	Commissioning agent will review selected equipment startup reports prepared by installing contractor. Commissioning agent will witness selected equipment startup procedures. Seven days prior notice is required to schedule commission agent witnessing the startup.	Contractor Equipment Startup Checklist (this checklist is part of the Submittal and Shop Drawing Review Checklist). Commissioning Issues Log
Construction	Prepare Functional Test Plans	Based on final construction documents (including applicable changes), and approved submittals, prepare Functional Test Plans for systems to be commissioned. Draft Functional Test Plans will be issued for review by owner, installing contractors and DDC Vendor. Final Functional Test Plans will be prepared incorporating review comments received from owner, contractors or DDC Vendor.	Draft Functional Test Plans for review by owner, installing contractors and DDC vendor. Final Functional Test Plans for use in systems testing.
Construction	TAB Review	Review HVAC systems Test and Balance Plan prepared by the TAB vendor. Review will be to determine general conformance with owner's requirements.	Commissioning Review Log
		Review TAB Report prepared by TAB vendor following system air and water balancing. Review will be focused on TAB results that affect system performance and/or commissioning. Specific attention will be given to equipment installation and operational issues identified by the TAB vendor.	Commissioning Issues Log

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Construction	Review O & M Manuals	Review Operations and Maintenance Manuals submitted by contractors for general conformance with specifications and owner's requirements.	Commissioning Review Log
Construction	Prepare Systems Manuals	Prepare detailed systems manuals for commissioned systems. The manuals will provide operating staff the information needed to understand and optimally operate the commissioned systems. The manuals will describe system design, components, capacity and sequences of operations. Manuals will include descriptions of interactions with other systems and common systems failure modes and responses.	Systems Manuals – 1 hardcopy plus 2 electronic copies on CD/DVD
Construction	Review Training Plans	Review contractor and manufacturer training plans and agendas for general conformance with specifications and owner's requirements. Observe selected training for quality of training and for general conformance with the training plan and agenda.	Commissioning Review Log
Construction	Warranty Review	Review contractor's and manufacturer's warranties for general conformance with specifications and owner's requirements.	Commissioning Review Log
Construction	Systems Functional Testing	Direct functional testing for systems to be commissioned. Testing will be conducted as detailed on the specific Functional Test Plan for each system to be commissioned. Functional testing will require support from the owner, mechanical contractor, electrical contractor, DDC Vendor, TAB Vendor, and specialty-systems installing contractors. Installing contractors must be available to respond to issues and problems identified during testing.	Executed Functional Test Plans. Commissioning Issues Log

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Construction	Construction Observation	Conduct Construction Observation visits to the construction site to observe construction activities. Specific attention will be given to installation of mechanical, electrical, and plumbing systems for general conformance with specifications and manufacturer's installation requirements. Specific attention will also be given to installation of site utilities, site improvements and building envelope construction for general conformance with plans, specifications and manufacturer's installation requirements.	Field Observation Reports Commissioning Issues Log.
Construction	Verify M&V instrumentation	Verify proper installation and calibration of instrumentation necessary to support the M&V program	Commissioning Issues Log
Construction	Final Commissioning Report	Compile a comprehensive commissioning report documenting all commissioning activities, including but not limited to: • Commissioning scope • Test methods and results • Outstanding commissioning issues • Issues log • Commissioning plan • Status reports • Submittal and O&M manual reviews • Training record • Pre-Functional Checklists • Design Review Comments Scope includes one submission of a preliminary report for owner review. Scope includes one submission of the Final Commissioning Report that incorporates owners review comments.	Preliminary Commissioning Report – 1 hardcopy for owner review. Final Commissioning Report – 1 hardcopy plus 2 electronic submissions on CD/DVD.

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Construction	Owner Architect and Construction Manager Meetings (Construction Phase)	Attend selected Owner/Architect/Contractor Meetings. Sebesta Blomberg will attend meetings to discuss commissioning issues, review the Commissioning Issues Log and to maintain awareness of general construction schedule and issues.	Meeting Notes (it is assumed the Construction Manager will provide the official minutes).
Construction	Commissioning Progress Meetings	Conduct Commissioning Progress Meetings to review system installation progress, system readiness, and preparation for functional systems testing. These meetings will also review status of unresolved commissioning issues and progress towards resolution of the issues. The Construction Manager, Construction Commissioning Manager, Construction Quality Control Manager, and commissioning representatives from the Mechanical/Electrical Design team, mechanical contractor, electrical contractor, DDC vendor, TAB vendor, and specialty systems installing contractors will attend these meetings.	Meeting minutes.
Construction	Status Reports	Provide periodic status reports detailing activities, significant unresolved issues, and upcoming commissioning activities. Prepare report outlining status of deliverables for the project. Status reports are submitted with invoices for professional services.	Monthly Narrative Status Report. Monthly Percent Complete Report.
Construction	Master Issues Log	Maintain a Commissioning Issues Log to document commissioning issues identified during construction and functional testing. The Commissioning Issues Log will include recommended responsible party and recommendations for resolution of the issue. The Commissioning Issues Log will also be used to document progress toward resolution and the final resolution	Commissioning Issues Log

Commissioning Scope			
Project Phase	**Task**	**Description**	**Deliverable**
Construction	Review Change Orders, ASI, and RFI	Review change orders, architect's supplemental instructions and requests for information (with design team response) for issues that affect commissioning. Review is for information only and does not constitute technical or contractual approval or disapproval.	Commissioning Requests for Information.
Construction	LEED Commissioning Document Review	Prepare LEED templates and required documentation relative to construction phase commissioning activities. Task to be performed electronically through the LEED On-Line web site and/or electronic communication with the LEED Facilitator.	Draft LEED Templates and Brief Narrative Reports
Warranty	Deferred and/or seasonal Testing	Direct testing that was deferred due to lack of system readiness or for seasonal requirements. Testing will be conducted in accordance with Functional Test Plans. Testing support will be required from the DDC Vendor and owner. We have assumed this testing will be performed during a two-day site visit approximately 10 months after substantial completion.	Executed Functional Test Plans. Commissioning Issues Log
Warranty	Post-Occupancy Warranty Checkup	Return to the project approximately 10 months into the 12 month warranty period to review the building operation with the facility staff and discuss outstanding issues related to commissioning and outstanding warranty issues. Provide suggestions for improvements. Assist facility staff in developing reports, documents and requests for service to remedy outstanding problems. We have assumed this will be performed during a (TBD)-day site visit approximately 10 months after substantial completion	Field Observation Report
Warranty	Final Commissioning Report Amendment	Amend Final Commissioning Report to document the Warranty Phase commissioning activities.	Amendment to Final Commissioning Report.

B. Design Phase Commissioning Services will be provided by the [location] office of [Commissioning Agent Name].

C. Construction Phase Commissioning Services will be provided at the Construction Site in [location].

D. The scope of Commissioning Services described above will meet the Fundamental Commissioning of Building Energy Systems requirements as outlined in the LEED® Energy & Atmosphere (EA) Pre-Requisite 1. The scope of services will also meet the Enhanced Commissioning requirements outlined in LEED® EA Credit 3.

E. The scope of Commissioning Services also includes developing and implementing a Measurement and Verification Plan to meet the requirements of LEED®- Energy and Atmosphere (EA) Credit 5.

V. Systems to Be Commissioned

A. The systems and equipment to be commissioned are outlined in the table below. A more detailed list of specific systems and equipment is provided in Appendix A.

Systems To Be Commissioned					
System	**Pre-Functional Checklists**	**Equipment Startup**	**Functional Testing**	**Sample Size**	**Remarks**
Div 21 - Fire Protection					
Fire Protection Systems	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]
Div 22 - Plumbing					
Domestic Hot Water Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Medial Gas Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Div 23 - HVAC					

Systems To Be Commissioned					
System	**Pre-Functional Checklists**	**Equipment Startup**	**Functional Testing**	**Sample Size**	**Remarks**
Air Handling Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Dehumidification Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Heating Hot Water Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Condensate Return Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Chilled Water Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Exhaust Fans	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]
Steam System	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Direct Digital Control System	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]
Laboratory Exhaust System	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Laboratory Ventilation System	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
OR Air Handling System	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Radiology/Imaging Cooling Systems	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]
Computer Room HVAC Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Div 26 - Electrical					
Utility service entrance Switchgear	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]

Systems To Be Commissioned					
System	**Pre-Functional Checklists**	**Equipment Startup**	**Functional Testing**	**Sample Size**	**Remarks**
Standby Generator Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Generator Paralleling Switchgear	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Generator Power Distribution Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Utility Power Unit Substations	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Generator Power Unit Substations	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Automatic Transfer Switches	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Normal Power Distribution Systems	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]
Life Safety Power Distribution Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Critical Power Distribution Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Essential Equipment Power Distribution Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Lighting Controls	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]
UPS Systems	Yes	Yes	Yes	100%	[list applicable bid packages or other remarks]
Div 27 - Communications					
Nurse Call / Code Blue	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]
Public Address and Mass Notification Systems	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]

Systems To Be Commissioned					
System	**Pre-Functional Checklists**	**Equipment Startup**	**Functional Testing**	**Sample Size**	**Remarks**
Healthcare Intercommunications and Program Systems	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]
Div 28 – Electronic Safety and Security					
Fire Detection and Alarm Systems	Yes	Yes	Yes	TBD	[list applicable bid packages or other remarks]

VI. Commissioning Team

A. The Commissioning Team shall consist of representatives from the following parties involved in the design and construction of this facility. The time at which individual members join the team and the level of their participation during the different phases of the project will vary from member to member.

Commissioning Team			
Item	**Team Member**	**Description**	**Contact Information**
PM	VAMC- Project Manager	Program Management Representative responsible for contractual and technical aspects of the project.	Name Organization Address City, State Zip Phone: Email:
RE	VAMC-Resident Engineer	On-site technical representative of the Contracting Officer.	Name Organization Address City, State Zip Phone: Email:

Commissioning Team			
Item	**Team Member**	**Description**	**Contact Information**
FMD	VAMC-Facilities Management Department	Representative of the Facilities Management Department	Name Organization Address City, State Zip Phone: Email:
QA	VAMC-Quality Assurance Coordinator	FMD Quality Assurance coordinator for Commissioning activities	Name Organization Address City, State Zip Phone: Email:
A	Architectural Design Professional	Architect's Construction Administration Representative	Name Organization Address City, State Zip Phone: Email:
MEP	Mechanical, Electrical and Plumbing Design Professional	MEP Construction Administration Representative	Name Organization Address City, State Zip Phone: Email:
CxA	Commissioning Agent	Project Manager for Commissioning Agent	Name Organization Address City, State Zip Phone: Email:

Commissioning Team			
Item	**Team Member**	**Description**	**Contact Information**
CxTL	Commissioning Agent Technical Lead	Primary point of contact for Commissioning technical issues	Name Organization Address City, State Zip Phone: Email:
CPM	Construction Project Manager	Contractor's Project Manager responsible for construction and coordination of sub-contractors	Name Organization Address City, State Zip Phone: Email:
CQC	Quality Control Manager	Contractor's Quality Control Manager responsible for managing the construction quality program	Name Organization Address City, State Zip Phone: Email:
FP	Fire Protection Contractor	Commissioning Representative for the Sub-contractor responsible for installation of fire protection systems	Name Organization Address City, State Zip Phone: Email:
PLMG	Plumbing Contractor	Commissioning Representative for the Sub-contractor responsible for installation of plumbing systems	Name Organization Address City, State Zip Phone: Email:

Commissioning Team			
Item	**Team Member**	**Description**	**Contact Information**
HVAC	Mechanical Contractor	Commissioning Representative for the Sub-contractor responsible for installation of HVAC systems	Name Organization Address City, State Zip Phone: Email:
EC	Electrical Contractor	Commissioning Representative for the Sub-contractor responsible for installation of MV and LV electrical systems	Name Organization Address City, State Zip Phone: Email:
SC	Specialty Systems Contractor	Commissioning Representative for the Sub-Contractor(s) responsible for installation of specialty and/or low voltage systems	Name Organization Address City, State Zip Phone: Email:
DDC	DDC Vendor	Commissioning Representative for the DDC vendor responsible for providing the control system(s)	Name Organization Address City, State Zip Phone: Email:
TAB	Testing and Balancing Vendor	Commissioning Representative for the TAB vendor responsible for certified air- and water-testing and balancing.	Name Organization Address City, State Zip Phone: Email:

B. Roles and Responsibilities for the Commissioning Team members are described elsewhere in this Commissioning Plan.

VII. Commissioning Communications and Document Distribution

A. The following table outlines the submittal and distribution requirements for various documents used in the commissioning process.

Communication Distribution Matrix				
Document	**Prepared by:**	**Submitted to:**	**Copies to:**	**Comments**
Owner's Project Requirements	PM	• Design Team	• QA • CxA • CPM	
OPR Comment Log	CxA	• PM	• QA • Design Team • CPM	
Basis of Design Document (Design Narrative)	Design Team	• PM	• QA • CxA • CPM	
Schematic Design Documents	Design Team	• PM	• QA • CxA • CPM	Design team submits direct to VAMC
Schematic Design Review Comment Log	CxA	• PM	• QA • Design Team • CPM	VAMC Review comments submitted separately to Design Team
Design Development documents	Design Team	• PM	• QA • CxA • CPM	Design team submits direct to VAMC Building Department as separate submission

Communication Distribution Matrix				
Document	**Prepared by:**	**Submitted to:**	**Copies to:**	**Comments**
DD Review Comment Log	CxA	• PM	• QA • Design Team • CPM	VAMC Review comments submitted separately to Design Team
Commissioning Specification Section 01810	CxA	• PM	• QA • Design Team	
Commissioning Specifications Coordination Matrix	CxA	• PM	• QA • Design Team	
Design Phase Controls Meeting	Minutes by Design Team Notes by CxA	• PM	• QA • CxA • CPM	
Preliminary Commissioning Plan	CxA	• PM	• QA • CPM • Design Team • DDC • TAB	
Progress CD Drawings and Specs	Design Team	• PM •	• QA • CxA • DDC	
Progress Set Review Comments Log	CxA	• PM	• QA • Design Team	
Final Construction Documents	Design Team	• PM	• QA • CxA • CPM	Design team submits direct to VAMC as separate submission
Final CD Review Comment Log	CxA	• PM	• QA • Design Team • CPM	VAMC Review comments submitted separately to Design Team

Communication Distribution Matrix				
Document	**Prepared by:**	**Submitted to:**	**Copies to:**	**Comments**
Design Phase Meeting Minutes	Design Team	• PM	• QA • CxA • CPM	
Focused Design Review Meeting Minutes	Minutes by Design Team Notes by CxA	• PM	• QA • CxA • CPM	
Final Commissioning Plan	CxA	• RE	• QA • Design Team • CPM • DDC • TAB	
Construction Kickoff Meeting Minutes	CPM	• RE	• QA • CxA • Design Team	
Duration Schedule for Commissioning Activities	CxA	• RE	• QA • CPM	Initial submission included in Final Commissioning Plan Updates provided as necessary
Submittals and Shop Drawings	CPM	• RE	• Design Team • CxA • QA	Submittals and Shop Drawings are submitted to the Design Team as separate submission
Submittal and Shop Drawing Comment Log	CxA	• RE	• CPM • Design Team • QA	Design team comments and/or approval provided separately to CPM and PM

Communication Distribution Matrix				
Document	**Prepared by:**	**Submitted to:**	**Copies to:**	**Comments**
Construction Phase Controls Meeting Minutes	CPM Notes by CxA	• RE	• QA • CxA • Design Team • DDC	
Preliminary Pre-Functional Checklists	CxA	• RE	• QA • CPM • DDC	
System Pre-Functional Checklist Comments	CPM PM DDC	• RE	• CxA • QA	
Final Pre-Functional Checklists	CxA	• RE	• CPM • QA	
Executed Pre-Functional Checklists	CPM	• RE	• CxA • QA	
Contractor Startup Reports	CPM	• RE	• CxA • QA • Design Team • DDC	
Contractor Startup Report Comment Log	CxA	• RE	• QA • CPM • Design Team • DDC	
Preliminary Functional Test Procedures	CxA	• RE	• QA • CPM • DDC	
Preliminary Functional Test Procedure Comments	PM CPM DDC	• RE	• CxA • QA • DDC	

Communication Distribution Matrix				
Document	**Prepared by:**	**Submitted to:**	**Copies to:**	**Comments**
Final Functional Test Procedures	CxA	• RE	• QA • CPM • DDC	
Executed Functional Test Procedures	CxA	• RE	• QA • CPM • DDC	
TAB Plan	TAB	• RE	• QA • CxA • Design Team	
TAB Plan Review Comment Log	CxA	• RE	• QA • TAB • Design Team	
TAB Daily Worksheets	TAB	• RE	• CxA • MEP	
TAB Final Report	TAB	• RE	• QA • Design Team • CxA	
TAB Final Report Comment Log	CxA	• RE	• QA • TAB • Design Team	
O&M Manuals	CPM	• RE	• QA • FMD • CxA • Design Team	
O&M Manual Comment Log	CxA	• RE	• CPM • QA • FMD • Design Team	

Communication Distribution Matrix				
Document	**Prepared by:**	**Submitted to:**	**Copies to:**	**Comments**
Systems Manuals	CxA	• RE	• QA • FMD • CPM • Design Team	
System Manual Review Comments	QA FMD CPM Design Team	• RE	• QA • FMD • CxA • CPM • Design Team	
Training Plans	CPM	• RE	• QA • FMD • CxA • Design Team	
Training Plan Comment Log	CxA	• RE	• QA • FMD • CPM • Design Team	
Warranty and other Closeout Documents	CPM	• RE	• QA • CxA • Design Team	
Warranty and Closeout Comment Log	CxA	• RE	• QA • CPM • Design Team	
System Functional Testing Field Reports	CxA	• RE	• QA • CPM • DDC	

Communication Distribution Matrix				
Document	**Prepared by:**	**Submitted to:**	**Copies to:**	**Comments**
Construction Observations Field Reports	CxA	• RE	• QA • CPM • DDC	
Preliminary Commissioning Report	CxA	• QA	• PM • CPM • DDC • TAB	
Commissioning Report Review Comments	QA	• CxA	• PM • CPM • DDC • TAB	
Final Commissioning Report	CxA	• QA	• PM • CPM • DDC • TAB	
Construction O/A/C Meeting minutes	CPM	• RE	• QA • CxA • Design Team • DDC	
Commissioning Status Reports	CxA	• QA	• PM	
Master Issues Log	CxA	• RE	• QA • CPM • DDC	
Change Orders, ASI, RFI	Design Team CPM	• RE	• QA • CxA • CPM • Design Team	
Deferred / Seasonal Testing Field Report	CxA	• RE	• QA • CPM • DDC	

Communication Distribution Matrix				
Document	**Prepared by:**	**Submitted to:**	**Copies to:**	**Comments**
Deferred / Seasonal Executed Functional Test Procedures	CxA	• RE	• QA • CPM • DDC	
Warranty Checkup Field Report	CxA	• RE	• QA • CPM • DDC	
Master Issues Log	CxA	• RE	• QA • CPM • DDC	
Commissioning Report Amendment	CxA	• QA	• PM	

VIII. Pre-Design Phase Commissioning

A. Design Intent Document: During the Pre-Design Phase, VAPM will solicit and award contracts for the Design Team, Construction Manager and Commissioning Agent. Once these contracts are executed, the Design Team will begin developing the project design. The CPM will assist the Design Team by providing advice on construction issues and periodic cost estimates. The Design Team will prepare a Design Narrative to document the VA project requirements. The mechanical, electrical, plumbing, controls and other technical sections will provide a reference for all design and commissioning requirements. This document will be updated as needed during the design process to document changes in the VA project requirements.

B. Design Narrative: The Design Team will also prepare a Design Narrative that provides documentation on the design assumptions, design parameters, design calculations, and decisions made during design to implement the Design Intent Document. The Design Narrative is also submitted to the VAPM for review.

C. The goal of the commissioning tasks in the Pre-Design Phase of the project include the following:

1. The CxA, PM, CPM and FMD representatives will review and provide written comments on the Design Intent Document.

2. The CxA, PM, CPM and FMD representatives will review and provide written comments on the Design Narrative.

IX. Design Phase Commissioning

A. Schematic Design Phase: The goals of the commissioning tasks in the Schematic Design Phase of the project include the following:

1. The CxA, PM, and FMD representatives will review and provide written comments on the Schematic Design documents submitted by the Design Team. The focus of the CxA review will be on adherence to the Design Narrative. The review comments will be geared towards aligning the design and design narrative with the Design Intent Document and/or updating the Design Narrative with decisions approved by VA during the Schematic Design Phase.

B. Design Development Phase: The goals of the commissioning tasks in the Design Development Phase of the project include the following:

1. The CxA, PM, and FMD representatives will review and provide written comments on the Design Development documents submitted by the Design Team. The focus of the CxA review will be on adherence to the Design Narrative as updated after the Schematic Design Phase. The review comments will be geared towards aligning the design and design narrative with the Design Narrative and/or updating the Design Narrative with decisions approved by VA during the Design Development Phase.
2. The CxA will prepare the Preliminary Commissioning Plan to provide an initial framework for commissioning activities that will follow. This Preliminary Commissioning Plan will be aligned with the project scope and schedule. It will be reviewed by the PM, FMD, CPM and other interested parties.
3. The CxA will also prepare preliminary commissioning specifications to be included in the project manual. The preliminary specifications will include Section 01 91 00 – GENERAL COMMISSIONING REQUIREMENTS as well as language to be included in other Division 7, Division 21, Division 22, Division 23, Division 26, Division 27, Division 28, and Division 31 specification sections. The Design Team will review the preliminary commissioning specifications and provide written comments to the CxA. The CxA will revise the Preliminary Commissioning Specification and re-submit to the Design Team.
4. A review conference is held with the Design Team, PM, FMD, CxA and CPM to coordinate review comments and responses.

5. The CxA, CPM, Design Team, PM, and FMD will hold a meeting to review mechanical, electrical and plumbing system selections and to develop the preliminary control system Sequences of Operations for the project. Based on the results of this meeting, the Design Team will use these concepts as the basis for designing the final control system specifications and Sequences of Operations to be included in the construction documents. The Design Team will notify and coordinate and changes with the other parties involved in the control system.
6. The CxA will update the Commissioning Plan to incorporate any changes resulting from the Design Development submission and review comments.
7. The CxA will also prepare the Commissioning Specifications Coordination Matrix. This document is based on the outline specifications provided by the Design Team. It provides recommended wording to be included in the technical specifications sections to identify commissioning, O&M manual and training requirements for the CPM and the installing contractors.
8. The Design Narrative will be updated by the CxA to incorporate decisions approved during the Design Development phase.

C. Construction Document Phase: The goals of the commissioning tasks in the Construction Document Phase of the project include the following:

1. The Design Team will prepare final construction documents that will be used to construct the facility. A progress set of drawings and specifications will be issued for review at approximately the 50% CD stage. The CxA, PM, CPM, and FMD will review the progress set to verify that the design is proceeding in accordance with the Design Narrative.
2. The CxA will prepare a final, detailed list of systems and equipment to be commissioned.
3. The CxA will prepare preliminary Pre-Functional Checklists and Systems Functional Performance Test procedures for each type of system to be commissioned. These will be published in the Preliminary Commissioning Plan to be included as an informational appendix to Specification Section 01 91 00 – GENERAL COMMISSIONING REQUIREMENTS that will be issued for bid.
4. A review conference will be conducted to coordinate review comments and provide direction for adjustments in the design prior to issuing the final construction documents.
5. The CxA will update the Design Narrative to reflect changes approved during the review conference.

6. The Design Team will issue final Construction Documents, including drawings, and specifications. These will be reviewed by the CxA, PM, VAMC User, and FMD. The CPM will also review the final construction documents and prepare the final estimates of construction costs.

X. Construction and Acceptance Phase Commissioning

A. The CxA will prepare the Construction Commissioning Plan that incorporates any changes due to the Final Construction Documents, Design Narrative. This Commissioning Plan outlines the commissioning activities during the Construction and Acceptance Phase of the project.

B. A Commissioning Kickoff Meeting will be held at the start of construction to describe the commissioning process for the Construction Team which includes the CPM, installing sub-contractors (Mechanical, Electrical, Plumbing, Controls Electrical, DDC, TAB, and others). Preliminary Pre-Functional Checklists and Functional Test Plans will be included to describe the level of involvement required of all parties.

C. The CxA will provide preliminary Commissioning Milestones, predecessors, successors, and durations to the CPM. The CPM will be able to use these data to integrate commissioning activities into the project construction schedule. The CxA will align commissioning activities with the construction schedule for each construction phase.

D. The CxA will attend periodic Owner/Architect/Contractor (O/A/C) meetings to discuss commissioning activities, field reports, issues log and responses to commissioning issues noted during construction.

E. Regular Commissioning Progress meetings will be held for each construction phase. These meetings are a forum to review progress and to discuss issues affecting installation, coordination, startup, and testing of the systems to be commissioned. Meeting attendees should include the Commissioning Agent, RE, CPM, mechanical, electrical, plumbing, controls and TAB subcontractors. Design team members, especially the MEP designers are also encouraged to attend.

F. It is anticipated these meetings will be held quarterly during the early stage of construction. Once the building has come out of the ground and the exterior shell is being constructed, the meetings will be held on a monthly basis. As the mechanical, electrical and plumbing systems are being installed, it is likely the commissioning meetings will be held bi-weekly.

G. The Commissioning Agent will witness selected equipment startups for mechanical, electrical and plumbing components. The purpose will be to observe any issues that may arise that would affect equipment or system operations.

H. The Commissioning Agent will conduct periodic Field Observations to review construction progress, overall quality of workmanship, and to review maintenance access to equipment. The CxA will issue a Field Observation Report following each visit. The report will describe any specific observations that are found. The specific observations will be tracked on the Commissioning Master Issues Log.

I. The RE, CPM, installing sub-contractors and the Design Team (as necessary) should review the Field Reports to determine the most appropriate resolution for the issue. The CxA will assist in determining the resolution as requested. The status of issue resolution will be a primary topic of discussion at the Commissioning Progress meetings and O/A/C meetings.

J. The CxA will review selected submittals and shop drawings relative to the systems to be commissioned. The review will be to determine if sufficient information is provided to describe system installation, operation and the information necessary to commission the equipment and systems.

K. The CxA will review the Operations & Maintenance data submitted by the installing contractor and the CPM. The Commissioning Specification provides specific requirements for O&M Manuals that are more detailed for those systems to be commissioned. The O&M Manuals will be review to determine compliance with these additional requirements.

L. The Cx A will prepare systems narratives and other information to be added to the O&M data provided by the installing contractors and the CPM to become the Systems Operations and Maintenance Manual (SOMM). The SOMM will provide operations and maintenance staff with an overview of the system design parameters, intended operating conditions and sequences. It will also provide data necessary to maintain and troubleshoot the equipment and systems.

M. The installing contractors and the CPM will prepare equipment training plans intended to provide basic equipment operating and maintenance procedures. The installing contractors and the CPM will prepare training plans that will outline the training to be provided and the intended outcome of the training. The CxA will review the training plans to determine that the training will meet the requirements of the specifications and the FMD staff.

N. The Commissioning Agent will prepare Pre-Functional Checklists that the installing sub-contractors will complete to document equipment and systems are complete and ready for testing.

O. The Commissioning Agent will also prepare detailed System Functional Performance Test plans that will provide detailed step-by-step procedures that will be used to verify system operations under all operating conditions. These test procedures will be issued to the RE, CPM, installing Contractors, DDC, TAB and FMD for review and comment. The reviews should focus on the ability to implement the steps, especially the control systems adjustments, necessary to perform the test. The reviewers should also note any procedures that would damage the equipment or system.

P. The installing sub-contractors are encouraged to use the System Functional Test Plans as a tool for pre-testing the equipment and systems prior to the "official" functional testing. This will allow early detection and resolution of problems.

Q. The CxA will assist the CPM in scheduling equipment training. The CxA will review training plans prepared by the CPM and the installing sub-contractors.

R. The CxA will conduct enhanced systems training for FMD staff. This training will focus on the system operation, design criteria, and troubleshooting of systems level issues. It is anticipated that the enhanced systems training will be conducted prior to functional testing to facilitate participation of the FMD staff in the testing activities.

S. It is the expectation that System Functional Testing will demonstrate that the systems perform in accordance with design criteria, construction documents and VA requirements. Functional testing pre-requisites are that the system components and equipment are completely installed, all required power connections are complete, all required control connections and control functions are operational, and that required air and hydronic testing and balancing has been completed. When required by construction specifications, third-party testing must also be complete and required test reports have been submitted to the RE and CxA for review.

T. Functional testing of each system to be commissioned will be conducted by the CxA. The CxA will witness and document the testing; the installing sub-contractors, DDC contractor, and TAB contractor will conduct the testing by operating the equipment, adjusting the control system and performing measurements in accordance with the System Functional Test Plan. The FMD staff is encouraged to assist in the testing as an additional training opportunity.

U. Issues and/or failures detected during the Functional Performance Testing will be documented on the test plan, on Field Observation reports and on the Master Issues Log. Installing sub-contractors, DDC contractor, and/or TAB contractor will be responsible for correcting each issue as directed by the RE, and reporting the corrective action to the RE and CxA. The CxA will document the corrective action on the Master Issues Log. The need for re-testing will be determined by the RE in consultation with the CxA.

V. Upon completion of all commissioning activities, including resolution of all issues on the Commissioning Master Issues Log, the CxA will prepare and issue the Final Commissioning Report. This report will include the final version of the Commissioning Plan, copies of all Commissioning Meeting Minutes, Commissioning Field Observation Reports, Pre-Functional Checklists, Functional Performance Test results, and the Commissioning Master Issues Log. The report will also include blank copies of the Functional Test Plans for use by FMD for future re-commissioning activities.

XI. Warranty Phase Commissioning

A. The CxA will review operational data from the VAMC DDC System to monitor system operations. Significant deviations from defined criteria will be noted and referred to FMD for further investigation.

B. Conduct any deferred or seasonal functional testing that was not completed during the Construction and Acceptance Phase. Issues identified during the deferred or seasonal testing will be documented on the Commissioning Issues Log. The CPM will be notified of the issue and will be responsible for resolution. The CPM will document the resolution and the CxA and FMD will verify the resolution. The RE in consultation from the CxA, will determine the need for re-testing.

C. Conduct a 10-month warranty review to identify any potential warranty issues prior to expiration of the warranty. The warranty review will include interviews with FMD staff and an on-site inspection of systems and equipment condition and operations.

D. Warranty issues identified during the review will be documented on the Commissioning Issues Log. Written notice of potential warranty issues will be provided to the RE. Upon direction by the RE, the CPM will schedule appropriate sub-contractors to correct the issues within the balance of the warranty period. The CPM will provide written documentation that each warranty issue has been resolved. The CxA and FMD will spot-check selected issues to verify resolution.

E. The CxA will prepare an amendment to the Final Commissioning Report to document the deferred or seasonal testing, any re-testing, and the results of the warranty review.

XII. Team Member Roles and Responsibilities

A. The following is an outline of team member responsibilities in the Design, Construction and Acceptance, and Warranty phases of the commissioning process. These responsibilities are meant to be limited to those tasks related to the commissioning process and are not intended to be representative of each team member's contractual responsibilities for other aspects of this project.

B. In the table that follows, the tasks identified for the "CxA" include the Commissioning Project Manager, Commissioning Technical Lead, or other Commissioning Specialists and sub-consultants as directed by the CxA.

C. In the table that follows, the tasks identified for the "Design Team" include the Architect, MEP Engineer, Civil Engineer or other design consultants as directed by the RE and Architect.

D. In the table that follows, the tasks identified for "Contractor" include the Construction Project Manager, as well as the commissioning representatives for the installing sub-contractors, as directed by the RE and the Construction Project Manager.

E. In the table that follows, the tasks identified for "DDC" include the owner's DDC Vendor as directed by the RE and CPM.

F. In the table that follows, the tasks identified for "TAB" include the owner's TAB Vendor as directed by the RE or CPM.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
Design	Review Owner's Project Requirements	Review VAMC Design Criteria and Owner's Project Requirement document prior to submission to LEED Facilitator.	VA PM	• Prepare and issue Owner's Project Requirements based on specific requirements, Ed Specs and District Design Criteria.
			CxA	• Review and comment on Owner's Project Requirements. Submit comments to the PM and QA.
			Design Team	• Review for understanding project requirements.
			CPM	• None.
			DDC	• None
			TAB	• None
Design	Review Design Narrative	Review the Design Narrative Document	VA PM	• Receive and distribute Basis of Design documents to CPM, CxA, and other VAMC agencies as necessary.
			CxA	• Review Design Narrative document. • Provide comment log to PM and Design Team.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			Design Team	• Prepare Phase 1 (Schematic Design) and Design Narrative to describe design approach.
			CPM	• None.
			DDC	• None
			TAB	• None
Design	Review Schematic design	Review Schematic Design for familiarization, general conformance with Owner's Project Requirements, Basis of Design and VAMC Design Criteria.	VA PM	• Receive and distribute Schematic Design package to Peer Reviewer, CxA, and other VAMC agencies as necessary.
			CxA	• Review Schematic Design • Provide comment log to PM and QA.
			Design Team	• Prepare Schematic Design. • Provide responses to CxA review comments. • Incorporate changes into design as directed by PM.
			CPM	• None.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			DDC	• None
			TAB	• None
Design	Design Development design	Review Design Development design for familiarization, general conformance with Owner's Project Requirements, Design Narrative, and VA Design Criteria.	VA PM	• Receive and distribute Design Development package to Peer Reviewer, CxA, DDC and other VAMC agencies as necessary.
			CxA	• Review Design Development drawings and specs. • Update Design Narrative • Provide comment log to PM and QA.
			Design Team	• Prepare Design Development drawings and specs. • Provide responses to CxA review comments. • Incorporate changes into design as directed by PM.
			CPM	• None.
			DDC	• None.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			TAB	• None
Design	Commissioning Specifications	Prepare Commissioning Specification "Section 01 91 00 – General Commissioning Requirements" to be included in project manual. Prepare Commissioning Specification for Division 21 – Fire Protection, Division 22 – Plumbing, Division 23 – HVAC, Division 26 – Electrical, Division 27 – Communications, and Division 28 – Electronic Safety and Security to provide detailed commissioning, operations & maintenance and training requirements for individual technical specification sections.	VA PM	• Review, comment and approve Cx specifications as part of project manual review.
			CxA	• Prepare Cx Specification Section 01 91 13. • Prepare systems commissioning specifications.
			Design Team	• Incorporate commissioning specifications into Project Manual. •
			CPM	• None.
			DDC	• None.
			TAB	• None.
Design	Design Phase Controls Meeting	Meet with Owner, Architect, and Mechanical/Electrical Design Engineer to review Building Control Systems and Sequences of	VA PM	• Schedule, facilitate and attend meeting.
			CxA	• Attend meeting to discuss control sequences and strategies.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		Operations. The focus of the meeting will be to obtain understanding of the interactions between systems and the control system in various operating modes.	Design Team	• Attend meeting to discuss control sequences and strategies.
			CPM	• None
			DDC	• None.
			TAB	• None
Design	Preliminary Commissioning Plan	Prepare Preliminary Commissioning Plan that describes the Commissioning Process, Commissioning Team with specific Roles and Responsibilities. The Commissioning Plan will include description of systems to be commissioned.	VA PM	• Review Cx Plan • Provide comments to CxA.
			CxA	• Prepare Cx Plan • Submit to PM and QA
			Design Team	• Review Cx Plan relative to Design Team roles and responsibilities.
			CPM	• None.
			DDC	• None.
			TAB	• None.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
Design	Focused Construction Document Review (Progress Set)	Perform a focused review of a Construction Document progress submission (recommend review prior to the 50% CD stage).	VAMC PM	• Receive and distribute Progress Set drawings and specs to QA, CxA, DDC and other VAMC agencies as necessary.
			CxA	• Review Progress Set drawings and specs. • Update Design Narrative • Provide comment log to PM and QA.
			Design Team	• Prepare Progress Set drawings and specs. • Provide responses to CxA review comments. • Incorporate changes into design as directed by PM.
			CPM	• None
			DDC	• None.
			TAB	• None
Design	Focused Construction Document Review	Perform a focused review of the final Construction Document submission. This review will include a back check of	VA PM	• Receive and distribute Construction Documents package to QA, CxA, DDC and other VAMC agencies as necessary.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		commissioning comments provided during previous reviews.	CxA	• Review Construction Document drawings and specs. • Update Design Narrative • Provide comment log to PM and QA.
			Design Team	• Prepare Construction Documents drawings and specs. • Provide responses to CxA review comments.
			CPM	• None.
			DDC	• None
			TAB	• None.
Design	Design Phase Meetings	Participate Design Phase meetings.	VA PM	• Schedule, facilitate and attend meetings
			CxA	• Attend approximately selected meetings to discuss Commissioning Issues.
			Design Team	• Conduct meetings • Provide meeting minutes to PM, CxA and others as directed by PM.
			CPM	• None

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			DDC	• None.
			TAB	• None.
Design	Focused Design Review Meetings	Attend Design Review meetings with to review the design and specific commissioning design review comments.	VA PM	• Schedule, facilitate and attend meetings.
			CxA	• Attend meetings to discuss commissioning review comments.
			Design Team	• Attend meetings to discuss design and to respond to commissioning and DDC comments.
			CPM	• None.
			DDC	• None.
			TAB	• None.
Construction	Final Commissioning Plan	Based on the final construction documents, update the Preliminary	VAMC PM	• Review and approve Commissioning Plan. • Provide comments to CxA and QA.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		Commissioning Plan to identify specific systems to be commissioned. The Final Commissioning Plan will also include specific individual roles and responsibilities and preliminary Pre-Functional Checklists and Functional Test Plans for systems to be commissioned.	CxA	• Prepare Final Commissioning Plan. • Prepare preliminary Pre-Functional Checklists • Prepare Preliminary Systems Functional Performance Test procedures. • Issue to PM and QA. • Incorporate comments into Cx Plan revisions as necessary.
			Design Team	• Review Cx Plan relative to Design Team roles and responsibilities. • Provide comments to PM and CxA.
			CPM	• Review Cx Plan relative to CPM and installing sub-contractor's roles and responsibilities. • Provide comments to PM and CxA.
			DDC	• Review Cx Plan relative to DDC roles and responsibilities. • Provide comments to QA and CxA.
			TAB	• Review Cx Plan relative to TAB roles and responsibilities. • Provide comments to QA and CxA.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
Construction	Construction Commissioning Kick Off meeting	Conduct an initial commissioning meeting with all contractors and commissioning team members. The purpose of the meeting will be to establish the purpose and proposed process for commissioning this facility in the construction, acceptance and warranties phases of the project. Review the individual roles and responsibilities of each participating commissioning team member as specified in the Construction Documents.	VA RE	• Schedule, facilitate and attend meeting.
			CxA	• Conduct meeting. • Prepare, present and discuss commissioning tasks, roles and responsibilities. • Prepare meeting agenda and minutes.
			Design Team	• Attend meeting.
			CPM	• Attend meeting.
			DDC	• Attend meeting
			TAB	• Attend meeting.
Construction	Duration Schedule for Commissioning Activities	Based on Final Commissioning Plan, prepare a duration schedule to show the duration, predecessors and successors for commissioning	VA RE	• Review commissioning schedule data. • Coordinate with CPM to incorporate commissioning activities into project schedule.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		activities. This duration schedule will be provided to the Construction Manager to include commissioning activities in the project construction schedule. This will allow commissioning activities to be smoothly integrated into the overall construction process.	CxA	• Prepare and issue commissioning activities schedule, including durations and predecessors. • Review project schedule prepared by CPM.
			Design Team	• None.
			CPM	• Incorporate commissioning activities into Master Construction Schedule.
			DDC	• Review project schedule prepared by CPM.
			TAB	• Review project schedule prepared by CPM.
Construction	Submittal and Shop Drawing Review List	Based on final construction documents, prepare a list of selected submittals and shop drawings for review by the Commissioning Agent.	VA RE	• None.
			CxA	• Prepare list of submittals and shop drawings to be provided to the CxA.
			Design Team	• None.
			CPM	• None.
			DDC	• None.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			TAB	• None.
Construction	Submittal and Shop Drawing Review	Review selected submittals and shop drawings to support the commissioning process. Review will be for the purpose of developing appropriate Pre-Functional Checklists and Functional Test Plans. Reviews will focus on the ability to commission the systems, maintainability and general conformance to owner's requirements. Commissioning review of submittals and shop drawings does not replace the Design Team responsibility for approval.	VA RE	• Receive and distribute submittals and shop drawings. • Distribute selected submittals and shop drawings to CxA. • Review and approve submittals
			CxA	• Review selected submittals and shop drawings. • Prepare issue comment log
			Design Team	• Review submittals and shop drawings. • Provide comments and recommendations to VA RE.
			CPM	• Prepare and issue submittals and shop drawings. • Incorporate RE comments into revised submittals and shop drawings.
			DDC	• Prepare and issue DDC submittals and shop drawings. • Incorporate RE comments into revised submittals and shop drawings.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			TAB	• None.
Construction	Controls Meeting	After receipt of the Controls Submittal, participate in or conduct a meeting with the Owner's representatives, Owner's Control Vendor, Owner's TAB contractor, Mechanical/Electrical Design team, mechanical sub-contractor and electrical sub-contractor to review the Controls Submittal and mechanical/electrical systems to be installed. Focus will be on how the selected sequences of operation interact with the mechanical/electrical systems and how well they meet the owner's requirements.	VA RE	• Schedule, facilitate and attend meeting.
			CxA	• Conduct Meeting • Prepare meeting agenda and minutes.
			Design Team	• Attend meeting
			CPM	• Coordinate and schedule Mechanical, Electrical and Controls Electrical sub-contractors to attend meeting. • Attend meeting.
			DDC	• Attend meeting
			TAB	• None.
Construction	Pre-Functional Checklists	Prepare Pre-Functional Checklists for systems,	VA RE	• Review checklists • Provide comments to CxA

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		components and/or equipment to be commissioned. These Pre-Functional Checklists will be used to document completion of system, component and/or equipment installation and to determine system readiness for functional testing. Pre-Functional Checklists should be completed by the installing contractors to document the installation process. Completed Pre-Functional Checklists are to be submitted to the commissioning agent a minimum of seven days prior to testing. Completed Pre-Functional Checklists will be spot checked by the commissioning agent to verify systems are ready for testing.	CxA	• Prepare preliminary checklists. • Issue to RE and CPM for review • Incorporate changes into final checklists as necessary.
			Design Team	• None.
			CPM	• Provide copies of sub-contractor QC installation checklists to CxA for review. • Review checklists prepared by CxA • Provide comments to CxA
			DDC	• Review checklists prepared by CxA • Provide comments to CxA
			TAB	• Review checklists prepared by CxA • Provide comments to CxA
Construction	Review Contractor Equipment	Commissioning agent will review selected equipment startup	VA RE	• Receive and distribute Contractor Startup Reports

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
	Startup Reports	reports prepared by installing contractor. Commissioning Agent will witness selected equipment startup procedures. Seven days prior notice is required to schedule commission agent witnessing the startup.	CxA	• Witness selected contractor equipment startups. • Review selected Contractor Startup Reports. • Provide comment log to RE and QA.
			Design Team	• Review Contractor Startup Reports.
			CPM	• Complete Contractor Startup Reports • Issue to RE and CxA.
			DDC	• Review selected Contractor Startup Reports.
			TAB	• Review selected Contractor Startup Reports.
Construction	Prepare Functional Test Procedures	Based on final construction documents (including applicable changes), and approved submittals, prepare Functional Test Procedures for systems to be commissioned. Draft Functional Test Procedures will be issued for review by owner, installing contractors and DDC Vendor. Final Functional Test Procedures will be	VA RE	• Review preliminary Functional Test Procedures. • Provide comments to CxA
			CxA	• Prepare preliminary Functional Test Procedures. • Issue to RE, CPM and DDC. • Incorporate comments into final Functional Test Procedures as necessary.
			Design Team	• None.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		prepared incorporating review comments received from owner, contractors or DDC Vendor.	CPM	• Distribute preliminary Functional Test Procedures to MC, EC and other installing sub-contractors. • Review preliminary Functional Test Procedures • Provide comments to CxA
			DDC	• Review preliminary Functional Test Procedures • Provide comments to CxA
			TAB	• Review preliminary Functional Test Procedures • Provide comments to CxA
Construction	TAB Plan Review	Review HVAC systems Test and Balance Plan prepared by the TAB vendor. Review will be to determine general conformance with owner's requirements.	VA RE	• Distribute TAB Plan to CxA, QA, CPM and Design Team.
			CxA	• Review TAB Plan • Provide comment log to PM and QA
			Design Team	• Review and approve TAB Plan.
			CPM	• Review TAB Plan • Provide comments to PM
			DDC	• Review TAB Plan • Provide comments to QA, CxA and PM

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			TAB	• Prepare preliminary TAB Plan • Issue to PM and QA. • Incorporate comments into Final TAB Plan as necessary.
Construction	TAB Report Review	Review TAB Report prepared by TAB vendor following system air and water balancing. Review will be focused on TAB results that affect system performance and/or commissioning. Specific attention will be given to equipment installation and operational issues identified by the TAB vendor.	VA RE	• Distribute TAB report to Design Team, and CxA. • Approve TAB Report in consultation with Design Team and CxA.
			CxA	• Review TAB report. • Provide comments to RE and Design Team.
			Design Team	• Review and provide recommendations to RE.
			CPM	• Review and submit TAB Report.
			DDC	• None
			TAB	• Provide preliminary TAB data (daily worksheets) to CxA for preliminary review. • Prepare TAB Report • Issue TAB report to RE.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
Construction	Review O & M Manuals	Review Operations and Maintenance Manuals submitted by contractors. Manuals will be reviewed for clarity, organization, usability and general conformance with specifications and owner's requirements.	VA RE	• Distribute O&M Manuals to CxA and Design Team. • Review and approve O&M Manuals.
			CxA	• Review O&M Manuals. • Provide comment log to RE and QA.
			Design Team	• Review O&M Manuals.
			CPM	• Prepare and issue O&M Manuals to PM.
			DDC	• Prepare and issue DDC O&M Manuals to PM.
			TAB	• None.
Construction	Prepare Systems Manuals for commissioned systems	Prepare detailed systems manuals for commissioned systems. The manuals will provide operating staff the information needed to understand and optimally operate the commissioned systems. The manuals will describe system design, components, capacity and sequences of operations. Manuals will include	VA RE	• Review and approve Systems Manuals. • Distribute Systems Manuals to FMD.
			CxA	• Using O&M Manuals, Basis of Design, and Construction Documents, prepare Systems Manual.
			Design Team	• None.
			CPM	• None>

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		descriptions of interactions with other systems and common systems failure modes and responses.	DDC	• None.
			TAB	• None.
Construction	Review Training Plans	Review contractor and manufacturer training plans and agendas for general conformance with specifications and owner's requirements. Observe selected training for quality of training and for general conformance with the training plan and agenda.	VA RE	• Schedule and facilitate training sessions. • FMD staff attends training sessions.
			CxA	• Review Training Plans. • Provide comment log • Witness selected training sessions.
			Design Team	• None.
			CPM	• In conjunction with installing sub-contractors and/or manufacturers' representatives, conduct training sessions.
			DDC	• Conduct DDC training sessions.
			TAB	• None.
Construction	Warranty Review	Review contractor's and manufacturer's warranties for general conformance with specifications and	VA RE	• Distribute warranty documents to FMD and CxA • Review and approve warranty documents

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		owner's requirements.	CxA	• Review warranty documents. • Provide comment log
			Design Team	• Review warranty documents and provide comments.
			CPM	• Prepare and issue warranty documents • Incorporate comments into final warranty documents.
			DDC	• Prepare and issue warranty documents for DDC. • Incorporate comments into final warranty documents.
			TAB	• None
Construction	Systems Functional Testing	Witness and document functional testing for systems to be commissioned. Testing will be conducted as detailed on the specific Functional Test Plan	VA RE	• Schedule, facilitate and witness systems functional testing. • FMD staff should assist in functional testing as additional systems training opportunity.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		for each system to be commissioned. Functional testing will require support from the CPM, MC, EC, DDC and TAB Vendor. Installing contractors should be available to respond to issues and problems identified during testing.	CxA	• Witness systems functional testing using previously prepared Functional Test Procedures. • Document systems testing on Functional Test Procedures. • Issue Field Reports to document deficiencies. • Update Master Commissioning Issues Log to document and track deficiencies.
			Design Team	• Review test documentation
			CPM	• CPM, MC and EC to conduct functional testing by operating systems in accordance with functional test procedures. • Make corrections, repairs or adjustments to systems during testing as directed by the RE. • Correct outstanding deficiencies after testing as directed by the RE. • Report corrective actions to RE and CxA upon completion.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			DDC	• Conduct functional testing by operating DDC in accordance with CxA directions and functional test procedures. • Assist in troubleshooting and corrective action as necessary
			TAB	• Assist functional testing as directed by the RE and functional test procedures. • Verify selected DDC data by spot measurements of air and/or water balancing data.
Construction	Systems Functional Retesting	Retest systems with deficiencies as recommended by the CxA and directed by the PM (Note: Retesting is not included in the scope of commissioning services and is provided as an additional service. The costs associated with retesting may be recovered from the	VA RE	• Approve retesting as recommended by CxA. • Schedule and coordinate retesting.
			CxA	• Make recommendations for necessary retesting. • Coordinate with RE to schedule retesting after deficiencies are corrected.
			Design Team	• None

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		Construction Manager in accordance with appropriate contract provisions.)	CPM	• Make necessary system repairs, adjustments and/or corrections prior to retesting. • Coordinate retesting as directed and approved by the RE. • Conduct systems retesting by operating systems as directed by RE and functional test procedures.
			DDC	• Assist in systems retesting by operating DDC as directed by RE and functional test procedures.
			TAB	• None.
Construction	Construction Observation	Conduct visits to the construction site to observe construction	VA RE	• None.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		activities. Specific attention will be given to installation of mechanical, electrical, and plumbing systems for general conformance with specifications and manufacturer's installation requirements. Specific attention will also be given to installation of site utilities, site improvements and building envelope construction for general conformance with plans, specifications and manufacturer's installation requirements.	CxA	• Conduct Construction Observation visits to observe construction progress, systems/equipment installation and general quality of construction. • Prepare Field Report to document general and specific observations and issues. • Update Master Issues Log to document and track specific issues reported on Field Report. • Monitor and verify corrective actions. • Update Master Issues Log to document corrective action progress and completion.
			Design Team	• Review Master Issues Log
			CPM	• Review Field Reports • Review Master Issues Log • Provide corrective actions as directed by the RE to resolve outstanding issues.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			DDC	• Review Field Reports relative to DDC issues. • Review Master Issues Log relative to DDC issues. • Report progress of corrective actions relative to DDC issues.
			TAB	• Review Field Reports relative to issues affecting TAB. • Review Master Issues Log relative to issues affecting TAB. • Report corrective actions relative to issues affecting TAB.
Construction	Final Commissioning Report	Compile a comprehensive commissioning report documenting all commissioning activities, including but not limited to: Commissioning scope Test methods and results Outstanding commissioning issues Issues log Commissioning plan Status reports Submittal and O&M manual reviews Training record Pre-Functional Checklists	VA RE	• Review preliminary Commissioning Report. • Provide comments to CxA. • Review and approve Final Commissioning Report
			CxA	• Prepare preliminary Commissioning Report. • Incorporate VA comments into final report. • Issue Final Commissioning Report.
			Design Team	• Review Final Commissioning Report

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		Design Review Comments .	CPM	• Review Final Commissioning report • Report on progress and completion of corrective actions.
			DDC	• Review Final Commissioning Report. • Report on progress and completion of corrective actions relative to DDC.
			TAB	• Review Final Commissioning Report. • Report on progress and completion of corrective actions relative to TAB.
Construction	Owner Architect and Construction Manager Meetings (Construction Phase)	Attend selected Owner/Architect/Contractor Meetings to discuss commissioning issues, review the Commissioning Issues Log, and to maintain awareness of general construction schedule and issues.	VA RE	• Schedule, facilitate and attend meetings.
			CxA	• Attend selected meetings to review commissioning issues.
			Design Team	• Attend meetings.
			CPM	• Conduct meetings. • Prepare and issue Meeting Minutes.
			DDC	• Attend selected meetings to review DDC issues.
			TAB	• Attend selected meetings to review TAB issues.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
Construction	Status Reports	Provide monthly status reports detailing activities, significant unresolved issues, and upcoming commissioning activities. Prepare report outlining status of deliverables for the project. Status reports are submitted with invoices for professional services.	VA RE	• Review and approve status reports.
			CxA	• Prepare Status Reports to summarize commissioning activities, significant unresolved issues and provide a two-month look-ahead of commissioning activities.
			Design Team	• None.
			CPM	• None.
			DDC	• None.
			TAB	• None.
Construction	Master Issues Log	Maintain a Commissioning Issues Log to document commissioning issues identified during construction and functional testing. The	VA RE	• Review Master Issues Log • Coordinate and direct corrective actions to resolve commissioning issues.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		Commissioning Issues Log will include recommended responsible party and recommendations for resolution of the issue. The Commissioning Issues Log will also be used to document progress toward resolution and the final resolution	CxA	• Provide monthly updates to Master Commissioning Log. • Provide updated Master Commissioning Log after each Construction Visit to document specific issues observed during the visit. • Update Master Issues Log to document progress on corrective actions. • Update Master Issues Log to document completion of corrective actions.
			Design Team	• None.
			CPM	• Review Master Issues Log. • Provide status of corrective actions. • Provide notification of corrective action completion.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			DDC	• Review Master Issues Log. • Provide documentation of punch list or other issues noted by DDC vendor. • Provide status of corrective actions relative to DDC issues. • Provide notification of corrective action completion relative to DDC issues.
			TAB	• Review Master Issues Log. • Provide documentation of punch list or other issues noted by TAB vendor. • Provide status of corrective actions relative to TAB issues. • Provide notification of corrective action completion relative to TAB issues.
Construction	Review Change Orders, ASI, and RFI	Review change orders, architect's supplemental instructions and requests for	VA RE	• Issue change orders, ASI and/or RFI. • Provide copies of change orders, ASI and RFI to CxA

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		information (with design team response) for issues that affect commissioning. Review is for information only and does not constitute technical or contractual approval or disapproval.	CxA	• Review change orders, ASI, and RFI for changes that affect system/equipment design or installation. • Incorporate changes into revised Functional Test Procedures or Pre-Functional Checklists.
			Design Team	• Respond to RFIs. • Prepare change orders and/or ASI. • Update construction documents as necessary.
			CPM	• Issue RFI. • Request change orders and ASI as needed.
			DDC	• Monitor system changes for impact on DDC installation and/or sequences of operations. • Update DDC programming or sequences of operations to implement approved changes.
			TAB	• Monitor system changes for impact on TAB. • Update TAB Plan as necessary to implement approved changes.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
Warranty	Monitor Systems Operation	Monitor system operation using trend data from DDC.	VA RE	• Coordinate corrective actions with CPM as necessary
			CxA	• Periodically monitor systems operation using DDC trend data. • Prepare and issue brief narrative reports documenting issues noted during systems monitoring. • Update Master Commissioning Log with issues noted during systems monitoring.
			Design Team	• None.
			CPM	• Provide corrective actions as directed by RE.
			DDC	• Provide corrective actions as directed by RE.
			TAB	• None.
Warranty	Deferred and/or seasonal Testing	Direct testing that was deferred due to lack of system readiness or for seasonal requirements. Testing will be conducted in accordance with Functional Test Plans. Testing support will be	VA RE	• Schedule, facilitate and witness deferred/seasonal testing. • FMD staff should assist in deferred/seasonal as additional systems training opportunity.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		required from the DDC Vendor and FMD.	CxA	• Witness deferred/seasonal testing using previously prepared Functional Test Procedures. • Document deferred/seasonal testing on Functional Test Procedures. • Issue Field Reports to document deficiencies. • Update Master Commissioning Issues Log to document and track deficiencies.
			Design Team	• None.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			CPM	• CPM, MC and EC will conduct seasonal/deferred testing by operating systems in accordance with RE directions and functional test procedures. • Make corrections, repairs or adjustments to systems during testing as directed by the RE. • Correct outstanding deficiencies after testing as directed by the RE. • Report corrective actions to RE and CxA upon completion.
			DDC	• Conduct deferred/seasonal testing by operating DDC in accordance with CxA directions and functional test procedures. • Assist in troubleshooting and corrective action as necessary

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
			TAB	• Assist deferred/seasonal testing as directed by the CxA and functional test procedures. • Verify selected DDC data by spot measurements of air and/or water balancing data.
Warranty	Post-Occupancy Warranty Checkup	Return to the project approximately 10 months into the 12 month warranty period to review the building operation with the facility staff and	VA RE	• Schedule and facilitate Warranty Checkup Visit. • Direct CPM and/or DDC to provide corrective action for Warranty claims.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
		discuss outstanding issues related to commissioning and outstanding warranty issues. Provide suggestions for improvements. Assist facility staff in developing reports, documents and requests for service to remedy outstanding problems.	CxA	• Conduct Warranty Checkup Visit. • Interview facility users and/or FMD staff to identify specific operational concerns. • Review FMD Work Order logs for potential warranty claim issues. • Verify corrective action on outstanding unresolved issues shown on Master Issues Log. • Document other deficiencies noted during Warranty Checkup Visit. • Prepare report of potential Warranty Claims noted during Warranty Checkup Visit.
			Design Team	• None.
			CPM	• Implement corrective actions on Warranty Claims as directed by RE.
			DDC	• Implement corrective actions on Warranty Claims as directed by RE.
			TAB	• None.

Commissioning Team Roles and Responsibilities				
Project Phase	**Cx Task**	**Description**	**Team Member**	**Responsibility**
Warranty	Final Commissioning Report Amendment	Amend Final Commissioning Report to document the Warranty Phase commissioning activities.	VA RE	• Review and approve Commissioning Report Amendment.
			CxA	• Prepare Final Report Amendment to document Warranty phase commissioning activities.
			Design Team	• None
			CPM	• None.
			DDC	• None.
			TAB	• None.

XIII. Commissioning Schedule

A. The following is a general outline of the Commissioning Schedule for the commissioning tasks that will be performed on the project site or at the Commissioning Agent Offices:

Commissioning Schedule				
Project Phase	**Task**	**Duration**	**Schedule**	**Predecessors**

Commissioning Schedule				
Project Phase	**Task**	**Duration**	**Schedule**	**Predecessors**
Design	Review Owner's Project Requirements	3 weeks	Comments submitted concurrent with design review comments	Receive Owner's Project Requirement document
Design	Review Design Narrative	3 weeks	Comments submitted concurrent with design review comments	Receive Design Narrative
Design	Review SD 1 design	3 weeks	Comment log issued 3 weeks after receipt of SD 1 design. Attend SD-1 Design Review meeting	Receive SD 1 documents including Design Narrative
Design	Review SD 2	3 weeks	Comment log issued 3 weeks after receipt of SD 2 design Attend SD-2 Design Review Meeting	Receive SD 2 drawings and specifications
Design	Commissioning Specifications	3 weeks	Specifications issued concurrent with Phase 2 comment log	Receive Phase 2 drawings and specifications
Design	Review DD1	3 weeks	Comment log issued 3 weeks after receipt of DD-1 design Attend DD-1 Design Review meeting	Receive DD-1 drawings and specifications
Design	Design Phase Controls Meeting	1 day	Schedule after Cx DD-1 Design Review	DD-1 Cx comment log issued
Design	Preliminary Commissioning Plan	3 weeks	Preliminary Cx Plan issued concurrent with DD-1 comment log	Receive DD-1 drawings and specifications
Design	Review DD2	3 weeks	Comment log issued 3 weeks after receipt of DD-2 design Attend DD-2 Design Review Meeting	Receive DD-2 drawings and specifications
Design	Update Design Narrative	3 weeks	Updated Design Narrative issued 3 weeks after DD-2 Design Review Meeting	DD-2 Design Review meeting. Receive DD-2 Design review comments from peer reviewer.

Commissioning Schedule				
Project Phase	**Task**	**Duration**	**Schedule**	**Predecessors**
Design	Focused DC-1 Review (Progress Set)	3 weeks	Comment log with back check update issued 3 weeks after receipt of progress set. Attend CD-1 Design Review meeting	Receive CD-1 drawings and specifications
Design	Update Design Narrative	3 weeks	Updated Design Narrative issued 3 weeks after CD-1 Design Review Meeting	CD-1 Design Review meeting. Receive CD-1 Design review comments from peer reviewer.
Design	Focused Final Construction Document Review	3 weeks	Comment log issued 3 weeks after receipt of final CDs	Receive Final Construction Document drawings and specifications
Design	Update Design Narrative	3 weeks	Updated Design Narrative issued 3 weeks after Final CD Design Review Meeting	Final CD Design Review meeting. Receive Final CD Design review comments from peer reviewer.
Design	Design Phase Meetings	1 day each	Scheduled by PM and Design Team	None
Construction	Preliminary Commissioning Plan	3 weeks	Concurrent with Final CD Design review	Receive Final CD drawings and specifications.
Construction	Construction Commissioning Kick Off meeting	1 day	Scheduled by RE and CPM	Contracting Officer's and RE Initial Construction Meeting
Construction	Final Commissioning Team	3 weeks	Issue 3 weeks after Construction Commissioning Kickoff Meeting	Commissioning Kickoff Meeting
Construction	Duration Schedule for Commissioning Activities	None	Issued as part of Final Commissioning Plan	Preliminary construction schedule
Construction	Submittal and Shop Drawing Request List	None	Issued as part of Final Commissioning Plan	Final Construction Document plans and specifications

Commissioning Schedule				
Project Phase	**Task**	**Duration**	**Schedule**	**Predecessors**
Construction	Submittal and Shop Drawing Review	2 weeks	Comment log issued 2 week after receipt of shop drawings and submittals	Receipt of submittal or shop drawings. Comment log will be updated after receipt of each requested submittal
Construction	Controls Meeting	1 day	Scheduled by RE and CPM Meeting notes issued 1 week after meeting.	Receive major HVAC equipment submittals. Receive DDC submittal with sequences of operations.
Construction	Pre-Functional Checklists	TBD	Preliminary checklists issued approximately 4 months prior to substantial completion Final checklists issued approximately 3 months prior to substantial completion	Receive equipment submittals Receive installing contractor's QC checklists
Construction	Witness selected Contractor Equipment Startup	1 day	Scheduled by CPM	1 week written notice of scheduled startup
Construction	Review Contractor Equipment Startup Checklists	1 week	Comment log issued 1 week after receipt of completed checklist	Receive Startup Checklist completed by installing sub-contractor.
Construction	Prepare Functional Test Procedures	TBD	Preliminary Functional Test Procedures issues approximately 4 months prior to substantial completion. Final Functional Test Procedures issues approximately 3 months prior to substantial completion	Receive all requested equipment submittals and shop drawings. Receive DDC submittal and final sequences of operations.

Commissioning Schedule				
Project Phase	**Task**	**Duration**	**Schedule**	**Predecessors**
Construction	TAB Plan Review	2 weeks	Comment log issued 2 weeks after receiving TAB Plan	Receive TAB Plan
Construction	TAB Report Review	2 weeks	Comment log issued 2 weeks after receiving TAB Report	Receive TAB Report
Construction	Review O & M Manuals	3 weeks	Comment log issued 3 weeks after receiving O&M Manuals	Receive O&M Manuals
Construction	Prepare Systems Manuals	8 weeks	Systems Manuals issued 8 weeks after receiving O&M Manuals	Receive O&M Manuals
Construction	Review Training Plans	3 weeks	Comment log issued 3 weeks after receiving Training Plans	Receive Training Plans
Construction	Warranty Review	3 weeks	Comment log issued 3 weeks after receiving Warranty documents	Receive Warranty documents
Construction	Systems Functional Testing	TBD	Functional testing to begin coordinated with construction schedule and systems completion	See separate table.
Construction	Systems Functional Retesting	TBD	TBD	Corrective actions complete

Commissioning Schedule				
Project Phase	**Task**	**Duration**	**Schedule**	**Predecessors**
Construction	Construction Observation	1 day	Construction observations scheduled concurrent with progress meetings – approximately 1 visit per month. More frequent visits may be scheduled during the 3 months preceding substantial completion Cx Specialist will provide a verbal out-brief of significant issues to the CPM prior to leaving the construction site. Field Report will be issued 1 week following visit.	None
Construction	Final Commissioning Report	6 weeks	Preliminary Commissioning Report issued approximately 6 weeks after completing Functional Testing	Functional Testing completed.
Construction	Owner Architect and Construction Manager Meetings (Construction Phase)	1 day	Scheduled by PM and CPM. CxA will attend approximately 1 meeting per month. More frequent attendance many be warranted during the 3 months prior to substantial completion.	None

Commissioning Schedule				
Project Phase	**Task**	**Duration**	**Schedule**	**Predecessors**
Construction	Status Reports	1 day	Status Reports will be issued monthly in conjunction with invoices for professional services	None
Construction	Master Issues Log	1 day	Master Issues Log will be updated and issued following each progress meeting and/or Construction Observation visit	Construction Observation visit and/or progress meeting.
Construction	Review Change Orders, ASI, and RFI	TBD	Ongoing throughout construction	Receive Change Order, ASI or RFI
Warranty	Deferred and/or seasonal Testing	TBD	Seasonal testing scheduled approximately 6 months after completing Functional Testing Deferred testing schedule to be determined	Seasonal changeover (i.e. summer-to-winter or winter-to-summer) Completion of system installation or corrective action completed
Warranty	Post-Occupancy Warranty Checkup	TBD	Scheduled approximately 10 months after substantial completion	Initial Functional Testing is complete. Seasonal/deferred testing is complete. Receive FMD work order log for HVAC equipment.
Warranty	Final Commissioning Report Amendment	2 weeks	Final Commissioning Report Amendment issued approximately 2 weeks following Warranty Checkup	Warrant Checkup visit complete

B. The following is a general outline of the Commissioning Schedule for the Functional Testing activities that will be performed at the construction site. This information is provided to assist the General Contractor in incorporating the commissioning activities into the overall construction schedule:

Functional Testing Activities				
System	**Test Duration**	**Schedule**	**Predecessors**	**Notes**
Mechanical Systems				
Ductwork Insulation	1 day	1 week prior notice by CPM	Ductwork complete	Witness selected duct pressure testing
Facility Water Distribution	1 day	1 week prior notice by CPM	Piping complete	Witness selected pipe pressure testing
Plumbing Piping	1 day	1 week prior notice by CPM	Piping complete	Witness selected pipe pressure testing
Plumbing Equipment	1 day	Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational	Functional testing of domestic hot water heating systems
Refrigeration Piping	1 day	1 week prior notice by CPM	Equipment installation in-process	Witness selected vacuum testing
Hydronic Pumps	4 hours per system	Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational TAB water balance	Functional testing of pump systems

Functional Testing Activities				
System	**Test Duration**	**Schedule**	**Predecessors**	**Notes**
Air-Cooled Refrigerant Condensers	2-4 hours per system	Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational	Functional testing of a representative sample of condenser systems
Air-Cooled Chilled Water Systems	1 day per system	1 week prior notice of startup by CPM Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational TAB water balance	Witness equipment startup Functional testing of all chillers
Centrifugal Water Chiller Systems	1 day per system	1 week prior notice of startup by CPM Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational TAB water balance	Witness equipment startup Functional testing of all chillers
Rotary Screw Water Chiller Systems	1 day per system	1 week prior notice of startup by CPM Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational TAB water balance	Witness equipment startup Functional testing of all chillers
Cooling Towers	1 day per system	1 week prior notice of startup by CPM Functional Testing TBD	Pre-Functional Checklist Equipment startup DDC Controls Operational TAB water balance	Witness equipment startup Functional testing of all cooling towers

Functional Testing Activities				
System	**Test Duration**	**Schedule**	**Predecessors**	**Notes**
Variable Frequency Motor Controls	Included in other testing	1 week prior notice of startup by CPM	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational	Witness selected equipment startup. Functional testing in conjunction with testing the motor and system controlled
Decentralized HVAC Equipment	2 – 4 hours per system	1 week prior notice of startup by CPM Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational	Witness selected equipment startup. Functional testing of a representative sample of systems
Electrical Resistance Duct Heaters	Included in other testing	TBD	Pre-Functional Checklist TAB air balance	Functional testing of duct heaters in conjunction with air handler or other system testing
Air Handling Units	1 day per AHU	1 week prior notice of startup by CPM Functional Testing TBD	Pre-Functional Checklist Equipment startup DDC Controls Operational TAB air & water balance	Witness selected equipment startup. Functional testing of all air-handling units
HVAC Power Ventilators	1 – 2 hours per system	1 week prior notice of startup by CPM	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational TAB air balance	Witness selected equipment startup. Functional testing of a representative sampling of equipment in conjunction with testing air handling units or other systems
Ductwork	1 day	1 week prior notice by CPM	Ductwork complete	Witness selected duct pressure testing

Functional Testing Activities				
System	**Test Duration**	**Schedule**	**Predecessors**	**Notes**
DDC System	1 day for head-end testing	1 week prior notice of startup by CPM Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational TAB air & water balance	Review DDC sequences of operation. Witness selected equipment startup. Functional testing of DDC in conjunction with air handler units, chillers, and other systems controlled. Review of DDC graphics and other human-interface equipment. Review of trend data to support functional testing and verify proper operation of systems controlled
Variable Air Volume Units	1 – 2 hours per AHU system	Functional Testing TBD	Pre-Functional Checklist Equipment startup Controls & DDC Interface Operational TAB air balance	Functional testing of a representative sampling
Tests Plumbing Piping Systems	1 day	1 week prior notice by CPM	Piping system complete	Witness selected plumbing piping tests
Tests HVAC Piping Systems	1 day	1 week prior notice by CPM	Piping system complete	Witness selected HVAC piping tests
Electrical Systems				
Electrical Utility Services	1 day	1 week prior notice of startup by CPM		Pre-startup testing. Witness startup of service equipment
Switchboards	1 day	1 week prior notice of startup by CPM		Pre-startup testing. Witness startup of switchboards

Functional Testing Activities				
System	**Test Duration**	**Schedule**	**Predecessors**	**Notes**
Grounding & Bonding Electrical Systems	1 day	1 week prior notice of 3rd party testing by CPM		Witness 3rd party ground resistance testing
Panelboards	1 – 2 hours per panel	1 week prior notice of startup by CPM		Pre-startup testing Witness startup of selected panelboards.
Enclosed Switches & Circuit Breakers	1 – 2 hours per switch or breaker	1 week prior notice of startup by CPM		Pre-startup testing Witness startup of selected equipment
Motor Controls	Included in other testing	TBD		Functional testing in conjunction with system testing of equipment controlled
Transfer Switches	Included in other testing	TBD		Functional testing in conjunction with generator testing
Interior Lighting	2 – 4 hours	TBD		Functional testing of daylighting and occupancy sensors
Exterior Lighting	1 – 2 hours	TBD		Functional testing of DDC-controlled contactors in conjunction with DDC testing
Emergency Lighting	Included in other testing	TBD		Functional testing in conjunction with loss of utility power testing.
Diesel Engine Driven Generator Assembly	10 – 12 hours	1 week prior notice of startup by CPM		Witness load bank testing Functional testing for compliance with NFPA 110

Functional Testing Activities				
System	**Test Duration**	**Schedule**	**Predecessors**	**Notes**
Lightning Protection for Structures	1 – 2 hours	TBD		Review of UL Master Label
Fire Alarm & Smoke Detection Systems	2 days	TBD		Functional testing of features not tested by local-authority (i.e. battery draw-down tests)
Intrusion Detection	2 – 4 hours	TBD		Functional testing of a representative sample of devices
Video Surveillance System	2 – 4 hours	TBD		Functional testing of a representative sample of devices
Integrated Systems Testing				
Loss of Utility Power Test	1 day	TBD	All functional systems testing complete with no significant deficiencies	Tests response by all systems to loss of utility power Tests response by all systems to restoration of utility power

Cx Plan Appendix A – Systems to Be Commissioned

A. Systems to be commissioned: The below tables show a detailed list of systems to be commissioned.

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
Facility Exterior Closure Systems							
System 1							
System 2							
System 3							

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
Fire Protection Systems							
System 1							
System 2							
System 3							

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
Plumbing Systems							
System 1							
System 2							
System 3							

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
HVAC Systems							
System 1							
System 2							
System 3							

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
Electrical Systems							
System 1							
System 2							
System 3							

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
Communications Systems							
System 1							
System 2							
System 3							

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
Electronic Safety and Security Systems							
System 1							
System 2							
System 3							

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
Site Utilities Systems							
System 1							
System 2							
System 3							

Systems to be Commissioned							
Equip Tag	**System**	**Pre-Functional Checklist**	**Submittal Required**	**Witness Equipment Startup**	**Functional Test Procedure**	**Sample Size**	**Notes**
Integrated Systems Testing							
System 1							
System 2							
System 3							

Cx Plan Appendix B – Pre-Functional Checklists

A. Preliminary Pre-Functional Checklists: The attached preliminary Pre-Functional Checklists are representative of the systems to be commissioned and the data to be provided on the Pre-Functional Checklists. The preliminary checklists are not all-inclusive, but have been coordinated with the specific requirements of this project. Final Pre-Functional Checklists will be developed following receipt of the equipment submittals and any updated construction documents, and specifications. Click a link to open a Preliminary Pre-Functional Checklist.

Domestic Water Heat Exchanger

DDC for HVAC

Variable Air Volume Units

Fire-Tube Steam Boilers

Centrifugal Water Chiller

Modular Indoor Air Handling Unit

Low Voltage Switchgear

Switchboards

Panelboards

Engine Generators

Automatic Transfer Switches

Cx Plan Appendix C – Functional Performance Test Procedures

A. Preliminary Systems Functional Test Procedures: The attached preliminary System Functional Performance Test procedures are representative of the systems to be commissioned and the rigorous nature of the testing to be performed. The preliminary test plans are not all-inclusive, but have been coordinated with the specific requirements of this project. Final Systems Functional Test Procedures will be developed following receipt of the equipment submittals, and any updated construction documents, and specifications. Click a link below to open a Preliminary Functional Test Procedure.

Domestic Water Heater Heat Exchanger

VAV with Reheat

Fire Tube Steam Boiler

Centrifugal Water Chiller

Modular Indoor Air Handling Unit

DDC for HVAC

Grounding and Bonding for Electrical Systems

Low Voltage Switchgear

Switchboards

Panelboards

Engine Generators

Automatic Transfer Switches

Cx Plan Appendix D – Commissioning Documents

A. Commissioning Documents: The attached documents are Commissioning Documents that will be used on this project.

Commissioning Design Review Comment Log

Commissioning Issues Log

Commissioning Meeting Minutes

Commissioning Field Report

Appendix G – Sample Commissioning Progress Meeting Minutes

The below document is an example of the Meeting Minutes prepared by the Commissioning Agent to document Commissioning Progress Meetings. Note that the minutes are intended to include both general discussion items and specific action items. The minutes are continuous and chronological and are intended to provide a comprehensive compilation of the commissioning issues discussed and resolved during the Commissioning Progress Meetings.

COMMISSIONING MEETING MINUTES

Meeting Information

Project:		Project Number:	
Meeting Date:		Meeting Time:	
Meeting Location:		Notes By:	
Meeting Purpose:			

Attendees

The following individuals attended the meeting. Meeting minutes are distributed to those in attendance and to those scheduled to attend:

Present	Copy	Name	Organization	Email
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			
☐	☐			

SAMPLE

Old Business:

Topic 1.	**Opened By:**	**Date Opened:**	**Closed By:**	**Date Closed:**
Discussion: [(date) – comment]				
Resolution:				
Action items: (Check box when complete)	**Date Assigned**:	**Assigned to:**		**Due Date:**
☐				

New Business:

Topic 2.	Opened By:	Date Opened:	Closed By:	Date Closed:
Discussion: [(date) – comment]				
Resolution:				
Action items: (Check box when complete)	**Date Assigned**:	**Assigned to:**		**Due Date**:
☐				

SAMPLE

Appendix H – Sample Commissioning Field Report

The below document is an example of a Commissioning Field Report prepared by the Commissioning Agent to document each Commissioning Site Observation Visit or System Functional Testing Session. The report includes a general narrative of the purpose for the visit; the construction activities underway during the visit; identification of specific commissioning issues/observations identified and added to the Master Issues Log during the visit; review of progress and/or resolution of previously identified commissioning issues/observations; outline of any contractor testing witnessed during the visit; identification of systems testing, including a summary of testing results, conducted during the visit; and other information that should be brought to the attention of the Contractor or Resident Engineer.

The Commissioning Field Report should include the following elements:

a. Project Name:
b. Field Report Number:
c. Date of Visit:
d. Observer:
e. Other Attendees:
f. Work In Progress / General Observations: (Narrative of project work in progress, including notes on General Construction work, HVAC work, Electrical work, Plumbing work, other work).
g. Systems Observed: (Identify specific systems observed during the field visit, including HVAC, Electrical, Plumbing, Other)
h. Tests Observed/Directed: (Identify specific contractor tests, equipment startups, System Readiness Checklists verified, or Systems Functional Performance Tests that were conducted, witnessed or directed. Include a brief narrative of the results)
i. Issues/Observations Added to Issues Log: (Describe any issues or observations added t the Issues Log. The description should be detailed enough to enable someone to understand the issue, why it is a problem, the system(s) affected by the issue, and any drawing or specification references that apply to the issue. Include a photo if possible).
j. Resolved Issues/Observations Reviewed: (For issues that have been reported as resolved, include a description of the Commissioning Agent's review, including a statement confirming that the issue is or is not resolved.)

k. Discussions/Recommendations/Action Items: (Include a description of any discussions, recommendations or action items noted during the field visit. Provide sufficient detail to allow follow-up and tracking.)

l. Photos: Include general photos as well as photos of new issues or resolved issues.)

Department of Veterans Affairs

[Project Title]

[Project Location]

COMMISSIONING FIELD REPORT

Project:				**Project Number:**	
Report Number:		**Report Date:**		**Date of Observations:**	
Prepared by:					
Purpose of Visit:					
Present at Site:					

General Observations

Specific Issues / Observations		
Issue ID:		[Insert photo]
Short Title:		
Date Opened:		
Tech Category:		
System:		
Assigned To:		
Reference:		
Opened By:		
Issue Description, Discussion, and Impact:		

Appendix J – Sample Commissioning Master Issues Log

The below document is an example of the data that should be included in the Commissioning Master Issues Log prepared and maintained by the Commissioning Agent. This Log is intended to be a comprehensive listing of commissioning issues and observations identified by the Commissioning Agent.

The Commissioning Master Issues Log should include the following information:

a. Commissioning Issues:
b. Issue Number: (Sequential Issue number)
c. Technical Category: (HVAC, Controls, TAB, Plumbing, MV Elect, LV Elect, Other)
d. Equipment/System ID: (System or Equipment Tag)
e. Description of Issue/Observation: (Narrative description of the Issue or Observation, include any drawing or specification reference)
f. Date Identified: (Date the issue was opened)
g. Identified by: (Name, company, position of the person who opened the issue)
h. Assigned to: (Indicate who is responsible to investigate the issue; VA, Designer, Contractor QC, Contractor, HVAC, Controls, TAB, Elect, CxA, Other)
i. Response/Resolution:
j. Resolution Update: (Narrative to track progress to resolve the issue)
k. Issue Status: (Open, Under Review, No Action Required, Closed, Deferred, Information Only)
l. Date of Resolution: (Date issue was closed)
m. Resolved by: (Name, Company, Position of the individual who closed the issue)
n. Commissioning Agent Review
o. Resolution Verification: (Narrative of CxA review of resolution)
p. Date Verified: (Date CxA reviewed the resolution)
q. Verified by: (Name of CxA who reviewed resolution)
r. Review Status: (Review Pending, Reviewed/Resolved, Reviewed/Not Resolved, Not Reviewed)
s. Project Impact:

t. Performance Impact: (short description of any system performance the issue would impose)

u. Cost Impact: (short narrative of project or operations cost impact the issue would impose)

v. Schedule Impact: (Short narrative of the project schedule the issue would impose)

The Master Commissioning Issues Log should be maintained in a manner that will allow easy filtering of issues by System, Technical Category, Assigned to, Status, or date fields.

Commissioning Issues Log															
ID	**Date Opened**	**Identified By**	**Tech Category**	**Equipment / System**	**Assigned to**	**Issue Description**	**Status Update**	**Est Compl Date**	**Status**	**Close Date**	**Ref Dwg or Spec**	**Noted during**	**Performance Impact**	**Cost Impact**	**Schedule Impact**
Cx-001															
Cx-002															
Cx-003															
Cx-004															
Cx-005															
Cx-006															
Cx-007															
Cx-008															
Cx-009															

Appendix K – Sample Pre-Functional Checklists

General

This appendix outlines procedures for developing Pre-Functional Checklists. The Commissioning Agent shall develop project-specific checklists for the systems to be commissioned.

Sample Pre-Functional Checklists

Examples of Pre-Functional Checklists for some common systems are included in the following documents:

Domestic Water Heat Exchanger

DDC for HVAC

Variable Air Volume Units

Fire Tube Steam Boiler

Centrifugal Water Chiller

Modular Indoor Air Handling Unit

Low Voltage Switchgear

Switchboards

Panelboards

Engine Generators

Automatic Transfer Switches

Pre-Functional Checklists

Pre-Functional Checklists shall describe system configuration and identify the required minimum installation that must be complete prior to Systems Functional Performance testing. The checklist will be completed by the Contractor to notify the VA and the Commissioning Agent the system is ready for testing.

Develop Pre-Functional Checklists for equipment and systems: Identify specific installation requirements that must be verified for each piece of equipment and system. Pre-Functional Checklists shall include, but is not necessarily limited to, the following information:

a. System and equipment or component name(s).

b. Equipment location and ID number:

c. Date:

d. Project name:

e. Mechanical Installation:
   1. Verify piping installation is complete. For example, verify chilled water piping, heating hot water piping, drain piping, insolating valves, control valves, etc is properly installed
   2. Verify ductwork installation is complete. For example, verify that ductwork, flexible connections, sound insulation, dampers, etc. are properly installed.
   3. Verify required gauges and indicators are installed. For example, verify that temperature gauges, pressure gauges, damper position indicators, etc. are provided and complete.
   4. Verify vibration isolation is installed. For example, verify that vibration isolators, spring hangers, vibration pads, etc. are installed properly. Verify shipping locks have been removed.
   5. Verify initial equipment adjustments are complete. For example, verify fan belt tension is properly adjusted. Verify circuit breakers adjustable trip settings have been set in accordance with the Coordination Study.
   6. Verify required clearance and access is provided. For example, filters are accessible for replacement, coil-pull area is free of obstructions, access ladders or platforms are installed. Also, verify access doors are operable and sealed.
   7. Verify required safety equipment and protection is properly installed. For example, verify guard rails, belt guards, and warning labels are installed.

f. Electrical Installation:
   1. Verify power is available at unit disconnect and the unit.
   2. Verify proper motor rotation.
   3. Verify power is available to unit controls
   4. Verify power is available to auxiliary equipment such as electric heating coils, damper motors, condensate pumps.

g. Controls Installation:
   1. Verify control valves and actuators are properly installed and operable.
   2. Verify control dampers and actuators are properly installed and operable.
   3. Verify control sensors are properly installed, calibrated, and identified in the system software and at the operator workstation.
   4. Verify control system graphics are complete and properly indicate system parameters.
   5. Verify that control system wiring point-to-point verification is complete.

h. Testing, Adjusting, and Balancing (TAB):
   1. Verify construction filters have been removed and replaced.
   2. Verify air balancing for the unit is complete

3. Verify water balancing for the unit is complete.
4. Verify unit TAB worksheets or report is complete.

i. Operations and Maintenance (O&M) Data:

1. Verify O&M Data has been submitted, reviewed, and approved.

j. Contractor Training:

1. Verify contractor training plan for the unit has been submitted, reviewed, and approved. .
2. Verify instructor qualifications have been submitted, reviewed, and approved.

Domestic Water Heat Exchangers
Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Signoff:

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

Equipment Information

Make		Model Number			
Serial Number		Function		Service Area	
GPM Fluid 1		GPM Fluid 2			
MBH Fluid 1		MBH Fluid 2			
Temp In/Out Fluid 1		Temp In/Out Fluid 2			

SAMPLE

Notes:	

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
General appearance good, no apparent damage	☐	☐			
Installation is per manufacturers instructions	☐	☐			
Verified that valves for equipment isolation have been provided per the drawings and specs	☐	☐			
Record drawings updated to reflect the actual installation	☐	☐			
Piping, fittings, valves and equipment properly supported and seismically anchored per the details	☐	☐			
Equipment label permanently affixed	☐	☐			
Pipes are supported independently of the heat exchanger	☐	☐			
Provisions in place for expansion compensation	☐	☐			
Piping, fittings and valves insulated per specification	☐	☐			
In-line equipment insulated per specification	☐	☐			
In-line equipment labeled per specification with flows indicated in the correct direction	☐	☐			
Heat Exchanger pressure tested per manufacturers recommendations	☐	☐			
Heat Exchanger properly flushed and cleaned per manufacturers recommendations (report attached)	☐	☐			
Heat exchanger detail checked against the drawings and all devices gages and appurtenances are in place	☐	☐			
Strainers and low-point drains opened and verified to be clean	☐	☐			
Construction strainers removed	☐	☐			
Test plugs (P/T) installed near all control sensors and as per spec	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Chemical treatment system or plan installed	☐	☐			
No leaking apparent	☐	☐			
Air vents and bleeds at high points of systems functional	☐	☐			
Isolation valves and balancing valves installed	☐	☐			
Notes:					

Valves					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Isolation valves provided at all branches and main takeoffs to facilitate isolation (as required by contract)	☐	☐			
Valve installation per manufacturer's instructions	☐	☐			
Valve manufacturer labels permanently affixed	☐	☐			
Manual isolation valves checked for proper seal and operation	☐	☐			
Valves installed in proper direction	☐	☐			
Valves stroke fully and easily and spanning is calibrated (see calibration section below)	☐	☐			
Valves that require a positive shut-off are verified to not be leaking when closed at normal operating pressure	☐	☐			
No leaking apparent	☐	☐			
Valves tagged and valve schedule submitted and displayed as required	☐	☐			
Adequate maintenance clearance in provided and valve is accessible	☐	☐			
Unions installed to allow for easy removal of control valves	☐	☐			
Notes:					

SAMPLE

TAB					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Installation of system and balancing devices is completed following NEBB or AABC procedures and contract documents	☐	☐			
Notes:					

Additional Comments:

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Back to Cx Plan Appendix B

SAMPLE

BACnet Verification System
Pre-Functional Checklist

Equipment ID	**[Equipment ID]**
Building	**[Building]**
Location	**[Room]**

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Signoff

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

Equipment Information

System	Device Type	Location	Manufacturer	Model Number	Serial Number
CDDCW	Computer				

SAMPLE

System	Device Type	Location	Manufacturer	Model Number	Serial Number
	Monitor				
	Printer				
SOFTWARE	Network Protocol				
	CDDCW Operating System				
	CDDCW Applications				
	Controller Applications				
	Graphics				
NETWORK	Gateway				
	Router				
	Bridge				
	Modem				
PNEUMATICS	Air compressor				
	Dryer				
	PRV				
CONTROLLER	AHU				
	Chiller				
	Heating				
UNITARY CONTROL	VAV				
	FCU				
GLOBAL DEVICES	Outside air temp sensor				
	OA humidity sensor				
	Power Surge suppressors				

SAMPLE

System	Device Type	Location	Manufacturer	Model Number	Serial Number
	Phone line surge suppressors				

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

General Configuration and Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Permanent labels affixed.	☐	☐			
Permanent mounting of all components is complete with wires run neatly.	☐	☐			
All wires are terminated and labeled.	☐	☐			
CPU cooling fan and heat sinks are operating and clean.	☐	☐			
Printers are tested and all ink supplies are filled.	☐	☐			
The paper tray is full and the printer is ready to print test results and all requested trend reports.	☐	☐			
All software is installed.	☐	☐			
All software is licensed to the government with an original loadable copy of the software and software license on sight or in a safe storage cabinet selected by the government.	☐	☐			
All graphic displays are created and loaded.	☐	☐			
All points specified to be linked to a graphic display have been associated to that display and appear when the graphic is selected.	☐	☐			
All points are labeled with a unique point descriptor.	☐	☐			
Specific Application parameters defined for all points.	☐	☐			
Power and lighting in place for component servicing and testing.	☐	☐			
Network Infrastructure operational.	☐	☐			
BACnet/IP (annex J) for Internet connectivity	☐	☐			

SAMPLE

General Configuration and Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
BACnet (Annex L) Standard devices for OWS, Building Controller, Advanced Application Controller, Application Specific Controller are provided (Annex L is Attached for reference).	☐	☐			
Server is rack-mounted in Ford House Office Building and can read/write to a floppy drive.	☐	☐			
Operator Work Station (OWS) including: Computer configured with sufficient speed and capacity to allow HVAC operations as described in the specifications and related printers, keyboard, mouse and display monitor to provide the required performance.	☐	☐			
Building Controllers programmed and operational.	☐	☐			
Advanced Application Controllers programmed and operational.	☐	☐			
Application Specific Controllers programmed and operational.	☐	☐			
Application and network software for all devices configured and operational.	☐	☐			
Operating software licenses and related source installation disks have been provided.	☐	☐			
Final data files have been installed, debugged and backed up.	☐	☐			
Manufacturer's BACnet Protocol Implementation Conformance Statement Submitted (refer to ASHRAE standard 135, section 22).	☐	☐			
Notes:					

Test and Balance					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
All system pressure and airflow Setpoints have been determined during the test and balance procedure per specifications.	☐	☐			
All calibration adjustments and set point values determined during the Test and Balance activity have been permanently loaded and saved to nonvolatile memory within this system (at each controller and backed up in a central OWS accessible and down loadable file)	☐	☐			

SAMPLE

Test and Balance					
Description	Yes	N/A	Initials	Date	Comments
Notes:					

Direct Digital Controls (DDC) System					
Description	Yes	N/A	Initials	Date	Comments
All DDC panels controlling field equipment are connected to the system	☐	☐			
Each DDC controller has a local port for full access and programming.	☐	☐			
Portable computer with OWS software for direct connection and local configuration, interrogation, and control of field controllers has been provided.	☐	☐			
All analog and digital points such as temperature/pressure reading points, status & alarming points' have been labeled and graphically depicted using a unique nomenclature and representative graphics	☐	☐			
All temperature sensing points are calibrated and read correctly from sensor to graphic display of HVAC system at OWS.	☐	☐			
All temperature/pressure Setpoints have been set to the correct values as determined by the engineer or by the balancing contractor during balancing.	☐	☐			
Current operating software and data base parameters are backed up at all levels of the DDC system. **This is critical, as power will be removed during verification testing.**	☐	☐			
All system failure alarms are programmed with a suitable alarm message sufficient to guide the operator to the appropriate action in the event the alarm is received	☐	☐			
Control device and panel labeling is complete	☐	☐			
Notes:					

SAMPLE

Electrical					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Power is connected to a clean reliable power source including surge protection that is labeled.	☐	☐			
Power disconnects (Circuit breakers) in place and labeled.	☐	☐			
DDC panel controlling OWS and related OWS components are connected to **emergency power**. Panel number: _____	☐	☐			
All electrical connections (both power and data) are tight	☐	☐			
Proper grounding and polarity (power and data) installed for component and unit	☐	☐			
Notes:					

Final					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Inspect the interior of the controls enclosures for accumulation of dirt or indications of water. In the event that any of the surfaces are found to be unacceptable or contaminated, the surface(s) and related active products should be cleaned prior to Functional Performance Testing (FPT).	☐	☐			
The entire system is installed and the software revision dates are recorded.	☐	☐			
Notes:					

SAMPLE

PFC ANNEX A - DESCRIPTIONS AND PROFILES OF STANDARDIZED BACnet DEVICES (NORMATIVE)

(This annex is part of this Standard and is required of its use.)

This annex provides descriptions of six "standardized" types of BACnet devices. Any device that implements all the required BACnet capabilities for a particular device type and interoperability area may claim to be a device of that particular type. Devices may also provide additional capabilities and shall indicate these capabilities in their PICS. The devices defined herein are: BACnet Operator Workstation, BACnet Building Controller, BACnet Advanced Application Controller, BACnet Application Specific Controller, BACnet Smart Actuator, and BACnet Smart Sensor.

A.1 BACnet Operator Workstation (B-OWS)

The B-OWS is the operator's window into a BACnet system. While it is primarily used for the operation of a system, it may be used for configuration activities that are beyond the scope of this standard. It is not intended to perform direct digital control. It enables the specification of the following:

Data Sharing

- Ability to provide the values of any of its BACnet objects
- Archival storage of data
- Presentation of data (i.e., reports and graphics)
- Ability to monitor the value of all BACnet object types, including all required and optional properties
- Ability to modify setpoints and parameters

Alarm and Event Management

- Operator notification and presentation of event information
- Alarm acknowledgment by operators
- Alarm summarization
- Adjustment of alarm limits
- Adjustment of alarm routing

Scheduling

- Modification of schedules
- Display of the start and stop times (schedule) of scheduled devices

Trending

- Modification of the parameters of a trend log
- Display and archive of trend data

Device and Network Management

- Ability to respond to queries about its status
- Ability to respond to requests for information about any of its objects
- Display of information about the status of any device on the BACnet internetwork
- Display of information about any object in the BACnet internetwork
- Ability to silence a device on the network that is transmitting erroneous data
- Ability to synchronize the time in devices across the BACnet internetwork
- Ability to cause a remote device to reinitialize itself
- Ability to backup and restore the configuration of other devices
- Ability to command half-routers to establish and terminate connections
- Ability to query and change the configuration of half-routers and routers

SAMPLE

A.2 BACnet Building Controller (B-BC)

A B-BC is a general-purpose, field-programmable device capable of carrying out a variety of building automation and control tasks. It enables the specification of the following:

Data Sharing

- Ability to provide the values of any of its BACnet objects
- Ability to retrieve the values of BACnet objects from other devices
- Ability to allow modification of some or all of its BACnet objects by another device
- Ability to modify some BACnet objects in other devices

Alarm and Event Management

- Generation of alarm / event notifications and the ability to direct them to recipients
- Maintain a list of unacknowledged alarms / events
- Notifying other recipients that the acknowledgment has been received
- Adjustment of alarm / event parameters

Scheduling

- Ability to schedule output actions, both in the local device and in other devices, both binary and analog, based on date and time

Trending

- Collection and delivery of (time, value) pairs

Device and Network Management

- Ability to respond to queries about its status
- Ability to respond to requests for information about any of its objects
- Ability to respond to communication control messages
- Ability to synchronize its internal clock upon request
- Ability to perform re-initialization upon request
- Ability to upload its configuration and allow it to be subsequently restored
- Ability to command half-routers to establish and terminate connections

A.3 BACnet Advanced Application Controller (B-AAC)

A B-AAC is a control device with limited resources relative to a B-BC. It may be intended for specific applications and supports some degree of programmability.

Data Sharing

- Ability to provide values for any of its BACnet objects upon request
- Ability to allow modification of some or all of its BACnet objects by another BACnet device

Alarm and Event Management

- Generation of limited alarm and event notifications and the ability to direct them to recipients

SAMPLE

- Tracking acknowledgments of alarms from human operators
- Adjustment of alarm parameters

Scheduling

- Ability to schedule actions in the local device based on date and time

Trending

- No requirement

Device and Network Management

- Ability to respond to queries about its status
- Ability to respond to requests for information about any of its objects
- Ability to respond to communication control messages
- Ability to synchronize its internal clock upon request
- Ability to perform re-initialization upon request

A.4 BACnet Application Specific Controller (B-ASC)

A B-ASC is a controller with limited resources relative to a B-AAC. It is intended for use in a specific application and supports limited programmability. It enables specification of the following:

Data Sharing

- Ability to provide the values of any of its BACnet objects
- Ability to allow modification of some or all of its BACnet objects by another device

Alarm and Event Management

- No requirement

Scheduling

- No requirement

Trending

- No requirement

Device and Network Management

- Ability to respond to queries about its status
- Ability to respond to requests for information about any of its objects
- Ability to respond to communication control messages

A.5 BACnet Smart Actuator (B-SA)

A B-SA is a simple control device with limited resources; it is intended for specific applications.

Data Sharing

- Ability to provide values for any of its BACnet objects upon request
- Ability to allow modification of some or all of its BACnet objects by another device

SAMPLE

Alarm and Event Management

- No requirement

Scheduling

- No requirement

Trending

- No requirement

Device and Network Management

- No requirement

A.6 BACnet Smart Sensor (B-SS)

A B-SS is a simple sensing device with very limited resources.

Data Sharing

- Ability to provide values for any of its BACnet objects upon request

Alarm and Event Management

- No requirement

Scheduling

- No requirement

Trending

- No requirement

Device and Network Management

- No requirement

A.7 Profiles of the Standard BACnet Devices

The following tables indicate which BIBBs must be supported by each device type for each interoperability area.

	B-OWS	B-BC	B-AAC	B-ASC	B-SA	B-SS
Data Sharing	DS-RP-A,B	DS-RP-A,B	DS-RP-B	DS-RP-B	DS-RP-B	DS-RP-B
	DS-RPM-A	DS-RPM-A,B	DS-RPM-B	DS-WP-B	DS-WP-B	
	DS-WP-A	DS-WP-A,B	DS-WP-B			
	DS-WPM-A	DS-WPM-B	DS-WPM-B			

SAMPLE

		DS-COVU-A,B				

	B-OWS	B-BC	B-AAC	B-ASC	B-SA	B-SS
Alarm & Event	AE-N-A	AE-N-I-B	AE-N-I-B			
Mgmt	AE-ACK-A	AE-ACK-B	AE-ACK-B			
	AE-INFO-A	AE-INFO-B	AE-INFO-B			
	AE-ESUM-A	AE-ESUM-B				

	B-OWS	B-BC	B-AAC	B-ASC	B-SA	B-SS
Scheduling	SCHED-A	SCHED-E-B	SCHED-I-B			

	B-OWS	B-BC	B-AAC	B-ASC	B-SA	B-SS
Trending	T-VMT-A	T-VMT-I-B				
	T-ATR-A	T-ATR-B				

	B-OWS	B-BC	B-AAC	B-ASC	B-SA	B-SS
Device &	DM-DDB-A,B	DM-DDB-A,B	DM-DDB-B	DM-DDB-B		
Network Mgmt	DM-DOB-A,B	DM-DOB-A,B	DM-DOB-B	DM-DOB-B		
	DM-DCC-A	DM-DCC-B	DM-DCC-B	DM-DCC-B		
	DM-TS-A	DM-TS-B or DM-UTC-B	DM-TS-B or DM-UTC-B			
	DM-UTC-A					
	DM-RD-A	DM-RD-B	DM-RD-B			
	DM-BR-A	DM-BR-B				
	NM-CE-A	NM-CE-A				

SAMPLE

Additional Comments:

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SAMPLE

Variable-Air Volume Units (Multiple) Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Signoff

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

SAMPLE

Equipment Data and System Readiness

Yes = Checked and Completed, N/A = Not Applicable

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
Equipment Data												
MC	Make											
MC	Model											
MC	Serial Number											
MC	Capacity											
MC	CFM											
MC	Volts/Phase											
MC	Function											
MC	Service Area											
TAB	Min CFM Setting											
TAB	Max CFM Setting											
System Readiness												
MC	Permanent labels affixed to equipment, switches, controls and safety devices.											
MC	Each equipment model number complies with approved submittal.											
MC	Connection to ductwork is tight and in good condition.											

SAMPLE

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
MC	Fan and motor properly installed and operational.											
MC	Correct VAV box location is shown on as-built drawings.											
MC	Air terminal units are installed level and plumb.											
MC	Equipment installation meets serviceability requirements.											
MC	Ductwork pressure test has been completed and approved.											
MC	Cabinet panels permanently affixed.											
MC	Thermal insulation has been installed according to specification.											
MC	Dampers are installed and operating properly.											
MC	Damper operator linkages are tight.											

SAMPLE

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
MC	Required length of straight duct provided upstream of air supply terminals.											
MC	Manual balancing dampers permanently marked at final setting.											
MC	Valve actuators have been fully stroked.											
MC	Automatic damper operates full stroke without binding.											
MC	Hot water is properly piped to the coil.											
MC	Piping is supported by hangers independent of the coil.											
MC	Hydrostatic test for re-heat piping complete and report submitted.											
MC	Strainers removed and cleaned after system flushing.											

SAMPLE

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
MC	Piping insulation complete and undamaged.											
MC	Isolation valves are installed, open and accurately located on as-built drawings.											
MC	Piping is labeled correctly and flow direction is indicated clearly.											
MC	P&T ports have been installed on the inlet and outlet piping of the coil or as indicated in the construction documents.											
MC	Coils are clean and fins are in good condition.											
MC	Control valves installed as indicated on the document details.											
MC	Air vents installed at high points in piping.											
MC	Drain valves installed at low points and have hose connections.											

SAMPLE

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
MC	All piping and accessories installed per contract document details.											
Testing and Balancing												
TAB	Water balancing is complete.											
TAB	Air balancing is complete.											
TAB	Balancing valves are marked at final setting.											
TAB	Dampers are marked at final setting.											
TAB	Test and balancing (T&B) report submitted.											
TAB	All system pressure and airflow set points have been documented during the test and balance procedure and will be included in the final TAB report.											
Electrical and Controls												
EC	Proper power voltage is supplied.											

SAMPLE

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
EC	Normal power supply energized and identified.											
EC	Control circuit energized and properly identified.											
EC	All control panels are in place.											
TCC	Control devices have been calibrated and programmed.											
TCC	Control loops have been tuned in field.											
TCC	Control damper(s) operator has been fully stroked.											
TCC	Coil control valve installed and terminated.											
TCC	Coil control valve powered and calibrated.											
TCC	Coil control valve is programmed and reads correctly at front end computer.											

SAMPLE

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
TCC	Operator Workstation - points programmed and generated in graphics.											
TCC	Discharge temperature sensor installed and accurately located on as-built drawings.											
Controls (Sensors I/O)												
TCC	**Analog Inputs**											
TCC	Zone Temperature											
TCC	Zone Setpoint											
TCC	Supply #1 CFM											
TCC	Supply #2 CFM											
TCC	Supply #3 CFM											
TCC	Exhaust #1 CFM / snorkel											
TCC	Exhaust #2 CFM											
TCC	Exhaust #3 CFM											
TCC	Exhaust #4 CFM											
TCC	Exhaust #1 Pressure / snorkel											
TCC	Exhaust #1 Discharge Air Temp											

SAMPLE

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
TCC	Exhaust #2 Discharge Air Temp											
TCC	Exhaust #3 Discharge Air Temp											
TCC	**Analog Outputs**											
TCC	Supply #1 Air Damper Position											
TCC	Supply #2 Air Damper Position											
TCC	Supply #3 Air Damper Position											
TCC	Exhaust #1 Air Damper Position/Snorkel											
TCC	Exhaust #2 Air Damper Position											
TCC	Exhaust #3 Air Damper Position											
TCC	Exhaust #4 Air Damper Position											
TCC	Supply #1 Reheat Valve Position											
TCC	Supply #2 Reheat Valve Position											
TCC	Supply #3 Reheat Valve Position											

SAMPLE

Responsible Contractor	Requirement (Tag numbers based on Mechanical Drawings)	Sign Off	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮	VAV ⋮
	Supplied From:		AHU-#	RTU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#	AHU-#
TCC	**Binary Outputs**											
TCC	Supply #1 Radiant Panel Valve											
TCC	Supply #2 Radiant Panel Valve											
TCC	Supply #3 Radiant Panel Valve											

Additional Comments:

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SAMPLE

Fire-Tube Boilers (Steam L.P.)
Pre-Functional Checklist

Equipment ID	**[Equipment ID]**
Building	**[Building]**
Location	**[Room]**

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Signoff

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

Equipment Information

Make		**Model Number**			
Serial Number		**Capacity BTUH**		**PPH**	
Volts/Phase		**Function**		**Service Area**	

SAMPLE

Notes:	

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
General appearance good, no apparent damage	☐	☐			
Fuel Oil Pipe, fittings and accessories complete	☐	☐			
Fuel Oil Pumps and accessories complete	☐	☐			
Pipe, gas, fittings and accessories complete	☐	☐			
Isolation valves and balancing valves installed	☐	☐			
Pipes not supported on boiler	☐	☐			
Steam system flushing complete, strainers cleaned and steam traps operational	☐	☐			
Condensate receiver and accessories installed	☐	☐			
Condensate receiver and accessories installed	☐	☐			
Condensate pipe, fittings and pumps complete	☐	☐			
Boiler temperature control installed	☐	☐			
Pressure gages installed	☐	☐			
Test plugs (P/T) installed near all control sensors and as per spec	☐	☐			
Flow switch installed as specified	☐	☐			
Proper boiler fluid level	☐	☐			
Expansion tanks and accessories installed	☐	☐			
Air removal fitting and accessories installed	☐	☐			
Equipment labels affixed	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Tube pull and access door space adequate and to code	☐	☐			
Combustion air supply installed	☐	☐			
No leaking apparent	☐	☐			
Boiler water condensate pumps and accessories installed	☐	☐			
Boiler safeties, burner controls and accessories installed	☐	☐			
Notes:					

Draft Fan (If Applicable)					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Fan is installed per manufacturer's instructions	☐	☐			
Casing in good condition; no dents	☐	☐			
Mountings checked and shipping bolts removed	☐	☐			
Vibration isolators installed	☐	☐			
Plenums free of debris	☐	☐			
Fan rotates freely and in correct direction	☐	☐			
Bearings lubricated	☐	☐			
Equipment guards and safety devices installed	☐	☐			
Starter installed and size coordinated with motor	☐	☐			
Motor correctly aligned	☐	☐			
Notes:					

SAMPLE

Gas Train					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Gas train Installed in accordance with NFPA, FM and IRI	☐	☐			
Gas train checked for leaks	☐	☐			
Gas piping installed and tested	☐	☐			
Gas train vents are terminated per code	☐	☐			
Gas train safety devices are operational	☐	☐			
Drip leg provided in gas main	☐	☐			
Gas cock valve orientation per manufacturers recommendations	☐	☐			
Gas cock valve accessible and travels freely	☐	☐			
Gas cock checked for leaks in closed position with the other gas train valves open	☐	☐			
Gas regulator installed per manufacturer's instructions	☐	☐			
Gas regulator properly located in non-turbulent section of pipe	☐	☐			
Gas regulator is properly oriented	☐	☐			
Gas regulator is wired correctly	☐	☐			
Gas regulator is accessible for test and service	☐	☐			
Gas pressure adjusted and verified within acceptable range	☐	☐			
Confirmed gas PRV operation	☐	☐			
Gas pressure sensor limits are appropriate for application	☐	☐			
High gas pressure switch installed per manufacturer's instructions	☐	☐			
High gas pressure switch is properly wired	☐	☐			
Low gas pressure switch installed per manufacturer's instructions	☐	☐			
Low gas pressure switch is properly wired	☐	☐			
Gas control valve installed per manufacturer's instructions	☐	☐			

SAMPLE

Gas Train					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Gas control valve installed vertical with direction of flow confirmed	☐	☐			
Gas control valve accessible and travels freely	☐	☐			
Gas control valve checked for leaks in closed position with the other gas train valves open	☐	☐			
Gas control valve had no visible damage	☐	☐			
Gas control valve nameplate readings checked against application and is applied correctly	☐	☐			
Drum relief valve setting adequate for application	☐	☐			
Drum relief valve discharge properly piped	☐	☐			
Stop-Check valve pressure rating applicable for duty	☐	☐			
Stop-Check valve installed per manufacturers instructions	☐	☐			
Notes:					

Fuel Oil Piping (If Applicable)					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Fuel Oil Piping Installed in accordance with NFPA, FM and IRI	☐	☐			
Fuel Oil Piping checked for leaks	☐	☐			
Fuel Oil Piping installed and tested	☐	☐			
Fuel Oil Piping safety devices are operational	☐	☐			
Fuel Oil Pumps and accessories installed	☐	☐			
Fuel Oil Pumps started up and operational per manufacturers recommendations	☐	☐			
Fuel Oil anamizer and accessories installed	☐	☐			
Gas cock checked for leaks in closed position with the other gas train valves open (manufacturers representative has started up burner with fuel oil)	☐	☐			
Fuel Oil Pressure adjusted and verified within acceptable range	☐	☐			

SAMPLE

Fuel Oil Piping (If Applicable)					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Confirmed Fuel Oil PRV operation	☐	☐			
Fuel Oil pressure sensor limits are appropriate for application	☐	☐			
High Fuel Oil pressure switch installed per manufacturer's instructions	☐	☐			
High Fuel Oil pressure switch is properly wired	☐	☐			
Low Fuel Oil pressure switch installed per manufacturer's instructions	☐	☐			
Low Fuel Oil pressure switch is properly wired	☐	☐			
Fuel Oil control valve installed per manufacturer's Instructions	☐	☐			
Fuel Oil control valve accessible and travels freely	☐	☐			
Fuel Oil control valve checked for leaks in closed position	☐	☐			
Fuel Oil control valve had no visible damage	☐	☐			
Fuel Oil control valve nameplate readings checked against application and is applied correctly	☐	☐			
Stop-Check valve pressure rating applicable for duty	☐	☐			
Stop-Check valve installed per manufacturers instructions	☐	☐			
Notes:					

Piping					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Steam piping complete, elbows minimized, pitched back to condensate receiver, makeup water piping and safety reliefs installed	☐	☐			
Piping supported independently of the boiler	☐	☐			
Piping type and flow direction labeled on piping	☐	☐			
Isolation valves, balancing valves and piping specialties installed	☐	☐			

SAMPLE

Piping					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Steam system flushing complete and strainers cleaned	☐	☐			
Chemical treatment system or plan installed	☐	☐			
Unions installed to allow for easy removal of control valves	☐	☐			
Steam supply functional (preference is to have the steam system VTP complete and satisfactory).	☐	☐			
Pressure gauges have been installed	☐	☐			
Notes:					

Electrical and Controls					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Power disconnect is located within site of the unit it controls and labeled	☐	☐			
All electric connections tight and installed properly	☐	☐			
Grounding installed for components and unit	☐	☐			
Safeties installed and operational	☐	☐			
Starter overload breakers installed and correct size	☐	☐			
All control devices, pneumatic tubing and wiring complete	☐	☐			
Control system interlocks connected and functional	☐	☐			
Size of over current heater in motor starter correct (where applicable)	☐	☐			
HOA Switch installed per manufacturer's instructions (if applicable)	☐	☐			
Operation of HOA switch checked in all positions	☐	☐			
Proper safeties in control when HOA switch in Hand position	☐	☐			
Sensors calibrated (see calibration section below)	☐	☐			
Multiple boiler interlocks completed	☐	☐			
Notes:					

SAMPLE

Flue					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Installed per manufacturers instructions	☐	☐			
Sloped toward boiler	☐	☐			
Clearance to combustibles per code	☐	☐			
Protection in place to prevent burning hazard	☐	☐			
Discharge is protected from rain and blockage	☐	☐			
Provisions in place for expansion compensation	☐	☐			
Discharge is located to preclude re-entrainment back into the building	☐	☐			
Draft checked and meets minimum requirements of boiler manufacturer	☐	☐			
Notes:					

Low Pressure Cutoff					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Installed per manufacturer's instructions	☐	☐			
Wire terminations checked and correct	☐	☐			
Notes:					

TAB					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Installation of system and balancing devices is completed following NEBB or AABC procedures and contract documents	☐	☐			
Notes:					

SAMPLE

Operational Checks					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Measure line to line voltage phase imbalance for all three-phase motors: (%Imbalance = 100 x (avg. - lowest) / avg.) Record imbalance of compressor. Imbalance less than 2%?	☐	☐			
Record full load running amps for all three-phase motors. _____rated FL amps x _____srvc factor = _____ (Max amps). Running less than max?	☐	☐			
No unusual noise and vibration when running	☐	☐			
Boiler safeties energized and tested	☐	☐			
Specified sequences of operation and operating schedules have been implemented with all variations documented	☐	☐			
Specified point-to-point checks have been completed and documentation record submitted for this system	☐	☐			
Startup report completed with this checklist attached. (Includes full listing of all internal settings with notes as to which settings are BAS controlled or monitored and which are integral	☐	☐			
Startup report includes written certification from boiler manufacturer that all specified features, controls and safeties have been installed and are functioning properly and that the installation and application comply with the manufacturer's recommendations	☐	☐			
Startup report includes optimal and actual percent CO_2, CO, O_2, stack temperature; combustion efficiency	☐	☐			
Piping gages, BAS and boiler panel temperature and pressure readouts match (see calibration section below)	☐	☐			
Notes:					

SAMPLE

Additional Comments:

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SAMPLE

Centrifugal Water Chiller (Water Cooled) Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Signoff

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

SAMPLE

Equipment Information

Make		Model Number			
Serial Number		Capacity BTUH		GPM Condenser ; Evaporator;	
Volts/Phase		Function		Service Area	
Notes:					

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
General appearance good, no apparent damage	☐	☐			
Proper vibration isolators installed and adjusted	☐	☐			
Seismic restraints in place	☐	☐			
Pipe fittings and accessories complete	☐	☐			
Isolation valves and balancing valves installed	☐	☐			
Pipes not supported on chiller	☐	☐			
Hydronic system flushing complete and strainers cleaned	☐	☐			
Cooling tower or condenser system checked out	☐	☐			
Evaporator air vent provided	☐	☐			
Water cooled condenser air vent provided	☐	☐			
Refrigerant relief pipe extended to outside	☐	☐			
Sequencer controls installed (If specified)	☐	☐			
Pressure gages installed	☐	☐			
Test plugs (P/T) installed near all control sensors and as per spec	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Flow switch installed as required	☐	☐			
Flow meters installed	☐	☐			
Proper refrigerant level	☐	☐			
No refrigerant leaking	☐	☐			
Proper oil level	☐	☐			
Refrigerant monitor installed	☐	☐			
Purge unit installed, if specified	☐	☐			
Equipment labels affixed	☐	☐			
Oil heater installed properly	☐	☐			
Over current motor heater installed and correct size	☐	☐			
Oil filter clean	☐	☐			
No fluid leaking apparent	☐	☐			
Notes:					

SAMPLE

Electrical and Controls					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Power disconnect is located within site of the unit it controls and labeled	☐	☐			
All electric connections tight and installed properly	☐	☐			
Grounding installed for components and unit	☐	☐			
Safeties installed and operational	☐	☐			
Starter overload breakers installed and correct size	☐	☐			
All control devices, pneumatic tubing and wiring complete	☐	☐			

Electrical and Controls					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Control system interlocks connected and functional	☐	☐			
Emergency power off (EPO) switch installed as specified	☐	☐			
Operation of EPO switch checked in all positions	☐	☐			
Proper safeties in control when EPO switch is active	☐	☐			
Sensors calibrated (see calibration section below)	☐	☐			
Refrigerant monitor and purse checked	☐	☐			
Notes:					

Piping					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Piping installation checked against the drawings and all devices gages and appurtenances are in place	☐	☐			
Piping supported independently of the chiller	☐	☐			
Piping type and flow direction labeled on piping	☐	☐			
Isolation valves, balancing valves and piping specialties installed	☐	☐			
System flushing complete and strainers cleaned	☐	☐			
Hydronic system flushing complete and strainers cleaned	☐	☐			
Notes					

TAB					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Installation of system and balancing devices is completed following NEBB or AABC procedures and contract documents	☐	☐			
Notes:					

SAMPLE

Operational Checks					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Measure line to line voltage phase imbalance for compressor: (%Imbalance = 100 x (avg. - lowest) / avg.) Record imbalance of compressor. Imbalance less than 2%?	☐	☐			
Record full load running amps for compressor. _____rated FL amps x _____srvc factor = _____ (Max amps). Running less than max?	☐	☐			
No unusual noise and vibration when running	☐	☐			
Compressor interlocking with oil pressure	☐	☐			
Adequate oil pressure when compressor shaft is turning	☐	☐			
Pre-rotation vane closed before compressor reaches full speed (centrifuge-modify as required)	☐	☐			
Pre-rotation vane steady when load changes	☐	☐			
Specified sequences of operation and operating schedules have been implemented with all variations documented	☐	☐			
Specified point-to-point checks have been completed and documentation record submitted for this system	☐	☐			
Startup report completed with this checklist attached. (Includes full listing of all internal settings with notes as to which settings are BAS controlled or monitored and which are integral	☐	☐			
Startup report includes written certification from chiller manufacturer that all specified features, controls and safeties have been installed and are functioning properly and that the installation and application comply with the manufacturer's recommendations	☐	☐			
Piping gages, BAS and chiller panel temperature and pressure readouts match (see calibration section below)	☐	☐			
Notes:					

SAMPLE

Additional Comments:

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SAMPLE

Modular Indoor Central-Station AHU (Variable Volume) Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Sign Here

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

SAMPLE

Equipment Information

Make		Model Number			
Serial Number		Capacity		CFM	
Volts/Phase		Function		Service Area	
Supply Fan HP		Return Fan HP		Exh. Fan HP	
Notes:					

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Cabinet and general installation completed	☐	☐			
Permanent labels affixed, including for fans	☐	☐			
Casing condition good: no dents, leaks, door gaskets installed, free of dirt and debris	☐	☐			
Access doors close tightly - no leaks	☐	☐			
Connection between duct (supply and return) and unit tight and in good condition	☐	☐			
Connections between unit sections and accessories tight and in good condition	☐	☐			
Vibration isolation equipment installed & released from shipping locks	☐	☐			
Maintenance access acceptable for unit and components	☐	☐			
Thermal insulation properly installed and according to specification	☐	☐			
Instrumentation installed according to specification (thermometers, pressure gages, flow meters, etc.)	☐	☐			
Clean up of equipment completed per contract documents	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Mountings checked - unit is secure and mounted level horizontally and vertically	☐	☐			
Notes:					

Return / Exhaust Fan Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Return / exhaust fan and motor aligned	☐	☐			
Return / exhaust fan belt tension and condition good	☐	☐			
Return / exhaust fan protective shrouds for belts in place and secure	☐	☐			
Return / exhaust fan area clean	☐	☐			
Return / exhaust fan and motor lubricated with lube lines installed and accessible	☐	☐			
Correct fan rotation	☐	☐			
Over current motor heaters installed and correct size	☐	☐			
R.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
Return fan start / stop installed and functional	☐	☐			
Return fan status measuring device installed and functional (current switch, D/P switch, etc.)	☐	☐			
E.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
Exhaust fan start / stop installed and functional	☐	☐			
Exhaust fan status measuring device installed and functional (current switch, D/P switch, etc.)	☐	☐			
Negative static pressure measuring device installed and functional (D/P switch, D/P transmitter, etc.)	☐	☐			
Relief damper closes tightly	☐	☐			
Relief damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			

SAMPLE

Return / Exhaust Fan Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Relief air quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
Building static pressure measuring device installed and functional (D/P switch, D/P transmitter, etc.)	☐	☐			
Smoke and fire dampers installed properly per contract docs (proper location, access doors, appropriate ratings verified)	☐	☐			
Smoke detector(s) installed properly per contract docs (proper location, access doors, appropriate ratings verified), interlocks installed and functional	☐	☐			
Notes:					

Economizer Section (3-damper section)					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
OSAT (Temperature) sensor shielded and operational	☐	☐			
OSARH (Humidity) sensor shielded and operational	☐	☐			
OACO2 (CO2) sensor operational	☐	☐			
OA Enthalpy sensor shielded and operational	☐	☐			
Minimum O.A. damper closes tightly	☐	☐			
Minimum O.A. balancing damper installed per drawings and verified by TAB's site visit	☐	☐			
Min. O.A. damper actuator installed and operational in full range with automatic control, 2-position (Opn /Clo)	☐	☐			
Min. O.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
O.A. damper closes tightly	☐	☐			
O.A. damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
O.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
RAT (Temperature) sensor operational	☐	☐			
RAH (Humidity) sensor operational	☐	☐			
RACO2 (CO2) sensor operational	☐	☐			

SAMPLE

Economizer Section (3-damper section)					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
R.A. damper closes tightly	☐	☐			
R.A. damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
R.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
MAT (Temperature) sensor operational	☐	☐			
MAH (Humidity) sensor operational	☐	☐			
M.A. damper closes tightly	☐	☐			
M.A. damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
Notes:					

Mixing Box Section (2-damper section)					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
OSAT (Temperature) sensor shielded and operational	☐	☐			
OSARH (Humidity) sensor shielded and operational	☐	☐			
OACO2 (CO2) sensor operational	☐	☐			
OA Enthalpy sensor shielded and operational	☐	☐			
Minimum O.A. damper closes tightly	☐	☐			
Minimum O.A. balancing damper installed per drawings and verified by TAB's site visit	☐	☐			
Min. O.A. damper actuator installed and operational in full range with automatic control, 2-position (Opn /Clo)	☐	☐			
Min. O.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
O.A. damper closes tightly	☐	☐			
O.A. damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
O.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
RAT (Temperature) sensor operational	☐	☐			

SAMPLE

Mixing Box Section (2-damper section)					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
RAH (Humidity) sensor operational	☐	☐			
RACO2 (CO2) sensor operational	☐	☐			
R.A. damper closes tightly	☐	☐			
R.A. damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
R.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
MAT (Temperature) sensor operational	☐	☐			
MAH (Humidity) sensor operational	☐	☐			
Notes:					

Blender Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Blender pressure differential measuring device installed and functional (magnehelic, inclined manometer, D/P transmitter, etc.)	☐	☐			
Inlet Air T (Temperature) sensor operational	☐	☐			
Outlet Air T (Temperature) sensor operational	☐	☐			
Blender area clean	☐	☐			
Notes:					

Filter Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Filters clean and tight fitting	☐	☐			

SAMPLE

Filter Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Filters installed and replacement type and efficiency permanently affixed to housing—construction filters removed	☐	☐			
Filter pressure differential measuring device installed and functional (magnehelic, inclined manometer, etc.)	☐	☐			
Notes:					

Energy Recovery Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Enthalpy wheel emulsion surfaces undamaged, clean and assembly is in good condition with tight connections	☐	☐			
Enthalpy wheel supply air discharge (downstream) air temperature sensor operational	☐	☐			
Enthalpy wheel supply air intake (upstream) air temperature sensor operational					
Enthalpy wheel exhaust air intake (upstream) air temperature sensor operational	☐	☐			
Enthalpy wheel exhaust air discharge (downstream) air temperature sensor operational	☐	☐			
Enthalpy wheel speed control operational	☐	☐			
Enthalpy wheel rotation correct	☐	☐			
Enthalpy wheel pressure differential measuring device installed and functional (magnehelic, D/P transmitter, etc.)	☐	☐			
Enthalpy wheel supply air discharge (downstream) relative humidity sensor operational	☐	☐			
Enthalpy wheel exhaust air discharge (downstream) relative humidity sensor operational	☐	☐			
ERU plates undamaged, clean and assembly is in good condition with tight connections	☐	☐			
ERU supply air discharge (downstream) air temperature sensor operational	☐	☐			
ERU supply air discharge (downstream) relative humidity sensor operational	☐	☐			

SAMPLE

Energy Recovery Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
ERU exhaust air intake (upstream) air temperature sensor operational	☐	☐			
ERU exhaust air intake (upstream) relative humidity sensor operational	☐	☐			
ERU exhaust air discharge (downstream) air temperature sensor operational	☐	☐			
ERU plate pressure differential measuring device installed and functional (magnehelic, D/P transmitter, etc.)	☐	☐			
Notes:					

Face & By-Pass Damper Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Face damper closes tightly	☐	☐			
Face damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
By-Pass damper closes tightly	☐	☐			
By-Pass damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
Face damper supply air discharge (downstream) air temperature sensor operational	☐	☐			
Face damper discharge air (upstream) air temperature sensor operational	☐	☐			
By-Pass damper supply air discharge (downstream) air temperature sensor operational	☐	☐			
By-Pass damper discharge air (upstream) air temperature sensor operational	☐	☐			
DAT (Temperature) sensor operational	☐	☐			
Notes:					

SAMPLE

Draw-Thru Coil Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Coils are clean and fins are in good condition	☐	☐			
Coil drain has been piped	☐	☐			
All condensate drain pans clean and slope to drain, per spec	☐	☐			
Pipe and fittings complete and properly supported	☐	☐			
Pipes properly labeled, color coordinated and flow directions are labeled.	☐	☐			
Pipe and fittings properly insulated	☐	☐			
Strainers in place and clean, blow down installed	☐	☐			
Piping system properly flushed	☐	☐			
No leaking apparent around fittings	☐	☐			
Valves properly labeled	☐	☐			
Valves installed in proper direction	☐	☐			
Control valve closes tightly	☐	☐			
Control valve actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
Test plugs (P/T) and isolation valves installed per drawings	☐	☐			
Pressure gauges and thermometers have been installed	☐	☐			
FRZ (Freeze-stat) averaging sensor installed and operational	☐	☐			
MAT (Temperature) sensor operational	☐	☐			
MAH (Humidity) sensor operational	☐	☐			
DAT (Temperature) sensor operational	☐	☐			
DAH (Humidity) sensor operational	☐	☐			
HWS (Temperature) sensor operational	☐	☐			
HWR (Temperature) sensor operational	☐	☐			
CHWS (Temperature) sensor operational	☐	☐			
CHWR (Temperature) sensor operational	☐	☐			
Coil Injection Pump start / stop operational	☐	☐			

SAMPLE

Draw-Thru Coil Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Coil Injection Pump status measuring device installed and functional (current switch, D/P switch, etc.)	☐	☐			
Notes:					

Access Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Access doors and panels clean and tight fitting	☐	☐			
Access doors and panels are of sufficient width and height to facilitate maintenance and replacement of equipment (coils, humidifiers, etc.)	☐	☐			
Access doors and panels have all gaskets and closure devices installed and functional	☐	☐			
Notes:					

Horizontal Coil Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Coils are clean and fins are in good condition	☐	☐			
Coil drain has been piped	☐	☐			
All condensate drain pans clean and slope to drain, per spec	☐	☐			
Pipe and fittings complete and properly supported	☐	☐			
Pipes properly labeled, color coordinated and flow directions are labeled.	☐	☐			
Pipe and fittings properly insulated	☐	☐			
Strainers in place and clean, blow down installed	☐	☐			
Piping system properly flushed	☐	☐			
No leaking apparent around fittings	☐	☐			
Valves properly labeled	☐	☐			

SAMPLE

Horizontal Coil Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Valves installed in proper direction	☐	☐			
Control valve closes tightly	☐	☐			
Control valve actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
Test plugs (P/T) and isolation valves installed per drawings	☐	☐			
Pressure gauges and thermometers have been installed	☐	☐			
FRZ (Freeze-stat) averaging sensor installed and operational	☐	☐			
MAT (Temperature) sensor operational	☐	☐			
MAH (Humidity) sensor operational	☐	☐			
DAT (Temperature) sensor operational	☐	☐			
DAH (Humidity) sensor operational	☐	☐			
HWS (Temperature) sensor operational	☐	☐			
HWR (Temperature) sensor operational	☐	☐			
Coil Injection Pump start / stop operational	☐	☐			
Coil Injection Pump status measuring device installed and functional (current switch, D/P switch, etc.)	☐	☐			
Notes:					

SAMPLE

Supply Fan Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Supply fan and motor aligned	☐	☐			
Supply fan belt tension and condition good	☐	☐			
Supply fan protective shrouds for belts in place and secure	☐	☐			
Supply fan area clean	☐	☐			

Supply Fan Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Supply fan and motor lubricated with lube lines installed and accessible	☐	☐			
Correct fan rotation	☐	☐			
Over current motor heaters installed and correct size	☐	☐			
S.A. quantity confirmed by airflow measuring station and verified by TAB's site visit	☐	☐			
Supply fan start / stop installed and functional	☐	☐			
Supply fan status measuring device installed and functional (current switch, D/P switch, etc.)	☐	☐			
Duct static pressure measuring device installed and functional (D/P switch, D/P transmitter, etc.)	☐	☐			
Duct high static pressure limit measuring device installed and functional (D/P switch, D/P transmitter, etc.)	☐	☐			
Smoke and fire dampers installed properly per contract docs (proper location, access doors, appropriate ratings verified)	☐	☐			
Smoke detector(s) installed properly per contract docs (proper location, access doors, appropriate ratings verified), interlocks installed and functional	☐	☐			
Notes:					

Discharge Diffuser Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Diffuser pressure differential measuring device installed and functional (magnehelic, inclined manometer, D/P transmitter, etc.)	☐	☐			
Inlet Air T (Temperature) sensor operational	☐	☐			
Outlet Air T (Temperature) sensor operational	☐	☐			
Diffuser area clean	☐	☐			
Notes:					

SAMPLE

Blow-Thru Coil Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Coils are clean and fins are in good condition	☐	☐			
Coil drain has been piped	☐	☐			
All condensate drain pans clean and slope to drain, per spec	☐	☐			
Pipe and fittings complete and properly supported	☐	☐			
Pipes properly labeled, color coordinated and flow directions are labeled.	☐	☐			
Pipe and fittings properly insulated	☐	☐			
Strainers in place and clean, blow down installed	☐	☐			
Piping system properly flushed	☐	☐			
No leaking apparent around fittings	☐	☐			
Valves properly labeled	☐	☐			
Valves installed in proper direction	☐	☐			
Control valve closes tightly	☐	☐			
Control valve actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
Test plugs (P/T) and isolation valves installed per drawings	☐	☐			
Pressure gauges and thermometers have been installed	☐	☐			
FRZ (Freeze-stat) averaging sensor installed and operational	☐	☐			
MAT (Temperature) sensor operational	☐	☐			
MAH (Humidity) sensor operational	☐	☐			
DAT (Temperature) sensor operational	☐	☐			
DAH (Humidity) sensor operational	☐	☐			
HWS (Temperature) sensor operational	☐	☐			
HWR (Temperature) sensor operational	☐	☐			
CHWS (Temperature) sensor operational	☐	☐			
CHWR (Temperature) sensor operational	☐	☐			

SAMPLE

Blow-Thru Coil Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Coil Injection Pump start / stop operational	☐	☐			
Coil Injection Pump status measuring device installed and functional (current switch, D/P switch, etc.)	☐	☐			
Notes:					

Final Filter Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Filters clean and tight fitting	☐	☐			
Filters installed and replacement type and efficiency permanently affixed to housing—construction filters removed	☐	☐			
Filter pressure differential measuring device installed and functional (magnehelic, inclined manometer, etc.)	☐	☐			
Notes:					

Humidifier Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Drip leg, for the humidifier, is installed upstream from steam trap a minimum of 12” tall for proper operations of trap.	☐	☐			
Control valve closes tightly	☐	☐			
Control valve actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
Piping is installed adjacent to the humidifier to allow service and maintenance.	☐	☐			
Shutoff valve, make-up valve, strainer and union are installed in humidifier make-up line.	☐	☐			
Condensate and drain traps have been installed and piped.	☐	☐			

SAMPLE

Humidifier Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
The electric–resistance heater container installed is cleanable and made of type 304 or 316 stainless steel material.	☐	☐			
A wall mounted, solid state, electronic-sensor controller capable of full modulation and cycling control is installed and wired to the humidifier.	☐	☐			
A duct high humidity limit humidistat is installed and wired.	☐	☐			
Steam distribution tree has been installed and pitched to prevent condensate from being discharged into the air stream	☐	☐			
An airflow sail switch is installed and wired to prevent humidification without airflow.	☐	☐			
A solenoid fill valve is installed with an automatic drain valve to maintain the water level and temper hot drain water.	☐	☐			
The controls are micro-processor based with modulating or cycling control and start/stop for interface with the central DDC building automation system.	☐	☐			
A factory trained service representative inspected components, assemblies, and equipment installations including connections to assist in testing.	☐	☐			
Notes:					

SAMPLE

Attenuator Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Sound attenuators installed	☐	☐			
Sound measurement readings taken and documented to support attenuator performance criteria	☐	☐			
No apparent duct restrictions	☐	☐			
Notes:					

Plenum Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Duct joint sealant properly installed	☐	☐			
No apparent severe duct restrictions	☐	☐			
Turning vanes in square elbows as per drawings	☐	☐			
Pressure leakage tests completed	☐	☐			
Ducts cleaned as per specifications	☐	☐			
Balancing dampers installed as per drawings and TAB's site visit	☐	☐			
Notes:					

Multi-Zone Coil Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Coils are clean and fins are in good condition	☐	☐			
Coil drain has been piped	☐	☐			
All condensate drain pans clean and slope to drain, per spec	☐	☐			
Pipe and fittings complete and properly supported	☐	☐			
Pipes properly labeled, color coordinated and flow directions are labeled.	☐	☐			
Pipe and fittings properly insulated	☐	☐			
Strainers in place and clean, blow down installed	☐	☐			
Piping system properly flushed	☐	☐			
No leaking apparent around fittings	☐	☐			
Valves properly labeled	☐	☐			
Valves installed in proper direction	☐	☐			
Control valve closes tightly	☐	☐			
Control valve actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			

SAMPLE

Multi-Zone Coil Section					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Test plugs (P/T) and isolation valves installed per drawings	☐	☐			
Pressure gauges and thermometers have been installed	☐	☐			
Multi-zone dampers closes tightly	☐	☐			
Multi-zone damper actuator installed and operational in full range with automatic control, modulating (0-100%)	☐	☐			
FRZ (Freeze-stat) averaging sensor installed and operational	☐	☐			
Hot Deck (Temperature) sensor operational	☐	☐			
Cold Deck (Temperature) sensor operational	☐	☐			
DAT (Temperature) sensor operational	☐	☐			
DAH (Humidity) sensor operational	☐	☐			
HWS (Temperature) sensor operational	☐	☐			
HWR (Temperature) sensor operational	☐	☐			
Coil Injection Pump start / stop operational	☐	☐			
Coil Injection Pump status measuring device installed and functional (current switch, D/P switch, etc.)	☐	☐			
Notes:					

SAMPLE

Ducts - General					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Duct joint sealant properly installed	☐	☐			
No apparent severe duct restrictions	☐	☐			
Turning vanes in square elbows as per drawings	☐	☐			
Pressure leakage tests completed	☐	☐			
Ducts cleaned as per specifications	☐	☐			

Balancing dampers installed as per drawings and TAB's site visit	☐	☐			
Notes:					

VFD and Hardwired Safety Controls					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Installation per manufacturer's requirements and start up instructions completed	☐	☐			
Drive location not subject to excessive moisture or dirt	☐	☐			
Drive location not subject to excessive temperatures	☐	☐			
Appropriate Volts vs. Hz curve is being used	☐	☐			
Drive size matches motor size	☐	☐			
Drive mounted on house keeping pad (if applicable)	☐	☐			
Cooling air flow path clean and unobstructed	☐	☐			
Permanent label affixed and UL stamp approved	☐	☐			
VFD interlocked to control system	☐	☐			
Unit is programmed with full written programming record on site	☐	☐			
Accel time set to _____ and Decel time set to _____	☐	☐			
Operation checked in HAND, OFF, and AUTO. As applicable operation also checked in BYPASS	☐	☐			
Where applicable, ensure safeties are active in all modes	☐	☐			
Coordinated with BAS for all interface ranges and signal isolation	☐	☐			
Restart on Power Failure parameter set to auto	☐	☐			
VFD powered (wired to controlled equipment)	☐	☐			
Grounding installed for components and unit	☐	☐			
Drive min and max speed set to _____ Hz min and 60 Hz max	☐	☐			

SAMPLE

VFD and Hardwired Safety Controls					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Security settings set per Owner direction and Password documented for Owner	☐	☐			
Drive response to loss of signal set to _____	☐	☐			
Output pulse resolution set to _____ MHz. (This is coordinated with the application to minimize audible noise and coordinated with driven bearing allowances.)	☐	☐			
Checked the input voltage with drive disconnected	☐	☐			
Input of motor FLA represents 100% to 105% of motor FLA rating	☐	☐			
Upper frequency limit set at 100%, unless explained otherwise	☐	☐			
Freeze-stat switch	☐	☐			
Supply fan high static sensor	☐	☐			
Return fan negative static sensor (If applicable)	☐	☐			
Discharge air smoke detector	☐	☐			
Return air smoke detector	☐	☐			
Notes:					

SAMPLE

Electrical and Controls					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Power disconnects located within sight of the unit it controls and labeled	☐	☐			
All electric connections tight	☐	☐			
Grounding installed for components and unit	☐	☐			
Safeties installed and operational	☐	☐			
Starter overload breakers installed and correct size	☐	☐			
All control devices and wiring complete	☐	☐			
Control system interlocks connected, programmed, functional and tuned	☐	☐			

Electrical and Controls					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Smoke detectors in place and operational	☐	☐			
Trend logs available for verification testing	☐	☐			
Manual control and set point override available	☐	☐			
Over current motor heaters installed and correct size	☐	☐			
Specified point-to-point checks have been completed and documentation record submitted for this system	☐	☐			
Sensors and gauges have been installed and documentation record submitted for this system	☐	☐			
Notes:					

TAB					
Description	**Yes**	N/A	Initials	Date	Comments
Installation of system and balancing devices is completed following NEBB or AABC procedures and contract documents	☐	☐			
Air test and balance complete for the entire AHU duct system (including outside air flow)	☐	☐			

SAMPLE

TAB					
Description	Yes	N/A	Initials	Date	Comments
Notes:					

Operational Checks					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Supply fan rotation correct	☐	☐			
Return/exhaust fan rotation correct	☐	☐			
Return /exhaust fan acceptable noise & vibration	☐	☐			
Supply fan has no unusual noise or vibration	☐	☐			
Inlet vanes aligned in housing, actuator spanned, modulate smoothly and proportional to input signal and EMS readout	☐	☐			
All dampers (OSA, RA, EA, etc.) stroke fully without binding and spans calibrated and BAS reading site verified	☐	☐			
Valves stroke fully and easily and spanning is calibrated	☐	☐			
Valves verified to not be leaking through coils when closed at normal operating pressure	☐	☐			
Notes:					

SAMPLE

Additional Comments:

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SAMPLE

Low-Voltage Switchgear – Data Center Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Signoff

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

EQUIPMENT DATA

Switchgear Nameplate	
Parameter	**Data**
Equipment ID	
Manufacturer	
Model	

SAMPLE

Type	
Order Number	
Date Manufactured	
Serial Number	
Nominal kVA	
Voltage	
Phase	
Wire	
Continuous Current	
Number of Sections	
Enclosure Type	

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

Inspection Checklist					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
As-Built Drawings complete, available and on-site.	☐	☐			
Equipment shop drawings available.	☐	☐			
Operation and Maintenance manuals available.	☐	☐			
Installation and startup manual available.	☐	☐			
Equipment warranty information completed and provided in O&M Manual.	☐	☐			
Verify receipt and acceptance of manufacturer's factory test reports.	☐	☐			
Doors to electrical room installed.	☐	☐			
Locks or temporary security measures installed & operational. Room can be secured.	☐	☐			
Electrical room clear of storage, temporary equipment, etc.	☐	☐			
Permanent lighting or 30 foot candle temporary lighting in service.	☐	☐			
Egress routes from electrical room are unobstructed.	☐	☐			

SAMPLE

Inspection Checklist					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Electrical room & equipment clean of construction debris and dust, and are dry.	☐	☐			
Working clearances meet NEC and contract documents.	☐	☐			
Equipment has been installed on a level housekeeping pad.	☐	☐			
Equipment anchored per manufacturer's instruction.	☐	☐			
Warning Signs installed per shop drawings and contract documents.	☐	☐			
All shipped-loose components installed.	☐	☐			
Equipment and switchgear grounding and bonding installed for each section.	☐	☐			
All grounding connections made with either exothermic process or with non-reversible compression fittings.	☐	☐			
Cabinet/compartment doors allow for full swing; latch open and close without binding; and no physical damage.	☐	☐			
Bus and units correspond to one-line diagram.	☐	☐			
All internal and field wiring completed and switchgear fully assembled.	☐	☐			
Interior low voltage switchgear bus and compartments vacuumed and wiped clean with manufacturer approved electrical cleaner.	☐	☐			
All bolted connections tightened to their proper torque values.	☐	☐			
All wiring installed properly with correct bend radius and no insulation damage.	☐	☐			
Testing agency has been scheduled to perform the test and the commissioning agent has been notified of the testing date.	☐	☐			
Test equipment requirements have been reviewed with the testing agency.	☐	☐			
Power available for test equipment.	☐	☐			
Installation is complete and ready for verification testing.	☐	☐			
Training Plan approved.	☐	☐			

SAMPLE

Inspection Checklist					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Training sessions of owner training completed / acceptance granted / training materials submitted to Commissioning Agent.	☐	☐			
Notes:					

Additional Comments:

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SAMPLE

Switchboards
Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Sign Here

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

SAMPLE

Equipment Information

Make		**Model Number**			
Serial Number		**NEMA Enclosure**		**KVA**	
Volts/Phase		**AMPS**		**KW**	
Service Area					
Notes:					

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
As-Built Drawings complete	☐	☐			
Equipment shop drawings available	☐	☐			
Operation and Maintenance manuals available	☐	☐			
Installation and startup manual available	☐	☐			
Equipment warranty information completed and provided in O&M Manual	☐	☐			
Verify receipt and acceptance of manufacturer's factory test reports	☐	☐			
Doors to electrical room installed.	☐	☐			
Locks or temporary security measures installed & operational. Room can be secured.	☐	☐			
Electrical room clear of storage, temporary equipment, etc.	☐	☐			
Permanent lighting or 30 foot candle temporary lighting in service.	☐	☐			
Egress routes from electrical room are unobstructed.	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Electrical room & equipment clean of construction debris and dust, and are dry.	☐	☐			
Working clearances meet NEC and contract documents	☐	☐			
Equipment has been installed on a level housekeeping pad.	☐	☐			
Equipment anchored per manufacturer's instruction	☐	☐			
Warning Signs installed per shop drawings and contract documents.	☐	☐			
All shipped-loose components installed.	☐	☐			
Electrical room grounding system complete.	☐	☐			
Ground bus(ses) have been installed and terminated to ground system. Grounding electrode connection to building steel completed per design drawings.	☐	☐			
Temporary switchboard circuit directory completed.	☐	☐			
Component/subsystems are clearly and correctly identified with temporary/permanent labels (bus, section, breakers and devices)	☐	☐			
Transient Voltage Suppression System installed per approved shop drawings.	☐	☐			
Switchboard labeled with engraved laminated plastic or metal nameplates mounted with corrosion-resistant screws.	☐	☐			
Shipping bolts and braces removed	☐	☐			
Shipping splits bolted together at proper torque	☐	☐			
All enclosure panels and doors in place, fitted & undamaged	☐	☐			
All shipped-loose components installed	☐	☐			
Current/Potential Transformer fuses are installed and connected.	☐	☐			
Verify neutral connection to ground.	☐	☐			
All bolted electrical connections have been tightened to their proper torque values. (Note: some connections will be disconnected as part of the FPT. These connections will be field torqued to proper settings at the conclusion of the field-testing.)	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
All Overcurrent protective devices have been installed at the proper ampere rating and all settings have been adjusted to match the system Coordination Study.	☐	☐			
Electrical testing representative has been scheduled to perform the test and the commissioning agent has been notified of the testing date.	☐	☐			
Test equipment requirements have been reviewed with electrical testing representative.	☐	☐			
Power available for test equipment.	☐	☐			
Installation is complete and ready for verification testing.	☐	☐			
Training Plan approved	☐	☐			
Training sessions of owner training completed / acceptance granted / training materials submitted to Commissioning Agent	☐	☐			
Notes:					

Additional Comments:

SAMPLE

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Panelboards
Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Signoff

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

SAMPLE

Equipment Information

Make		**Model Number**			
Serial Number		**NEMA Enclosure**		**KVA**	
Volts/Phase		**AMPS**		**KW**	
Service Area					
Notes:					

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
As-Built Drawings complete	☐	☐			
Equipment shop drawings available	☐	☐			
Operation and Maintenance manuals available	☐	☐			
Installation and startup manual available	☐	☐			
Equipment warranty information completed and provided in O&M Manual	☐	☐			
Verify receipt and acceptance of manufacturer's factory test reports	☐	☐			
Verify room, enclosure, and equipment are dry and clean. Building is closed in and sealed to prevent entry of moisture due to weather conditions.	☐	☐			
Doors to electrical room installed.	☐	☐			
Locks or temporary security measures installed and operational. Room can be secured.	☐	☐			
Electrical room clear of storage, temporary equipment, etc.	☐	☐			
Permanent lighting or 30 foot candle temporary lighting in service.	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Egress routes from electrical room are unobstructed.	☐	☐			
Electrical equipment clean of construction debris, dust, and moisture.	☐	☐			
Working clearances meet NEC and contract documents	☐	☐			
Panelboard has been installed and anchored per manufacturer's recommendations	☐	☐			
Warning Signs installed per shop drawings and contract documents.	☐	☐			
Electrical room grounding system complete.	☐	☐			
Ground bus(ses) have been installed and terminated to ground system.	☐	☐			
Panelboard ratings match one-line drawing.	☐	☐			
Temporary panelboard circuit directory completed.	☐	☐			
Secondary service, feeder and branch circuit conductors per specifications: 208/120 V System as follows: Phase A: Black Phase B: Red Phase C: Blue Neutral: White Ground: Green 480/277 V System as follows: Phase A: Brown Phase B: Orange Phase C: Yellow Neutral: Gray Ground: Green	☐	☐			
Component/subsystems are clearly and correctly identified with temporary/permanent labels (bus, section, breakers and devices)	☐	☐			
Panelboard Transient Voltage Suppression System (TVSS) installed per construction and approved shop drawings.	☐	☐			
Panelboard labeled with engraved laminated plastic or metal nameplates mounted with corrosion-resistant screws.	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Panelboard short circuit rating meets construction and approved shop drawing requirements	☐	☐			
Panelboard provided with equipment ground bus per approved shop drawings	☐	☐			
Panelboard equipped with shunt trip if applicable per approved shop drawings	☐	☐			
Filler plates installed in unused spaces.	☐	☐			
Shipping bolts and braces removed	☐	☐			
All enclosure panels and doors in place, fitted, undamaged	☐	☐			
All shipped-loose components installed	☐	☐			
Verify neutral bus isolated from ground.	☐	☐			
All bolted electrical connections have been tightened to their proper torque values.	☐	☐			
All field connections have been tightened to their proper torque values.	☐	☐			
All Overcurrent protective devices have been installed at the proper ampere rating and all settings have been adjusted to match the system Coordination Study.	☐	☐			
Operating mechanism of each circuit breaker has been mechanically exercised.	☐	☐			
All vent openings are free from obstructions.	☐	☐			
Electrical testing representative has been scheduled to perform the test and the commissioning agent has been notified of the testing date.	☐	☐			
Test equipment requirements have been reviewed with electrical testing representative.	☐	☐			
Power available for test equipment.	☐	☐			
Installation is complete and ready for verification testing.	☐	☐			
Training Plan approved	☐	☐			
Training sessions of owner training completed / acceptance granted / training materials submitted to Commissioning Agent.	☐	☐			
Notes:					

SAMPLE

Additional Comments:

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SAMPLE

Engine Generators
Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Signoff

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

SAMPLE

Equipment Information

Make		**Model Number**			
Serial Number		**NEMA Enclosure**		**KVA**	
Volts/Phase		**AMPS**		**KW**	
Service Area					
Notes:					

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
As-Built drawings complete.	☐	☐			
Equipment shop drawings available.	☐	☐			
Operation and Maintenance manuals available.	☐	☐			
Installation and startup manual available.	☐	☐			
Equipment warranty information completed and provided in O&M Manual.	☐	☐			
Verify receipt and acceptance of manufacturer's factory test reports.	☐	☐			
Doors to generator room installed.	☐	☐			
Locks or temporary security measures installed & operational. Room can be secured.	☐	☐			
Generator room clear of storage, temporary equipment, etc.	☐	☐			
Permanent lighting or 30 foot candle temporary lighting in service.	☐	☐			
Egress routes from generator room are unobstructed.	☐	☐			
Generator room & equipment clean of construction debris and dust, and are dry.	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Working clearances meet NEC and contract documents.	☐	☐			
Equipment has been installed on a level housekeeping pad.	☐	☐			
Equipment anchored per manufacturer's instruction.	☐	☐			
Warning signs installed per shop drawings and contract documents.	☐	☐			
All shipped-loose components installed.	☐	☐			
Electrical room grounding system complete.	☐	☐			
Ground bus (ses) have been installed and terminated to ground grid system.	☐	☐			
Generator neutral bus is not solidly grounded by factory-installed bonding jumper as specified for a four-pole system.	☐	☐			
Generator frame and enclosure bonded to ground.	☐	☐			
All wiring installed properly with correct bend radius and no insulation damage.	☐	☐			
All power conductors have been braced/tied per manufacturer's installation instructions.	☐	☐			
All piping, electrical, and control connections between skid-mounted devices and non-skid-mounted devices made with flexible connections (pipe, conduit, etc.).	☐	☐			
All bolted electrical connections have been tightened to their proper torque values.	☐	☐			
Manufacturer's field service personnel have completed preliminary checkout and startup.	☐	☐			
Engine lube oil system is fully operational and free of leaks.	☐	☐			
Engine coolant system is fully operational and free of leaks.	☐	☐			
Engine fuel supply system is fully operational and free of leaks.	☐	☐			
Fuel supply system tank is full and ready for operation.	☐	☐			
Engine exhaust is fully operational and free of leaks.	☐	☐			
Engine exhaust has rain cap installed at exterior outlet.	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Engine exhaust has condensate drain installed at silencer.	☐	☐			
Engine exhaust has expansion fitting installed in exhaust piping to account for expansion.	☐	☐			
Engine exhaust system, silencer and pipe, are fully insulated.	☐	☐			
Intake air and discharge air dampers functional.	☐	☐			
Batteries are fully charged and in service.	☐	☐			
Battery charger electrically connected to power source and control wiring connections to generator control panel completed.	☐	☐			
Generator remote annunciation panel is remotely installed, electrically connected and fully operational.	☐	☐			
Generator remote E-stop is remotely installed, electrically connected and fully operational.	☐	☐			
Generator control wiring to switchgear installed, electrically connected, and operational with control wiring installed in separate conduit per manufacturer's recommendations.	☐	☐			
Generator control wiring to building management control panel is installed, electrically connected and fully operational.	☐	☐			
All contacts, devices, etc. for interface with SCADA-system are installed, functional and wired to terminal strips for connection of field wiring.	☐	☐			
Remote annunciator panel is installed, electrically connected and operational.	☐	☐			
All circuit breaker protecting devices have been set and recorded per the protective device coordination study.	☐	☐			
Metering current transformer ratio and accuracy class matches drawings/specs.	☐	☐			
Metering potential transformer ratio and accuracy class matches drawings/specs.	☐	☐			
Metering wiring phase and polarity matches meter instruction manual wiring diagrams.	☐	☐			
Utility power is available and connected for system operation.	☐	☐			

SAMPLE

General Installation					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
All sensors have been installed and calibrated according to manufacturing and design specification.	☐	☐			
All status and alarm indicators are installed and functioning properly.	☐	☐			
All field and interconnecting wiring is completed and labeled at each end with visible and readable tags. (Printed markings on the conductors are NOT acceptable.).	☐	☐			
Field landed control wiring terminations are made using ring connectors NOT fork connectors.	☐	☐			
All manufacturing factory and field start-up tests attached to this SRC.	☐	☐			
Testing agency has been scheduled to perform the test and the commissioning agent has been notified of the testing date.	☐	☐			
Test equipment requirements have been reviewed with the testing agency.	☐	☐			
Power available for test equipment.	☐	☐			
Installation is complete and ready for verification testing.	☐	☐			
Training plan approved.	☐	☐			
Training sessions of owner training completed / acceptance granted / training materials submitted to Commissioning Agent.	☐	☐			
All specified tools, equipment & spare parts are on site.	☐	☐			
Notes:					

SAMPLE

Additional Comments:

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SAMPLE

Automatic Transfer Switches
Pre-Functional Checklist

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

Statement of Readiness

The above equipment and/or systems integral to them are complete and ready for functional testing, except as noted. None of the outstanding items preclude safe and reliable functional tests being performed. This checklist does not take the place of the manufacturer's recommended checkout and startup procedures or report.

Responsible Contractor Sign Here

CONTRACTOR	PRINTED NAME	SIGNATURE	DATE
General Contractor (GC)			
Mechanical Contractor (MC)			
Electrical Contractor (EC)			
TAB Contractor (TAB)			
Controls Contractor (CC)			

This statement of readiness has been received by the Commissioning Agent on _____ and will be incorporated as part of the final commissioning report.

SAMPLE

EQUIPMENT DATA

Static Switch Nameplate	
Parameter	**Data**
Equipment ID	
Manufacturer	
Model	
Catalog Number	
Date Manufactured	

Static Switch Source #1 Isolation Circuit Breaker (CB1) Nameplate	
Parameter	**Data**
Manufacturer/Model	
Frame Amps	
Volts	
GFI Module	
SC Rating	
Current Rating	

Static Switch Source #2 Isolation Circuit Breaker (CB2) Nameplate	
Parameter	**Data**
Manufacturer/Model	
Frame Amps	
Volts	
GFI Module	

SAMPLE

Static Switch Source #2 Isolation Circuit Breaker (CB2) Nameplate	
Parameter	**Data**
SC Rating	
Current Rating	

Static Switch Output Isolation Circuit Breaker (CB3) Nameplate	
Parameter	**Data**
Manufacturer/Model	
Frame Amps	
Volts	
GFI Module	
SC Rating	
Current Rating	

Static Switch Bypass to Source #1 Circuit Breaker (CB4) Nameplate	
Parameter	**Data**
Manufacturer/Model	
Frame Amps	
Volts	
GFI Module	
SC Rating	
Current Rating	

SAMPLE

Static Switch Bypass to Source #2 Circuit Breaker (CB5) Nameplate	
Parameter	**Data**
Manufacturer/Model	
Frame Amps	
Volts	
GFI Module	
SC Rating	
Current Rating	

System Readiness Checklist

Yes = Checked and Completed, N/A = Not Applicable

Inspection Checklist					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
As-Built Drawings complete, available and on-site.	☐	☐			
Equipment shop drawings available.	☐	☐			
Operation and Maintenance manuals available.	☐	☐			
Installation and startup manual available.	☐	☐			
Equipment warranty information completed and provided in O&M Manual.	☐	☐			
Verify receipt and acceptance of manufacturer's factory test reports.	☐	☐			
Doors to electrical room installed.	☐	☐			
Locks or temporary security measures installed & operational. Room can be secured.	☐	☐			
Electrical room clear of storage, temporary equipment, etc.	☐	☐			
Permanent lighting or 30 foot candle temporary lighting in service.	☐	☐			
Egress routes from electrical room are unobstructed.	☐	☐			

SAMPLE

Inspection Checklist					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Electrical room & equipment clean of construction debris and dust, and are dry.	☐	☐			
Working clearances meet NEC and contract documents.	☐	☐			
Equipment has been installed on a level housekeeping pad or properly attached to the structure or wall.	☐	☐			
Equipment anchored per manufacturer's instruction.	☐	☐			
Warning Signs installed per shop drawings and contract documents.	☐	☐			
All shipped-loose components installed.	☐	☐			
Electrical room grounding system complete.	☐	☐			
Grounding electrode conductor has been attached to the building ground ring.	☐	☐			
Shipping bolts and braces removed.	☐	☐			
ATS doors allow for full swing; latch open and close without binding; and no physical damage.	☐	☐			
All field and interconnecting wiring is completed and labeled at each end with visible and readable tags. (Printed markings on the conductors are NOT acceptable.).	☐	☐			
All bolted connections tightened to their proper torque values.	☐	☐			
All wiring installed properly with correct bend radius and no insulation damage.	☐	☐			
All contacts, devices, etc. for interface with SCADA system are installed, functional and wired to terminal strips for connection of field wiring.	☐	☐			
Verify Normal and Emergency line side phase rotation.	☐	☐			
Verify that NORMAL and EMERGENCY sources are available.	☐	☐			
ATS settings have been adjusted per the Engineer/specifications.	☐	☐			

SAMPLE

Inspection Checklist					
Description	**Yes**	**N/A**	**Initials**	**Date**	**Comments**
Equipment layout and schematic wiring diagrams available and on-site.	☐	☐			
System sequence of operation available and on-site.	☐	☐			
Remote STS summary alarm wiring complete and tested.	☐	☐			
Logic and control connections are routed away from power runs for noise prevention.	☐	☐			
Modbus TCP/IP network interface connection made and operational.	☐	☐			
Machine room space air conditioning working and available for use.	☐	☐			
Factory-supplied critical spare parts inventory delivered and available on-site.	☐	☐			
Factory test and startup documentation provided with copies attached to this SRC.	☐	☐			
Testing agency has been scheduled to perform the test and the commissioning agent has been notified of the testing date.	☐	☐			
Test equipment requirements have been reviewed with the testing agency.	☐	☐			
Power available for test equipment.	☐	☐			
Installation is complete and ready for verification testing.	☐	☐			
Training Plan approved.	☐	☐			
Training sessions of owner training completed / acceptance granted / training materials submitted to Commissioning Agent.	☐	☐			
Notes:					

SAMPLE

Additional Comments:

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SAMPLE

Appendix L – Sample Systems Functional Test Procedures

General

This appendix outlines procedures for developing System Functional Performance Test Procedures. The Commissioning Agent shall develop project-specific test procedures for the systems to be commissioned.

Sample System Functional Performance Test Protocols

Examples of System Functional Performance Test Protocols for some common systems are included with this Appendix.

Domestic Water Heat Exchanger
VAV with Reheat
Fire Tube Steam Boiler
Centrifugal Water Chiller
Modular Indoor Air Handling Unit
DDC for HVAC
Grounding and Bonding for Electrical Systems
Low Voltage Switchgear
Switchboards
Panelboards
Engine Generators
Automatic Transfer Switches

System Functional Performance Testing

Test procedures shall fully describe system configuration and steps required for each test; appropriately documented so that another party can repeat the tests with virtually identical results.

a. Test Methods: Functional performance testing and verification may be achieved by direct manipulation of system inputs (i.e. heating or cooling sensors), manipulation of system inputs with the building automation system (i.e. software override of sensor inputs), trend logs of system inputs and outputs using the building automation system, or short-term monitoring of system inputs and outputs using stand alone data loggers. A combination of

methods may be required to completely test the complete sequence of operations. The Commissioning Agent shall determine which method, or combination, is most appropriate.

b. Setup: Each test procedure shall be performed under conditions that simulate normal operating conditions as closely as possible. Where equipment requires integral safety devices to stop/prevent equipment operation unless minimum safety standards or conditions are met, functional performance test procedures shall demonstrate the actual performance of safety shutoffs in real or closely-simulated conditions of failure.

c. Sampling: Multiple identical pieces of non-life-safety or non-critical equipment may be functionally tested using a sampling strategy. The sampling strategy shall be developed by the Commissioning Agent. If, after three attempts at testing the specified sample percentage, failures are still present, then all remaining units shall be tested at the contractors' expense.

d. Develop functional performance test procedures for equipment and systems: Identify specific test procedures and forms to verify and document proper operation of each piece of equipment and system. Coordinate test procedures with the contractor for feasibility, safety, equipment and warranty protection. Functional performance test forms shall include the following information:

1. System and equipment or component name(s).
2. Equipment location and ID number.
3. Date.
4. Project name.
5. Participating parties.
6. Instructions for setting up the test, including special cautions, alarm limits, etc.
7. Specific step-by-step procedures to execute the test.
   - Verify system installation conforms to the construction documents
   - Verify system starts and shuts down in response to both manual and automatic Start and Stop commands.
   - Verify system safety shut down protection operates properly in accordance with manufacturer's requirements.
   - Verify the system performs properly under various operating modes as required in the Sequences of Operation. For example verify an Air Handling Unit operates in the Occupied, Unoccupied, and Morning Warm-Up modes.

- Verify the system performs properly under various conditions. For example, verify a heating hot water system maintains the hot water temperature at setpoint under normal, high and low load conditions.
- Verify the system performs properly in response to changes in operating parameters. For example, verify an Air Handling Unit responds in a stable manner when an operating parameter such as the Discharge Air Temperature Setpoint is changed.
- Verify the system performs properly under abnormal conditions. For example, verify a Chilled Water System recognizes when a pump fails and that the standby pump automatically starts, the chilled water system continues proper operation, and that the appropriate alarms or notifications are activated.
- Verity the system-under-test interacts properly with other systems. For example, when testing an Air Handling Unit, verify the unit is properly shut down by the Fire Alarm System
- Indicate Acceptance criteria of proper performance with a Yes / No check box, or a data box with space for observed data and expected range.
- Provide a section for comments, issues and observations.

e. System Trending: Prior to testing, perform system trending, using data acquisition equipment or the building automation system to record system operation over a two to three day period.

1. Investigate the dynamic interactions between components in the building system.
2. Evaluate the scheduling, the interaction between heating and cooling, and the effectiveness of the HVAC system in meeting the comfort requirements.
3. See below for further information on trending and alarming.

f. Conduct Testing: Coordinate, observe and record the results of system functional performance testing.

1. Verify the intended operation of individual components and system interactions under various conditions and modes of operation.
2. Where acceptance criteria are not met, identify the need for retesting.
3. Coordinate retesting as necessary until satisfactory performance is verified.

System Trending and Alarming

Trending is a method of testing as a stand-alone method or to augment manual testing. The DDC system should be used to trend any and all points of the system or systems at intervals specified below.

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.

Critical alarms are intended to be alarms that require the immediate attention of, and action from 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.

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.

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.

The DDC System should 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.

The DDC System should provide graphical. Trending requirements are indicated below and included with the Functional Performance Test Procedures. Trending shall occur before, during and after functional testing. The DDC System should produce graphical representations of the trended DDC points that show each system operating properly during steady state conditions as well as during the functional tests. These graphical reports should be submitted to the Resident Engineer and Commissioning Agent for review and analysis before, during dynamic operation, and after functional testing. The following trend requirements and trend submissions should be provided:

Pre-testing, Testing, Post-testing – Trend reports of trend logs and graphical trend plots are required as defined by the CxA. The trend log points, sampling rate, graphical plot configuration, and duration will be dictated by the CxA. At any time during the Commissioning Process the Commissioning Agent may recommend changes to aspects of trending as deemed necessary for proper system analysis. The Contractor shall implement any changes as directed by the Resident Engineer. Any pre-test trend analysis comments generated by the Commissioning Team will be addressed and resolved by the Contractor prior to the execution of Functional Performance Testing.

Dynamic plotting – The Contractor shall also provide dynamic plotting during functional testing at frequent intervals for points determined by the Functional Test Procedure. The graphical plots will be formatted and plotted at durations determined by the Functional Test Procedure.

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 Functional 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.

Point Trending and Alarming - The following tables indicate the points to be trended and alarmed by system. The Operational Trend column indicates the trend duration for normal operations. The Testing Trend Duration column indicates the trend duration prior to functional systems 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 without recording an excessive number of alarms.

The tables below include typical points for systems as typically found in VA facilities. The systems, point list, and other data included in the table should be carefully reviewed and modified for specific projects.

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		

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 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		
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

Dual-Path Air Handling Unit Trending and Alarms							
Point	**Type**	**Trend Interval**	**Operational Trend Duration**	**Testing Trend Duration**	**Alarm Type**	**Alarm Range**	**Alarm Delay**
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	Closed	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
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		

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 S/S	DO	COV	24 hours	3 days	N/A		
AHU Energy	Calc	1 Hour	30 day	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		
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 °F	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 Hurs	3 days	N/A		
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		

Hydronic Hot Water Trending and Alarms							
Point	**Type**	**Trend Interval**	**Operational Trend Duration**	**Testing Trend Duration**	**Alarm Type**	**Alarm Range**	**Alarm Delay**
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		
Primary Loop Supply Temperature	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**
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
Chiller 2 Evaporator Iso-Valve	DI	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 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 ^{o}F	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 ^{o}F	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 By-Pass Valve	AO	15 Minutes	12 Hours	3 days	N/A		
Chiller 2 Condenser By-Pass Valve	AO	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 By-Pass Valve	AO	15 Minutes	12 Hours	3 days	N/A		
Cooling Tower 1 Fan Speed	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**
Cooling Tower 2 By-Pass 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
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

Steam Boiler System Trending and Alarms							
Point	**Type**	**Trend Interval**	**Operational Trend Duration**	**Testing Trend Duration**	**Alarm Type**	**Alarm Range**	**Alarm Delay**
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
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		

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 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		
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 ^{o}F 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		

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

Circulating Domestic Water Heater-Hx
Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:
Operational Assumptions: Domestic water make up valve is open. System hot water circulation pump is on. The control valve is modulating to maintain set point temperature. Domestic water heating unit is assumed to begin the test in the Idle Mode, with no load conditions and the water temperature at set point. Associated Building Automated System (BAS) has been tested and is operating correctly.

SAMPLE

Testing Dates and Summary Results

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

SAMPLE

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

Supplies Required for Testing (To be provided by the contractor)

Tools / Supplies	
Laptop with TC Program	Infrared Thermometer Gun
PID Loop Tuning Software	Humidity Tester
Aerosol for Smoke and Freeze stat Test	Basic Tool Pouch
Radio Communications	Flashlight

System Readiness Summary Checklist

Description	Yes	No	Date
System Ready for Test	☐	☐	
Required Personnel Available	☐	☐	
Required Tools/Test Equipment/Supplies Available	☐	☐	
Required Safety Equipment Available	☐	☐	

SAMPLE

Set-Points, Limits, and Schedules

☐ AHU can be assigned a schedule. ☐ Schedule can be programmed daily.

☐ If system runs 24 hours a day, check here. If not, fill in the occupied mode schedule below.

	AM												PM											
Day	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Sun																								
Mon																								
Tues																								
Wed																								
Thurs																								
Fri																								
Sat																								
Holi																								

Parameter	**Setpoint**		**Adjustable Range**	
	Design	**Actual**	**Design**	**Actual**
Outside Air Temperature (°F)				
Preheat valve full open outside air temperature (°F)				
Discharge Air Temperature (°F)				
Night Setback Temperature (°F)				
Night Setback Differential				
Mixed Air Temperature (°F)				
Minimum Start-up Fan Speed (%)				
Time at Minimum Fan Speed for Start-up (min)				
Average Zone Humidity (%RH)				
Maximum supply air humidity (%RH)				
Discharge Air Static Pressure (in H2O)				
High Static Alarm (in H2O)				
Low Static Alarm (in H2O)				
System Shutdown High Static Limit (in H2O)				
Damper Position				

SAMPLE

Initial Ambient Conditions

Ambient Conditions			
Outside Air Temp		Outside Air RH %	
Observations			

Trend Data Required To Support Testing

Check if trend point chart(s) and Frequency Graph(s) are provided per trend requirements shown below.

Trend Log Setup #1 - Temperature					
Pre-Testing	**Post Testing**	**Point**	**Frequency**	**Duration**	**Provided**
☐	☐	System Flow Rate			☐ Yes ☐ No
☐	☐	Flow Rate Set Point			☐ Yes ☐ No
☐	☐	Water Quality			☐ Yes ☐ No
☐	☐	Damper Position			☐ Yes ☐ No
☐	☐	System Pressure			☐ Yes ☐ No
☐	☐	Pressure Set Point			☐ Yes ☐ No
Record Issues				**Issue Log Item Number**:	

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**
C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL MECHANICAL INSPECTION						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
1. Record the start time	Recorded.	☐	☐	Time:_____(am/pm)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
2. Observe initial operating conditions	The fan is on and the discharge damper is open.	☐	☐		☐	☐
	The HOA switch is in the auto position.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
HEATING OPERATION						
3. Record initial position of each immersion thermostat and hot water temperature at sink.	Record temperature dial positions & temperature.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Adjust thermostat to be just shy of the high setting.	Record temperature leaving at adjacent sink.	☐	☐		☐	☐
	Change in temperature is accurate based on direction of change in thermostat.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
5. Adjust thermostat to be just shy of the low setting.	Record temperature leaving at adjacent sink.	☐	☐		☐	☐
	Change in temperature is accurate based on direction of change in thermostat.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
6. Override the discharge water temperature set point to 10ºF higher than the current discharge temperature.	The control valve is to modulate open to maintain set point temp.	☐	☐	Water temp. at start of test: _____ºF New water temp. set point: _____ºF	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
7. Return thermostat to its original settings.	System returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
IDLING CONTROL						
8. Override the unit discharge temperature set point to 10ºF lower than the current discharge water temperature.	The control valve modulates closed to maintain the unit discharge temperature.	☐	☐	Discharge water temp at start of action: _____ºF New DWT set point: _____ºF	☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
Record issues				Issue Log Item:		
				Initial	Date	
9. Override the discharge water temperature set point to a value equal to the design water temperature. Measure entering and leaving water temperatures.	Control valve modulates opens to maintain the set point temperature.	☐	☐	Entering water temperature: _____ºF Leaving water temperature: _____ºF Percent schedule capacity: _____%	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
10. Release the discharge water temperature set point overrides.	Control valve modulates to maintain their respective discharge water temperature set points.	☐	☐	Note: Wait until discharge water temperatures are satisfied, before proceeding.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
HEATER STATUS ALARM AT BAS						
11. Close the supply valve.	Alarm is received at BAS.	☐	☐		☐	☐
	Control valve closes.	☐	☐		☐	☐
	Return pump stops.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
Record issues				Issue Log Item:		
				Initial	Date	
12. Open the Supply Valve	Alarm is cleared at BAS.	☐	☐		☐	☐
	All components resume normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
13. Close the makeup water valve.	Alarm is received at central control station.	☐	☐		☐	☐
	Control valve closes.	☐	☐		☐	☐
	Return pump stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
14. Open the makeup water valve	Alarm is cleared.	☐	☐		☐	☐
	All components resume normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on next page)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
HEATER STATUS ALARM AT BAS						
15. Open the hot water faucets to service sinks and toilet room sinks.	Control valve modulates to maintain set point temp.	☐	☐	Water temp. at start of test: _____ºF Time portion of test is started: _____	☐	☐
	Return pump is on.	☐	☐		☐	☐
	Make-up valve is open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
16. Verify flow at test sinks.	Estimate total flow.	☐	☐	Estimated flow (GPM.) _____	☐	☐
	Measure leaving water temp. at remote test sink.	☐	☐	Water temp. : _____ºF	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
17. Run hot water until discharge water temp. starts to drop.	Alarm is received at BAS.	☐	☐	Leaving Water temp.: _____ºF Time duration from when test was started: _____	☐	☐
	Control valve closes.	☐	☐		☐	☐
	Return pump stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on next page)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
18. Close hot water valves at test sinks and return to normal operating condition.	Alarm is cleared.	☐	☐		☐	☐
	All components resume normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
HIGH PRESSURE CUTOFF						
19. Override pressure sensor to 10% higher than high pressure alarm set point.	High status alarm is received at the BAS control station.	☐	☐		☐	☐
	The return pump stops.	☐	☐		☐	☐
	The control valve is closed.	☐	☐		☐	☐
	Domestic makeup water goes to 100%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
20. Re-set the discharge high pressure cutout back to original set point.	Alarm is cleared.	☐	☐	Note: Need to verify which type of control set point will be adjustable from control panel.	☐	☐
	The system resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on next page)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
RETURN TO INITIAL CONDITIONS						
21. Reset all set-points and overrides to the initial values.	The system resumes initial operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
22. Record End Time	Recorded.	☐	☐	Time: _____ (am/pm)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

SAMPLE

Test Notes and Lessons Learned

SAMPLE

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VAV with Reheat
Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:
Operational Assumptions: All fans are operating. Outside temperature is above 50°F. The system is in occupied mode operation. All of the terminal unit zones used for Unoccupied Mode heating/cooling control is maintaining their occupied space temperature set points within 5°F. Associated Building Automated System (BAS) has been tested and is operating correctly. Trend logging has been initiated.

SAMPLE

Initial Test		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 1		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 2		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Deferred/Seasonal Test		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

SAMPLE

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

Supplies Required for Testing (To be provided by the contractor)

Tools / Supplies	
Laptop with TC Program	Infrared Thermometer Gun
PID Loop Tuning Software	Humidity Tester
Aerosol for Smoke and Freeze stat Test	Basic Tool Pouch
Radio Communications	Flashlight

System Readiness Summary Checklist

Description	Yes	No	Date
System Ready for Test	☐	☐	
Required Personnel Available	☐	☐	
Required Tools/Test Equipment/Supplies Available	☐	☐	
Required Safety Equipment Available	☐	☐	

SAMPLE

Set-Points, Limits, and Schedules

☐ AHU can be assigned a schedule. ☐ Schedule can be programmed daily.

☐ If system runs 24 hours a day, check here. If not, fill in the occupied mode schedule below.

	AM												PM											
Day	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Sun																								
Mon																								
Tues																								
Wed																								
Thurs																								
Fri																								
Sat																								
Holi																								

Parameter	Setpoint		Adjustable Range	
	Design	**Actual**	**Design**	**Actual**
Outside Air Temperature (°F)				
Preheat valve full open outside air temperature (°F)				
Discharge Air Temperature (°F)				
Night Setback Temperature (°F)				
Night Setback Differential				
Mixed Air Temperature (°F)				
Minimum Start-up Fan Speed (%)				
Time at Minimum Fan Speed for Start-up (min)				
Average Zone Humidity (%RH)				
Maximum supply air humidity (%RH)				
Discharge Air Static Pressure (in H_2O)				
High Static Alarm (in H_2O)				
Low Static Alarm (in H_2O)				
System Shutdown High Static Limit (in H_2O)				
Damper Position				

SAMPLE

Initial Ambient Conditions

Ambient Conditions			
Outside Air Temp		Outside Air RH %	
Observations			

Trend Data Required To Support Testing

Check if trend point chart(s) and Frequency Graph(s) are provided per trend requirements shown below.

Trend Log Setup #1 - Temperature					
Pre-Testing	**Post Testing**	**Point**	**Frequency**	**Duration**	**Provided**
☐	☐	System Flow Rate			☐ Yes ☐ No
☐	☐	Flow Rate Set Point			☐ Yes ☐ No
☐	☐	Water Quality			☐ Yes ☐ No
☐	☐	Damper Position			☐ Yes ☐ No
☐	☐	System Pressure			☐ Yes ☐ No
☐	☐	Pressure Set Point			☐ Yes ☐ No
Record Issues				Issue Log Item Number:	

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**

C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Ensure all trend information is setup by the controls contractor	Trend OK.	☐	☐	Test Start Time: _____(am/pm)	☐	☐
	Space temperature.	☐	☐		☐	☐
Record setup values for each VAV box indicate TAB CFME's	Space temp set point.	☐	☐		☐	☐
	CFM Max Heating.	☐	☐		☐	☐
	CFM Min Heating.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
2. Check the operating conditions at the BAS front end and confirm the system is operating automatically under specified sequence.	Occupancy setting corresponds to the occupancy table above.	☐	☐		☐	☐
	There are no operator overrides currently on.	☐	☐		☐	☐
	No alarm conditions exist.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on next page_						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
Verification of Temperature Airflow Control – Occupied						
3. Adjust thermostat set point to equal current space temperature	Damper goes to minimum position.	☐	☐		☐	☐
	Heating valve closed.	☐	☐		☐	☐
	Record CFM.	☐	☐		☐	☐
	CFM is at minimum per TAB set point.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Adjust the local thermostat set point to be 5°F higher than the current space temperature Wait 3 minutes to record final values	The unit damper remains @ its minimum position (or heating max, if Dual VAV box).	☐	☐		☐	☐
	The heating coil control valve modulates open to maintain space temperature set point.	☐	☐		☐	☐
	Initial discharge temp.	☐	☐		☐	☐
	Final discharge temp.	☐	☐		☐	☐
	Heating max CFM.	☐	☐		☐	☐
	CFM is at maximum per TAB set point.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
5. Adjust the local thermostat set point to be 5°F lower than the current space temperature Wait 3 minutes to record final value	Unit damper opens fully to max cooling set point (or cooling max if Dual VAV box).	☐	☐		☐	☐
	The heating coil control valve is closed.	☐	☐		☐	☐
	Initial CFM.	☐	☐		☐	☐
	Final CFM.	☐	☐		☐	☐
	CFM is at maximum per TAB set point.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
6. Reset the space temperature set point to original value	The unit damper should be in its minimum / normal position.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
Verification of Unoccupied Mode						
7. Put the unit into unoccupied mode	Damper position closed.	☐	☐		☐	☐
	Reheat valve closed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
Verification of Warm Up and Cool Down Mode						
8. Put the unit into warm-up mode	Damper position 100% open.	☐	☐		☐	☐
	Temperature set point 71°F.	☐	☐		☐	☐
	Reheat valve modulating for heating.	☐	☐		☐	☐
	Record CFM.	☐	☐		☐	☐
	CFM is at maximum per TAB set point.	☐	☐		☐	☐
	Initial discharge temp.	☐	☐		☐	☐
	Final discharge temp.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on next page)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
9. Put the unit into cool down mode	Reheat valve closed.	☐	☐	*Per controls, 30% is equated with minimum, 100% with maximum	☐	☐
	Temperature set point 71°F	☐	☐		☐	☐
	CFM between 30%.	☐	☐		☐	☐
	And 100%.	☐	☐		☐	☐
	Record CFM.	☐	☐		☐	☐
	Initial discharge temp.	☐	☐		☐	☐
	Final discharge temp.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
10. Reset the unit into its original settings	Unit returns to its original conditions.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
Verification of Occupied Mode						
11. Put the unit into occupied heating mode	Damper position modulating to maintain temperature.	☐	☐		☐	☐
	Temperature set point 71°F.	☐	☐		☐	☐
	CFM minimum 30%.	☐	☐		☐	☐
	CFM maximum 100%.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Reheat valve modulating for heating when box has reached minimum CFM position.	☐	☐		☐	☐
	Reheat valve 100% open box modulating from minimum position to 100% open.	☐	☐		☐	☐
	Record CFM Max.	☐	☐		☐	☐
	Record CFM set pt.	☐	☐		☐	☐
	Record night set pt.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
12. Reset the unit into its original default settings.	System returns to its original default settings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
Bypass Mode						
13. Put AHU/RTU-__ into VFD bypass mode	VAV damper is fully open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
14. Return AHU/RTU-___ to normal operation	System operates normally.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
Return to Initial Conditions						
15. Reset the space temperature set-point to the original value	System returns to initial conditions.	☐	☐		☐	☐
	Record CFM set pt.	☐	☐		☐	☐
	Record temperature set pt.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
16. Record test stop time	Recorded.	☐	☐	Time:_____(am / pm)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

Test Notes and Lessons Learned

SAMPLE

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Fire Tube Boiler (Low Pressure Steam) System Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:

Two boilers in penthouse of addition share equipment room with chiller plant addition.

The system includes, boilers #7, 8 that expand the capacity of the campus but are not interconnected, Two duplex condensate pumps in boiler room and Mezzanine CRP 3, 4; feed water heat exchanger HX-7; storage tank and feed water pumps BFP 1, 2, 3; and chemical treatment. Low pressure steam is used for humidifiers that are tested with the related air handling equipment, and two heating hot water heat exchangers.

The Boilers include various safety sensors, valves, fire controls, and fuel oil pumps considered integral to the boiler operation and tested as part of the boiler.

Make up air handling unit 10 provides combustion air and runs when boilers are ON. AHU-10 is tested in a separate FPT. The Fuel Oil Pumps with associated leak detection are tested in a separate FPT. Heat Exchangers HX5, 6 building heating water; and humidifiers are tested on separate FPT's.

Operational Assumptions:

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

SAMPLE

Re-Test 1		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 2		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Deferred/Seasonal Test		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

SAMPLE

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

Supplies Required for Testing (To be provided by the contractor)

Tools / Supplies	
Laptop with TC Program	Infrared Thermometer Gun
PID Loop Tuning Software	Basic Tool Pouch
Radio Communications	Flashlight

SAMPLE

System Readiness Summary Checklist

Description	Yes	No	Date
System readiness checklist completed, approved	☐	☐	
All control system functions for this and all interlocking systems are programmed and operable per contract documents, including final set-points and schedules with debugging, loop tuning and sensor calibrations completed	☐	☐	
Punch list items corrected	☐	☐	
Spot-check system readiness checklist	☐	☐	
Installation Per Design Documentation & Latest Approved Change Orders	☐	☐	
O&M Manuals Delivered and Available on Site	☐	☐	
Field-Marked Copy of As-Built System Schematics Available	☐	☐	
Specified Contractor's Test Reports (CTR) Completed	☐	☐	
Specified Contractor Training of Owner's Employees Completed	☐	☐	
Components/Subsystems Clear and Correctly Identified	☐	☐	
Pumps and piping are properly installed.	☐	☐	

SAMPLE

Set-Points, Limits, and Schedules

☐ AHU can be assigned a schedule. ☐ Schedule can be programmed daily.

☐ If system runs 24 hours a day, check here. If not, fill in the occupied mode schedule below.

	AM												PM											
Day	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Sun																								
Mon																								
Tues																								
Wed																								
Thurs																								
Fri																								
Sat																								
Holi																								

Parameter	Setpoint		Adjustable Range	
	Design	Actual	Design	Actual
Boiler Room Space Temp				
Feed Water Temp				
Boiler Steam Pressure St Pt				
Boiler flame purge Delay				
Boiler Pressure Build-up Delay				
Boiler Low Fire De-energize Delay				
Max fire to call for Lag boiler				
Controller High Pressure Limit				
Boiler Lead Lag Schedule				
Exhaust Fan ON Space Temp Exceeds				
Condensate Pump Flow Rate/Pressure				
Feed Water Conductivity St Pt; Hi Limit				
Feed Water Conductivity St Pt; Hi Limit				
Minimum fire rate low load				

SAMPLE

Initial Ambient Conditions

Ambient Conditions			
Outside Air Temp		Outside Air RH %	
Observations			

Trend Data Required To Support Testing

Check if trend point chart(s) and Frequency Graph(s) are provided per trend requirements shown below.

Trend Log Setup #1 - Temperature					
Pre-Testing	**Post Testing**	**Point**	**Frequency**	**Duration**	**Provided**
☐	☐	Boiler #1 On/Off STATUS			☐ Yes ☐ No
☐	☐	Boiler #2 On/Off STATUS			☐ Yes ☐ No
☐	☐	Boiler #1 ALARM STATUS			☐ Yes ☐ No
☐	☐	Boiler #2 ALARM STATUS			☐ Yes ☐ No
☐	☐	Boiler #1 Gas / Oil Fuel Selection STATUS			☐ Yes ☐ No
☐	☐	Boiler #2 Gas / Oil Fuel Selection STATUS			☐ Yes ☐ No
☐	☐	Boiler #1 Supply Pressure or Temp.			☐ Yes ☐ No
Record Issues				Issue Log Item Number:	

SAMPLE

Trend Log Setup #2 - Temperature					
Pre-Testing	**Post Testing**	**Point**	**Frequency**	**Duration**	**Provided**
☐	☐	Make-Up Water Supply Temperature			☐ Yes ☐ No
☐	☐	Boiler #2 Supply Pressure or Temp.			☐ Yes ☐ No
☐	☐	Common Header Pressure / Temperature			☐ Yes ☐ No
☐	☐	Outside Air Temp.			☐ Yes ☐ No
Record Issues				Issue Log Item Number:	

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**

C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PREPARE FOR VERIFICATION TESTING						
1. Confirm equipment is operating as expected. If not make adjustments with the BAS, Building Automation System.	System is ON and will always have call for heating (includes recovery from loss of power).	☐	☐	Steam Pressure Common Header _____psi	☐	☐
	System has stable operation.	☐	☐	Boiler 7 ____	☐	☐
	Record common header P.	☐	☐	Boiler 8 _____	☐	☐
	AHU-10 has been commissioned and is operating.	☐	☐	AHU-10 is tested in another test procedure.	☐	☐

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	AHU-10 is expected to run continuously during normal operation.	☐	☐	Boilers don't run if AHU10 OFF Boiler Feedwater Pumps Only run when level is Low and Boiler is ON. They do not run continuously when boiler is ON.	☐	☐
	Only one Boiler is required for existing load.	☐	☐		☐	☐
	At least one pump of the secondary hot water selection PHWP-4, 5, and 6 is ON.	☐	☐		☐	☐
	The fuel oil pumps, FOP are OFF.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
2. Confirm that there is always a call for the boilers to run	System is ON and will always have call for heating (includes recovery from loss of power).	☐	☐	Steam Pressure Common Header _____psi Boiler 7 ____ Boiler 8 _____ AHU-10 is tested in another test procedure. Boilers don't run if AHU10 OFF Boiler Feedwater Pumps Only run when level is Low and Boiler is ON. They do not run continuously when boiler is ON.	☐	☐
	System has stable operation.	☐	☐		☐	☐
	Record common header P.	☐	☐		☐	☐
	AHU-10 has been commissioned and is operating.	☐	☐		☐	☐
	AHU-10 is expected to run continuously during normal operation.	☐	☐		☐	☐
	Only one Boiler is required for existing load.	☐	☐		☐	☐
	At least one pump of the secondary hot water selection PHWP-4, 5, and 6 is ON.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	The fuel oil pumps, FOP are OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
3. If there is actually a very high or low load then adjust RTU outside air or fan VSD CFM so get required loads.	System is ON and will always have call for heating (includes recovery from loss of power).	☐	☐	Steam Pressure Common Header _____psi Boiler 7 ____ Boiler 8 _____ AHU-10 is tested in another test procedure. Boilers don't run if AHU10 OFF Boiler Feedwater Pumps Only run when level is Low and Boiler is ON. They do not run continuously when boiler is ON.	☐	☐
	System has stable operation.	☐	☐		☐	☐
	Record common header P.	☐	☐		☐	☐
	AHU-10 has been commissioned and is operating.	☐	☐		☐	☐
	AHU-10 is expected to run continuously during normal operation.	☐	☐		☐	☐
	Only one Boiler is required for existing load.	☐	☐		☐	☐
	At least one pump of the secondary hot water selection PHWP-4, 5, and 6 is ON.	☐	☐		☐	☐
	The fuel oil pumps, FOP are OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
4. Set fuel selector switch to GAS	System is ON and will always have call for heating (includes recovery from loss of power).	☐	☐	Steam Pressure Common Header _____psi	☐	☐
	System has stable operation.	☐	☐	Boiler 7 ____	☐	☐
	Record common header P.	☐	☐	Boiler 8 _____	☐	☐
	AHU-10 has been commissioned and is operating.	☐	☐	AHU-10 is tested in another test procedure. Boilers don't run if AHU10 OFF	☐	☐
	AHU-10 is expected to run continuously during normal operation.	☐	☐	Boiler Feedwater Pumps Only run when level is Low and Boiler is ON.	☐	☐
	Only one Boiler is required for existing load.	☐	☐	They do not run continuously when boiler is ON.	☐	☐
	At least one pump of the secondary hot water selection PHWP-4, 5, and 6 is ON.	☐	☐		☐	☐
	The fuel oil pumps, FOP are OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
5. Confirm equipment is operating as assumed above. If not make adjustments within the Building Automation System (BAS)	Confirmed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
VERIFICATION OF BOILER LEAD/LAG OPERATION						
6. If Lead Lag have a schedule then set it to switch 1 minute from current time	Lead LAG selection changes.	☐	☐	The boilers have microprocessor controls, but only a manual switch is indicated for lead lag selection. Determine if lead/lag is based only on the manual selection switch or if there is a weekly schedule or runtime hours that could be used? Lead Boiler: B-____ Lag Boiler: B-____	☐	☐
	There may be a Message sent to the Operator workstation, OWS to request manual alternating of Boiler LEAD per preset run-time.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on following page)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
7. If Lead is made by switch on local panel use it to rotate Lead	Lead LAG selection changes.	☐	☐	The boilers have microprocessor controls, but only a manual switch is indicated for lead lag selection. Determine if lead/lag is based only on the manual selection switch or if there is a weekly schedule or runtime hours that could be used? Lead Boiler: B-____ Lag Boiler: B-____	☐	☐
	There may be a Message sent to the Operator workstation, OWS to request manual alternating of Boiler LEAD per preset run-time.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
8. Note the runtime hours of the lead and lag boiler feed water pumps (BFP)	BFP 1 will run with Boiler 7 and Pump 2 with boiler 8.	☐	☐	Lead Boiler # _7/ BFP-1 Run time: _____ Lag Boiler # __8/ BFP-2 Run Time: _____ Load: _____MBH	☐	☐
	Observe in software that the designation of lead and lag, accumulated runtime assignment and association of pumps are accessible, and modifiable from OWS. This was not clear in specs so an acceptable observation will be NA.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Skip any portion of this step not included in the application.	☐	☐	The Lead Lag schedule will change during the duration of the following test steps. But the actual firing order of Lead and Lag is expected to remain the same until Both Boilers are OFF.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. Set the lead Boiler to have 0.5 hours more time than the lag boiler. (or set the Lead Lag scheduler to .5 hours in the future)	BFP 1 will run with Boiler 7 and Pump 2 with boiler 8.	☐	☐	Lead Boiler # _7/ BFP-1 Run time: _____ Lag Boiler # __8/ BFP-2 Run Time: _____ Load: _____MBH The Lead Lag schedule will change during the duration of the following test steps. But the actual firing order of Lead and Lag is expected to remain the same until Both Boilers are OFF.	☐	☐
	Observe in software that the designation of lead and lag, accumulated runtime assignment and association of pumps are accessible, and modifiable from OWS. This was not clear in specs so an acceptable observation will be NA.	☐	☐		☐	☐
	Skip any portion of this step not included in the application.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
10. Reduce the settling time and start and stop delay to two minutes.	BFP 1 will run with Boiler 7 and Pump 2 with boiler 8.	☐	☐	Lead Boiler # _7/ BFP-1 Run time: _____ Lag Boiler # __8/ BFP-2 Run Time: _____ Load: _____MBH The Lead Lag schedule will change during the duration of the following test steps. But the actual firing order of Lead and Lag is expected to remain the same until Both Boilers are OFF.	☐	☐
	Observe in software that the designation of lead and lag, accumulated runtime assignment and association of pumps are accessible, and modifiable from OWS. This was not clear in specs so an acceptable observation will be NA.	☐	☐		☐	☐
	Skip any portion of this step not included in the application.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
11. Prepare testing to combine both real loads and flows to provide operational requirements	RTU's are on and heating valves are open so heat has someplace to go.	☐	☐	Need to confirm there are no other demands from the other WEAVER LAKE Boilers 1-6 that may call for second boiler to start. This test should only involve B7, 8 lead lag Record temperatures: OAT: ____, Boiler Feed water T ____ Common Supply Steam T__,	☐	☐
	Outside air dampers are modulated as needed to create loads approximately as required for the various tests steps.	☐	☐		☐	☐
	Adjust flow to attain loads required for each step.	☐	☐		☐	☐
	During testing space thermal conditions may not be maintained and AHU/RTU control may need to be modified to allow heating and cooling.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
12. All existing system boilers B-1 to 6 are ON or "available" but staging is at the B-7, 8 level	RTU's are on and heating valves are open so heat has someplace to go.	☐	☐	Need to confirm there are no other demands from the other WEAVER LAKE Boilers 1-6 that may call for second boiler to start. This test should only involve B7, 8 lead lag Record temperatures: OAT: ____,	☐	☐
	Outside air dampers are modulated as needed to create loads approximately as required for the various tests steps.	☐	☐		☐	☐
	Adjust flow to attain loads required for each step.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	During testing space thermal conditions may not be maintained and AHU/RTU control may need to be modified to allow heating and cooling.	☐	☐	Boiler Feed water T ____ Common Supply Steam T__,	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
13. Operator to command to "OFF" existing boilers if needed to assure the test boilers are the next to operate.	RTU's are on and heating valves are open so heat has someplace to go.	☐	☐	Need to confirm there are no other demands from the other WEAVER LAKE Boilers 1-6 that may call for second boiler to start. This test should only involve B7, 8 lead lag Record temperatures: OAT: ____, Boiler Feed water T ____ Common Supply Steam T__,	☐	☐
	Outside air dampers are modulated as needed to create loads approximately as required for the various tests steps.	☐	☐		☐	☐
	Adjust flow to attain loads required for each step.	☐	☐		☐	☐
	During testing space thermal conditions may not be maintained and AHU/RTU control may need to be modified to allow heating and cooling.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
14. Set delay limits and settling time to 1 minute	RTU's are on and heating valves are open so heat has someplace to go.	☐	☐	Need to confirm there are no other demands from the other WEAVER LAKE Boilers 1-6 that may call for second boiler to start. This test should only involve B7, 8 lead lag Record temperatures: OAT: ____, Boiler Feed water T ____ Common Supply Steam T__,	☐	☐
	Outside air dampers are modulated as needed to create loads approximately as required for the various tests steps.	☐	☐		☐	☐
	Adjust flow to attain loads required for each step.	☐	☐		☐	☐
	During testing space thermal conditions may not be maintained and AHU/RTU control may need to be modified to allow heating and cooling.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
15. Reduce the load slowly	The Lead boiler lowers its firing rate.	☐	☐	Boiler fire rate is based on rising and falling header pressure. The boiler fails this step if the fire rate cannot turn down to 17%, and remain stable operation.	☐	☐
	When the fire rate drops to about 17% the boiler steam pressure starts to rise.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
16. Note progressive observations	The Lead boiler lowers its firing rate.	☐	☐	Boiler fire rate is based on rising and falling header pressure.	☐	☐
	When the fire rate drops to about 17% the boiler steam pressure starts to rise.	☐	☐	The boiler fails this step if the fire rate cannot turn down to 17%, and remain stable operation.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
17. Continue to lower load	When boiler pressure reaches the high safety limit the boiler remains enabled, but stops firing.	☐	☐	If the run time or scheduler has timed out expect the Lead to change on restart.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
18. Raise load to original level	Boiler responds to load increase and initiates fire cycle after minimum off delay.	☐	☐		☐	☐
	Blower purge.	☐	☐		☐	☐
	Ignition cycle.	☐	☐		☐	☐
	Fire rate adjustment to load.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
19. Continue to increase Load	Fire rate increases to full fire.	☐	☐	Pressure in Header when the fire rate increases: _____psi	☐	☐
	Lag boiler starts with purge, ignition and low fire rate.	☐	☐		☐	☐
	Lag boiler fire rate increases.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
20. Decrease LOAD	Lag fire rate decreases.	☐	☐	The boiler fails this step if the fire rate cannot turn down to 17%.	☐	☐
	Fire rate decreases to 17%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
21. Decrease the load below upper limit for unload	Lag boiler shuts down.	☐	☐	Indicate the time required from loss of load to Pump shut down. ___:___ ___:___ ___:___ Boiler off/ Pump Off :/: Delay If liquid level remains high enough the pump will not cycle ON	☐	☐
	After the Lag boiler proves it is OFF (after 60 seconds) the appropriate Lag feed water pump stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
22. Note the time from when the load drops until the boiler pump stops.	Lag boiler shuts down.	☐	☐	Indicate the time required from loss of load to Pump shut down. ___:___ ___:___ ___:___ Boiler off/ Pump Off :/: Delay If liquid level remains high enough the pump will not cycle ON	☐	☐
	After the Lag boiler proves it is OFF (after 60 seconds) the appropriate Lag feed water pump stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
23. Continue decreasing the load to see that the boiler does shut down. Leave the fire rate at that level.	Lead boiler fire rate decreases.	☐	☐	Pressure in Header when the fire rate decreases: _____psi The boiler fails this step if the fire rate cannot turn down to 17% and remain stable operation.	☐	☐
	Lead boiler is enabled but OFF on high steam safety.	☐	☐		☐	☐
	Lead Boiler changes to Lag if automatic scheduler or runtime Lead alternator is active.	☐	☐		☐	☐
	Lead Boiler modulates to 17% fire rate.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
24. Create a boiler fault on the lead boiler	The lead boiler stops.	☐	☐	Pressure in Header when the lag starts: _____psi	☐	☐
	An alarm is reported, to the OWS.	☐	☐		☐	☐
	The lag boiler starts.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
25. Note reaction.	The lead boiler stops.	☐	☐	Pressure in Header when the lag starts: _____psi	☐	☐
	An alarm is reported, to the OWS.	☐	☐		☐	☐
	The lag boiler starts.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
26. Restore alarms or faults created in lead boiler.	The Lead boiler restarts.	☐	☐		☐	☐
	Because the load is low the lag boiler stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
27. SKIP these steps if no auto lead function	The lead boiler (7) changes status to be the “new lag” boiler.	☐	☐	The specifications do not indicate any other requirement except runtime for the transfer, but if there are others (e.g. both must be off for the run time transfer to be enacted) create those conditions to see the automatic transfer. Hours for switching Lead ____	☐	☐
	Boiler (7) shuts down.	☐	☐		☐	☐
	Boiler (8) starts as the “new lead”.	☐	☐		☐	☐
	The runtime for the old lead boiler (7) is set to 00:00.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
28. Wait for the lead boiler run time to exceed switch over hours	The lead boiler (7) changes status to be the “new lag” boiler.	☐	☐	The specifications do not indicate any other requirement except runtime for the transfer, but if there are others (e.g. both must be off for the run time transfer to be enacted) create those conditions to see the automatic transfer. Hours for switching Lead ____	☐	☐
	Boiler (7) shuts down.	☐	☐		☐	☐
	Boiler (8) starts as the “new lead”.	☐	☐		☐	☐
	The runtime for the old lead boiler (7) is set to 00:00.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
29. Note the automatic transfer of LEAD to become the LAG. This must be verified to be automatic and not a direct command.	The lead boiler (7) changes status to be the "new lag" boiler.	☐	☐	The specifications do not indicate any other requirement except runtime for the transfer, but if there are others (e.g. both must be off for the run time transfer to be enacted) create those conditions to see the automatic transfer. Hours for switching Lead ____	☐	☐
	Boiler (7) shuts down.	☐	☐		☐	☐
	Boiler (8) starts as the "new lead".	☐	☐		☐	☐
	The runtime for the old lead boiler (7) is set to 00:00.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
30. Wait for stable operation of new lead	Alarm Lag boiler ON reports to OWS.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
31. Manually turn on the new lag boiler	Alarm Lag boiler ON reports to OWS.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
32. Restore "auto" operation to lag boiler	Lag boiler goes OFF.	☐	☐		☐	☐
	Alarm clears.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
33. Note the conditions after 5 minutes	The system transition is complete and has become stable.	☐	☐	Record runtimes Boiler # _8 _____ Boiler # __7_____ Load: _____MBH	☐	☐
Record issues				Issue Log Item: Initial / Date		
34. Adjust the load for one boiler required	The system transition is complete and has become stable.	☐	☐	Record runtimes Boiler # _8 _____ Boiler # __7_____ Load: _____MBH	☐	☐
Record issues				Issue Log Item: Initial / Date		
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
VERIFICATION OF BOILER PRESSURE CONTROL						
35. Adjust the low fire shutoff delay set point to 1 minute. (Wait 5 minutes for steam pressure to stabilize)	Only the Lead boiler remains on.	☐	☐	Steam pressure set point _____psi	☐	☐
	Lag boiler is OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
36. Adjust the steam pressure set point to 5psi higher than the current steam pressure (Wait 5 minutes for steam pressure to stabilize)	The Lead boiler modulates toward full fire.	☐	☐	Steam pressure set point _____psi	☐	☐
	The Lag boiler may Start if lead can not provide for load.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
37. Adjust the steam pressure set point to 5psi higher than the current steam pressure set point (Wait 5 minutes for steam pressure to stabilize)	The Lag boiler is enabled.	☐	☐	Steam pressure set point _____psi	☐	☐
	After 5 minutes, Lag boiler goes to low fire.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
38. Adjust the steam pressure set point to 5psi* lower than the current set point (Wait 5 minutes for steam pressure to stabilize)	LAG boiler goes to low fire.	☐	☐	Steam pressure set point _____psi	☐	☐
	After 3 minutes at low fire, LAG boiler is de-energized.	☐	☐	*May need to adjust set point lower in 2 psi increments until low fire is achieved.	☐	☐
	Lead boiler Reduces from full fire.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
39. Set the Pressuretrol® controller high pressure limit to be 5psi lower than the current pressure	The lead boiler is OFF due to high pressure limit.	☐	☐	Controller high pressure limit set point _____psi	☐	☐
	The Lag boiler is enabled.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
40. Reset the steam pressure set point to the original value (10-15 psi)	The boilers resume “normal” operational conditions.	☐	☐	Steam pressure set point _____psi	☐	☐
	Wait 5 minutes for steam pressure to stabilize.	☐	☐	Low fire time delay set point _____min Controller high pressure limit set point _____psi	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
41. Reset the low fire delay to the original setting	The boilers resume "normal" operational conditions.	☐	☐	Steam pressure set point _____psi Low fire time delay set point _____min Controller high pressure limit set point _____psi	☐	☐
	Wait 5 minutes for steam pressure to stabilize.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
42. Reset the pressure controller limit to the original value	The boilers resume "normal" operational conditions.	☐	☐	Steam pressure set point _____psi Low fire time delay set point _____min Controller high pressure limit set point _____psi	☐	☐
	Wait 5 minutes for steam pressure to stabilize.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
VERIFICATION OF BOILER FAILURE SEQUENCE						
43. Turn the Lead boiler off locally to simulate failure	The Lead boiler is OFF.	☐	☐		☐	☐
	The Lag boiler is enabled.	☐	☐		☐	☐
	After 5 minutes, the Lag boiler begins fire and adjusts to load.	☐	☐		☐	☐
	An alarm registers at the BAS for lead boiler failure.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
44. Turn the Lag boiler off locally to simulate dual boiler failure	The Lead boiler is OFF.	☐	☐	Even when there is a call for heating the secondary pumps stop if no boilers are ON.	☐	☐
	The Lag boiler is OFF.	☐	☐		☐	☐
	An alarm registers at the BAS for Lag boiler failure.	☐	☐		☐	☐
	The secondary pumps PHWP 4, 5, 6 stop with second boiler failure.	☐	☐		☐	☐
	Low header pressure alarm reports to BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
45. Wait for header pressure to drop	The Lead boiler is OFF.	☐	☐	Even when there is a call for heating the secondary pumps stop if no boilers are ON.	☐	☐
	The Lag boiler is OFF.	☐	☐		☐	☐
	An alarm registers at the BAS for Lag boiler failure.	☐	☐		☐	☐
	The secondary pumps PHWP 4, 5, 6 stop with second boiler failure.	☐	☐		☐	☐
	Low header pressure alarm reports to BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
46. Restore the Lead boiler fault	The Lead boiler is enabled.	☐	☐	Verify that when the Lead boiler is brought back on, it resumes Lead role. Is there a time delay before the steam control valve closes on a de-energized boiler?	☐	☐
	After purge and ignition Lead boiler adjusts fire to meet load.	☐	☐		☐	☐
	The Lag boiler is OFF.	☐	☐		☐	☐
	Lead Boiler failure alarm clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
47. Turn the Lag boiler back to ON state	The Lead boiler remains energized.	☐	☐	Lag Boiler may start if actual line pressure is still low and lead boiler is at full fire.	☐	☐
	The Lag boiler remains OFF (provided steam pressure set point is met).	☐	☐		☐	☐
	Lag Boiler failure alarm clears at BAS.	☐	☐		☐	☐
	System resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
VERIFICATION OF BOILER FEED WATER PUMPS, SAFETY CIRCUIT AND ALARMS						
48. Boiler Feedwater Pump Observe during normal operation low water level on Lead Boiler 7	Boiler fed water pump BFP-1 starts for B-7.	☐	☐		☐	☐
	Make up water solenoid valve opens as feed water tank water level falls.	☐	☐		☐	☐
	Steam valve for HX-7 opens to maintain feed water temperature.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
49. Change Lead boiler to boiler 8	Boiler fed water pump BFP-2 starts for B-8.	☐	☐		☐	☐
	Make up water solenoid valve opens as feed water tank water level falls.	☐	☐		☐	☐
	Steam valve for HX-8 opens to maintain feed water temperature.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
50. Observe during normal operation low water level on Lead Boiler 8	Boiler fed water pump BFP-2 starts for B-8.	☐	☐		☐	☐
	Make up water solenoid valve opens as feed water tank water level falls.	☐	☐		☐	☐
	Steam valve for HX-8 opens to maintain feed water temperature.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
51. Manually stop BFP 2	Boiler fed water pump BFP-3 starts for B-8 low water call for make up.	☐	☐	Confirm that valve setup would allow BFP-3 to also serve Boiler 7.	☐	☐
	Boiler B-8 is served with water and fills for normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
52. Manually enable BFP3 to run with boiler	Boiler fed water pump BFP-3 starts for B-8 low water call for make up.	☐	☐	Confirm that valve setup would allow BFP-3 to also serve Boiler 7.	☐	☐
	Boiler B-8 is served with water and fills for normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
53. Manually adjust valves so BFP 3 delivers water to Boiler-8	Boiler fed water pump BFP-3 starts for B-8 low water call for make up.	☐	☐	Confirm that valve setup would allow BFP-3 to also serve Boiler 7.	☐	☐
	Boiler B-8 is served with water and fills for normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Testing continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
54. Observe action on low water on Boiler 8	Boiler fed water pump BFP-3 starts for B-8 low water call for make up.	☐	☐	Confirm that valve setup would allow BFP-3 to also serve Boiler 7.	☐	☐
	Boiler B-8 is served with water and fills for normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
55. Return BFP-3 to standby and valve BFP-2 as service for B-8	BFP-2 provides makeup water for boiler 8.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
56. Return BFP-2 to serve B-8.	BFP-2 provides makeup water for boiler 8.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
57. Boiler Safety Water Level With Boiler 7 as lead boiler and with a load for one boiler complete the following section for Boiler B-7.	The controller starts low water level sequence.	☐	☐		☐	☐
	The feed water pump STARTS.	☐	☐		☐	☐
	As water level drops further the LOW alarm trips.	☐	☐		☐	☐
	The burner circuit is open and the burners shut OFF.	☐	☐		☐	☐
	A local alarm is sounded.	☐	☐		☐	☐
	A general alarm is registered at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
58. Boiler Safety Water Level Blow down the boiler column to a point that trips the low-level switch.	The controller starts low water level sequence.	☐	☐		☐	☐
	The feed water pump STARTS.	☐	☐		☐	☐
	As water level drops further the LOW alarm trips.	☐	☐		☐	☐
	The burner circuit is open and the burners shut OFF.	☐	☐		☐	☐
	A local alarm is sounded.	☐	☐		☐	☐
	A general alarm is registered at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
59. Boiler Safety Water Level Limit boiler feed water to assure it does not fill faster than blow down	The controller starts low water level sequence.	☐	☐		☐	☐
	The feed water pump STARTS.	☐	☐		☐	☐
	As water level drops further the LOW alarm trips.	☐	☐		☐	☐
	The burner circuit is open and the burners shut OFF.	☐	☐		☐	☐
	A local alarm is sounded.	☐	☐		☐	☐
	A general alarm is registered at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
60. Water fills the boiler back to acceptable level	The boiler resumes “normal” operating sequence.	☐	☐		☐	☐
	The local alarm is cleared.	☐	☐		☐	☐
	The general alarm clears at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
(Test continues on the following page._						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
61. Fuel oil Set fuel mode switch to “oil”	FOP-1 starts when the selector is set to oil.	☐	☐	There may be a report sent to BAS that the system in OIL mode, and that FOP1 is ON.	☐	☐
	FO is delivered to the boiler by FOP1.	☐	☐		☐	☐
	Local control shows FOP-1 ON.	☐	☐		☐	☐
	Boiler fires.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
62. Fuel oil Set FOP-1 to Lead	FOP-1 starts when the selector is set to oil.	☐	☐	There may be a report sent to BAS that the system in OIL mode, and that FOP1 is ON.	☐	☐
	FO is delivered to the boiler by FOP1.	☐	☐		☐	☐
	Local control shows FOP-1 ON.	☐	☐		☐	☐
	Boiler fires.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
63. Fuel oil Allow ether boiler to start	FOP-1 starts when the selector is set to oil.	☐	☐	There may be a report sent to BAS that the system in OIL mode, and that FOP1 is ON.	☐	☐
	FO is delivered to the boiler by FOP1.	☐	☐		☐	☐
	Local control shows FOP-1 ON.	☐	☐		☐	☐
	Boiler fires.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
64. Simulate a fault in FOP-1	FOP-1 stops.	☐	☐	If possible trip a pump overload, to trigger alarm and shutdown. The thermal overload is a unique alarm and reports locally and to BAS There may be a 30 second delay before the Lag pump starts.	☐	☐
	An alarm reports locally.	☐	☐		☐	☐
	An alarm FOP 1 Failure reports to BAS.	☐	☐		☐	☐
	FOP-2 starts.	☐	☐		☐	☐
	The boiler continues to run.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
65. Simulate a fault in FOP-2	FOP-2 stops.	☐	☐	Boiler may need a manual reset if SO record procedure here: The loss of flow alarm is a unique alarm that reports locally and at BAS.	☐	☐
	An alarm reports locally.	☐	☐		☐	☐
	An alarm FOP 2 Failure reports to BAS.	☐	☐		☐	☐
	Boiler shuts down.	☐	☐		☐	☐
	Low FO Flow Alarm reports to BAS after 30 seconds.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
66. Shut off circuit to controller for 10 seconds to simulate a loss of power, then turn back ON	Controller recovers from loss of power and automatically restarts.	☐	☐	The controller may report a return from loss of power alarm.	☐	☐
	FOP-1 starts.	☐	☐		☐	☐
	The Local and BAS alarms for FOP-1 clear.	☐	☐		☐	☐
	Boiler starts.	☐	☐		☐	☐
	FO Flow Alarm Clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
67. Correct Simulated fault in FOP-1	Controller recovers from loss of power and automatically restarts.	☐	☐	The controller may report a return from loss of power alarm.	☐	☐
	FOP-1 starts.	☐	☐		☐	☐
	The Local and BAS alarms for FOP-1 clear.	☐	☐		☐	☐
	Boiler starts.	☐	☐		☐	☐
	FO Flow Alarm Clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
68. Manually acknowledge alarm by depressing "reset" button	Controller recovers from loss of power and automatically restarts.	☐	☐	The controller may report a return from loss of power alarm.	☐	☐
	FOP-1 starts.	☐	☐		☐	☐
	The Local and BAS alarms for FOP-1 clear.	☐	☐		☐	☐
	Boiler starts.	☐	☐		☐	☐
	FO Flow Alarm Clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
69. Correct Simulated fault in FOP-2	FOP-2 remains OFF as LAG.	☐	☐		☐	☐
	The Local and BAS alarms for FOP-2 clear.	☐	☐		☐	☐
	Boiler remains ON.	☐	☐		☐	☐
	After Lead selection is changed FOP 2 Starts.	☐	☐		☐	☐
	FOP-1 Stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
70. Manually acknowledge alarm by depressing “reset” button	FOP-2 remains OFF as LAG.	☐	☐		☐	☐
	The Local and BAS alarms for FOP-2 clear.	☐	☐		☐	☐
	Boiler remains ON.	☐	☐		☐	☐
	After Lead selection is changed FOP 2 Starts.	☐	☐		☐	☐
	FOP-1 Stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
71. Use a small amount of fuel to bridge the contacts on the leak detector (or lift float if that is the sensor type) in the outer fuel tank.	Alarm sounds locally.	☐	☐	This is a unique pump set leak alarm that reports locally and at BAS.	☐	☐
	BAS reports Alarm.	☐	☐		☐	☐
	In addition a pipe leak stops the system and Both Pumps are OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
72. Use water or fuel to close contact on pipe leak detector.	Alarm sounds locally.	☐	☐	This is a unique pump set leak alarm that reports locally and at BAS.	☐	☐
	BAS reports Alarm.	☐	☐		☐	☐
	In addition a pipe leak stops the system and Both Pumps are OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
73. Change fuel Mode switch to “GAS”	FOP-2 Stops.	☐	☐		☐	☐
	The BAS and Local control show System in GAS fuel mode.	☐	☐		☐	☐
	Boiler remains ON.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
74. Boiler Safety Flame Detection Disconnect the lead to the flame sensor from the control board	The controller senses no flame.	☐	☐		☐	☐
	The gas valve closes as a safety.	☐	☐		☐	☐
	The local control alarms.	☐	☐		☐	☐
	A general alarm registers at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
75. Reconnect the lead to the flame sensor	The boiler begins startup sequence.	☐	☐	On restart the boiler lead lag may reverse. Report actual reaction.	☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
76. Reset the boiler if not recycling be itself	The boiler begins startup sequence.	☐	☐	On restart the boiler lead lag may reverse. Report actual reaction.	☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
77. Boiler Safety Water Level Change boiler 8 to Lead	The controller starts low water level sequence.	☐	☐		☐	☐
	The feed water pump STARTS.	☐	☐		☐	☐
	As water level drops further the LOW alarm trips.	☐	☐		☐	☐
	The burner circuit is open and the burners shut OFF.	☐	☐		☐	☐
	A local alarm is sounded.	☐	☐		☐	☐
	A general alarm is registered at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
78. Boiler Safety Water Level With Boiler 8 as lead boiler and with a load for one boiler complete the following section for Boiler B-8.	The controller starts low water level sequence.	☐	☐		☐	☐
	The feed water pump STARTS.	☐	☐		☐	☐
	As water level drops further the LOW alarm trips.	☐	☐		☐	☐
	The burner circuit is open and the burners shut OFF.	☐	☐		☐	☐
	A local alarm is sounded.	☐	☐		☐	☐
	A general alarm is registered at the BAS	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
79. Boiler Safety Water Level Blow down the boiler column to a point that trips the low-level switch.	The controller starts low water level sequence.	☐	☐		☐	☐
	The feed water pump STARTS.	☐	☐		☐	☐
	As water level drops further the LOW alarm trips.	☐	☐		☐	☐
	The burner circuit is open and the burners shut OFF.	☐	☐		☐	☐
	A local alarm is sounded.	☐	☐		☐	☐
	A general alarm is registered at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
80. Boiler Safety Water Level Limit boiler feed water to assure it does not fill faster than blow down	The controller starts low water level sequence.	☐	☐		☐	☐
	The feed water pump STARTS.	☐	☐		☐	☐
	As water level drops further the LOW alarm trips.	☐	☐		☐	☐
	The burner circuit is open and the burners shut OFF.	☐	☐		☐	☐
	A local alarm is sounded.	☐	☐		☐	☐
	A general alarm is registered at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
81. (Self Acting) Water fills the boiler back to acceptable level	The boiler resume "normal" operating sequence.	☐	☐		☐	☐
	The local alarm is cleared.	☐	☐		☐	☐
	The general alarm clears at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
82. Boiler Safety Flame Detection Disconnect the lead to the flame sensor from the control board	The controller senses no flame.	☐	☐		☐	☐
	The gas valve closes as a safety.	☐	☐		☐	☐
	The local control alarms.	☐	☐		☐	☐
	A general alarm registers at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
83. Reconnect the lead to the flame sensor	The boiler begins startup sequence.	☐	☐	On restart the boiler lead lag may reverse. Report actual reaction.	☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
84. Reset the boiler if not recycling be itself	The boiler begins startup sequence.	☐	☐	On restart the boiler lead lag may reverse. Report actual reaction.	☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
85. Set-up Complete the following section that applies to both boilers.	Common safety circuits apply to both boilers regardless of LEAD.	☐	☐	Confirm in software that the common shut down safeties, alarm reporting and restart apply to both boilers.	☐	☐
	Neither boiler runs when a common safety is energized.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
86. Boiler Safety – Boiler Emergency Shut OFF Activate the Emergency Shut OFF Switch	The controller looses all power.	☐	☐	It was not clear on loss of power to boiler control if any staged or planned shutdown would apply. Without a controller there is not timer to delay any shut down action. Without power the alarm identification may be loss of communications, and after time a low boiler system pressure. Record observed or expected results per Software.	☐	☐
	The gas valve closes as a safety.	☐	☐		☐	☐
	The Boiler begins shut down cycle.	☐	☐		☐	☐
	The local control alarms.	☐	☐		☐	☐
	A loss of power alarm registers at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
87. Restore the Emergency Shut OFF switch	The boiler begins startup sequence.	☐	☐		☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
88. Reset the boiler if not recycling be itself	The boiler begins startup sequence.	☐	☐		☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
89. Boiler Safety – Combustion Air Failure Manipulate the AHU-10 damper end switch to indicate damper is not fully opened	The controller senses Damper Failed to OPEN.	☐	☐		☐	☐
	AHU-10 Stops.	☐	☐		☐	☐
	Loss of AHU Flow Reports.	☐	☐		☐	☐
	The gas valve closes as a safety.	☐	☐		☐	☐
	The Boiler begins shut down cycle.	☐	☐		☐	☐
	The Boiler system control alarms.	☐	☐		☐	☐
	A general alarm reports at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
90. Restore the end switch	The boiler begins startup sequence.	☐	☐		☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
91. Reset the boiler if not recycling be itself	The boiler begins startup sequence.	☐	☐		☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
92. Manipulate the AHU-10 differential pressure proof-of-flow switch to indicate fan is OFF	The controller senses loss of AHU-10 FLOW.	☐	☐		☐	☐
	The gas valve closes as a safety.	☐	☐		☐	☐
	The Boiler begins shut down cycle.	☐	☐		☐	☐
	The local control alarms.	☐	☐		☐	☐
	A general alarm registers at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
93. Restore the flow switch	The boiler begins startup sequence.	☐	☐		☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
	The boiler system operates normally.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
94. Reset the boiler if not recycling be itself	The boiler begins startup sequence.	☐	☐		☐	☐
	The boiler is ON.	☐	☐		☐	☐
	The local alarm clears.	☐	☐		☐	☐
	The general alarm at the BAS clears.	☐	☐		☐	☐
	The boiler system operates normally.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
CONDENSATE PUMP OPERATION						
95. Briefly bump each pump ON with HOA	Momentary start proves HOA ON works but does not drain too much condensate.	☐	☐	Use “Hand Off Auto” to turn pumps OFF in the following steps	☐	☐
	Lead condensate pump starts.	☐	☐	____ Height of condensate above finished floor when Lead pump starts.	☐	☐
	Record level pump starts.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
96. At condensate receiver tank, allow level to rise until pump starts.	Momentary start proves HOA ON works but does not drain too much condensate.	☐	☐	Use "Hand Off Auto" to turn pumps OFF in the following steps	☐	☐
	Lead condensate pump starts.	☐	☐	____	☐	☐
	Record level pump starts.	☐	☐	Height of condensate above finished floor when Lead pump starts.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
97. Pump only 5 seconds then execute next step.	Momentary start proves HOA ON works but does not drain too much condensate.	☐	☐	Use "Hand Off Auto" to turn pumps OFF in the following steps	☐	☐
	Lead condensate pump starts.	☐	☐	____	☐	☐
	Record level pump starts.	☐	☐	Height of condensate above finished floor when Lead pump starts.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
98. Disconnect power to or turn off the Lead condensate pump.	Lead condensate pump stops.	☐	☐	Note if any alarms:_____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
99. Allow condensate level to rise until lag condensate pump starts	Back-up condensate pump starts.	☐	☐	____" Height of condensate above finished floor when Lead pump starts.	☐	☐
	Record level pump starts.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
100 Pump only 5 seconds then execute next step.	Back-up condensate pump starts.	☐	☐	____" Height of condensate above finished floor when Lead pump starts.	☐	☐
	Record level pump starts.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
101 Disconnect power to or turn off the Lag condensate pump.	Lag condensate pump stops.	☐	☐	Alarm Message should be clear what has failed. The piping and drain should be arranged to limit hot condensate from causing injury.	☐	☐
	Alarm Reports to BAS.	☐	☐		☐	☐
	There is a drain for condensate to overflow tank.	☐	☐		☐	☐
	Watch boiler feed water tank for low level if it goes low and calls for water note this at end of test section G.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
102 Wait if needed for Highest level to report Condensate pump failure alarm	Lag condensate pump stops.	☐	☐	Alarm Message should be clear what has failed. The piping and drain should be arranged to limit hot condensate from causing injury.	☐	☐
	Alarm Reports to BAS.	☐	☐		☐	☐
	There is a drain for condensate to overflow tank.	☐	☐		☐	☐
	Watch boiler feed water tank for low level if it goes low and calls for water note this at end of test section G.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
103 Restore power to or turn on the Lead then Lag condensate pump	Lead pump starts.	☐	☐		☐	☐
	As level drops Alarm clears.	☐	☐		☐	☐
	Condensate flows freely and without leakage to boiler system receiver tank.	☐	☐		☐	☐
	When tank gets to low level the lead pump stops and switches to old lag pump.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
104 Allow pump to run to its automatic shut off point.	Lead pump starts.	☐	☐		☐	☐
	As level drops Alarm clears.	☐	☐		☐	☐
	Condensate flows freely and without leakage to boiler system receiver tank.	☐	☐		☐	☐
	When tank gets to low level the lead pump stops and switches to old lag pump.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
105 Allow condensate to fill to start level	Lead pump has alternated to the old Lag pump.	☐	☐		☐	☐
	New Lead pump starts.	☐	☐		☐	☐
	Condensate flows freely and without leakage to boiler system receiver tank.	☐	☐		☐	☐
	When tank gets to low level the lead pump stops and switches to old lag pump.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
BOILER FEED WATER & CHEMICAL TREATMENT						
106 Let Boiler 7 liquid level drop below demand level	Feed water pump 1 starts.	☐	☐	Feed water pumps 1, 2, 3 may have different assignments but one will be to one boiler and one as standby.	☐	☐
	Feed water pump 2 and standby pump 3 remain OFF.	☐	☐		☐	☐
	Water flows fast enough to replace boiler water before low limit safety shuts off boiler.	☐	☐		☐	☐
	When water level goes high pump stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
107 Let Boiler 8 liquid level drop below demand level	Feed water pump 2 starts.	☐	☐		☐	☐
	Feed water pump 1 and standby pump 3 remain OFF.	☐	☐		☐	☐
	Water flows fast enough to replace boiler water before low limit safety shuts off boiler.	☐	☐		☐	☐
	When water level goes high pump stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
108 Transfer Assignment for Boiler 7 to the standby pump.	Feed water pump 3 starts.	☐	☐		☐	☐
	Feed water pump 1 and 2 remain OFF.	☐	☐		☐	☐
	Water flows fast enough to replace boiler water before low limit safety shuts off boiler.	☐	☐		☐	☐
	When water level rises pump stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
109 Allow Boiler 7 level to rise above switch level	Feed water pump 3 starts.	☐	☐		☐	☐
	Feed water pump 1 and 2 remain OFF.	☐	☐		☐	☐
	Water flows fast enough to replace boiler water before low limit safety shuts off boiler.	☐	☐		☐	☐
	When water level rises pump stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
110 Adjust the conductivity set pt on controller to 1000 µS/cm less than the current system conductivity level or set scheduled blow down for 2 minutes.	The blow down valve is opened and the system is discharging to maintain the required conductivity level or timed release.	☐	☐	Submittals were not clear on what initiates blow down. Record Conductivity setting ____ Record Schedule _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
111 Reset the conductivity set point or timer to the original value.	The converter blow down valve is closed to maintain the new conductivity requirements.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
112 Allow or drain Feed water tank to below make up level	The cold water valve opens to add water through HX-7 into the feed water tank.	☐	☐		☐	☐
	Observe reaction in test section H HX-7.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
113 Allow Feed water tank to rise	The cold water valve Closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
HEAT EXCHANGER HX-7 MAKE UP WATER HEATER						
114 With make up water OFF the heating control valve is closed	Even with low temperature in make up water line there is no heating with make up water OFF.	☐	☐	If a call for make up is not observed during normal operation create a call by draining the feed water tank. Record level when make up opens_____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
115 Supply water temperature drops without circulation	Even with low temperature in make up water line there is no heating with make up water OFF.	☐	☐	If a call for make up is not observed during normal operation create a call by draining the feed water tank. Record level when make up opens_____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
116 Call for make up water so HX7 control is ON	Steam control valve modulates to maintain supply water temperature.	☐	☐	With only a short time for make up water flow the supply water may go from several degrees below set point to several above and not stabilize before make up tank is filled.	☐	☐
	As temperature increases above set point valve modulates closed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
117 Supply water temp drops with flow	Steam control valve modulates to maintain supply water temperature.	☐	☐	With only a short time for make up water flow the supply water may go from several degrees below set point to several above and not stabilize before make up tank is filled.	☐	☐
	As temperature increases above set point valve modulates closed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
118 Lower High temperature alarm set point below existing supply Temp	Local high temp limit alarm sounds.	☐	☐	Record high limit setpoint _____	☐	☐
	Cold water solenoid valve opens.	☐	☐		☐	☐
	Over heated water is dumped from shell.	☐	☐		☐	☐
	BAS Alarm reports.	☐	☐		☐	☐
	Steam Valve closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
119 Clear High temperature alarm	Alarm clears.	☐	☐		☐	☐
	HX-7 returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
120 Reset alarm setpoint	Alarm clears.	☐	☐		☐	☐
	HX-7 returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
121 Simulate power loss	Steam valve closes in 10 seconds.	☐	☐		☐	☐
	Controller is OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
122 Restore power	Controller returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
123 Feed water tank ends call for make up water	When cold water valve closes heating valve closes.	☐	☐	Record level when make up closes_____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
124 Restore to normal any special action required to initiate operation	System is running normally.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
RETURN TO INITIAL CONDITIONS						
125 Record test stop time	Recorded.	☐	☐	Time: (am/pm)_____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

SAMPLE

Test Notes and Lessons Learned

SAMPLE

Back to page L-1

Back to Cx Plan Appendix C

Centrifugal Water Chiller
Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:
Operational Assumptions: Associated air handling equipment and ducts has been tested and is operating correctly. The test begins while the room is in the occupied mode.

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

SAMPLE

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

SAMPLE

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

Supplies Required for Testing (To be provided by the contractor)

Tools / Supplies	
Laptop with TC Program	Infrared Thermometer Gun
PID Loop Tuning Software	Humidity Tester
Aerosol for Smoke and Freeze stat Test	Basic Tool Pouch
Radio Communications	Flashlight

System Readiness Summary Checklist

Description	Yes	No	Date
System Ready for Test	☐	☐	
Required Personnel Available	☐	☐	
Required Tools/Test Equipment/Supplies Available	☐	☐	
Required Safety Equipment Available	☐	☐	

SAMPLE

Set-Points, Limits, and Schedules

☐ AHU can be assigned a schedule. ☐ Schedule can be programmed daily.

☐ If system runs 24 hours a day, check here. If not, fill in the occupied mode schedule below.

	AM												PM											
Day	12	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	8	9	10	11
Sun																								
Mon																								
Tues																								
Wed																								
Thurs																								
Fri																								
Sat																								
Holi																								

Parameter	**Setpoint**		**Adjustable Range**	
	Design	**Actual**	**Design**	**Actual**
Outside Air Temperature (°F)				
Preheat valve full open outside air temperature (°F)				
Discharge Air Temperature (°F)				
Night Setback Temperature (°F)				
Night Setback Differential				
Mixed Air Temperature (°F)				
Minimum Start-up Fan Speed (%)				
Time at Minimum Fan Speed for Start-up (min)				
Average Zone Humidity (%RH)				
Maximum supply air humidity (%RH)				
Discharge Air Static Pressure (in H_2O)				
High Static Alarm (in H_2O)				
Low Static Alarm (in H_2O)				

SAMPLE

Parameter	Setpoint		Adjustable Range	
	Design	Actual	Design	Actual
System Shutdown High Static Limit (in H_2O)				
Damper Position				

Initial Ambient Conditions

Ambient Conditions			
Outside Air Temp		Outside Air RH %	
Observations			

Trend Data Required To Support Testing

Check if trend point chart(s) and Frequency Graph(s) are provided per trend requirements shown below.

Trend Log Setup #1 - Temperature					
Pre-Testing	Post Testing	Point	Frequency	Duration	Provided
☐	☐	System Flow Rate			☐ Yes ☐ No
☐	☐	Flow Rate Set Point			☐ Yes ☐ No
☐	☐	Water Quality			☐ Yes ☐ No
☐	☐	Damper Position			☐ Yes ☐ No
☐	☐	System Pressure			☐ Yes ☐ No
☐	☐	Pressure Set Point			☐ Yes ☐ No
Record Issues				Issue Log Item Number:	

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**

C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Record the starting conditions	Recorded.	☐	☐	Lead Chiller CH-_____ Lead Chiller Status_____ Lag Chiller CH- _____ Lag Chiller Status_____ Primary Pump Status_____ Lead Secondary Pump P-_____ Lead Secondary Pump Status_____ Stand-by Secondary Pump P-_____ Stand-by Secondary Pump Status _____ Time: (am / pm)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
2. Confirm equipment is operating as assumed above. If not make adjustments within the Building Automation System (BAS)	Confirmed	☐	☐	Time: _____ (am / pm)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
VERIFICATION OF MANUAL CHILLER CONTROL						
3. Via the CSM's Control Mode, set the chilled water system to Manual control.	Chiller 1 is disabled.	☐	☐	The specifications do not describe the relationship between pump status and chiller status. Please record any differences from the Expected Results noted during test.	☐	☐
	Chiller 2 is disabled.	☐	☐		☐	☐
	Primary pump P-3 remains ON for (insert time delay).	☐	☐		☐	☐
	Primary pump P-4 remains ON for (insert time delay).	☐	☐	Starting Max Chiller Stop-to-Start Cycle Timer setpoint_____min	☐	☐
	The Lead secondary chilled water pump STOPS.	☐	☐	New Max Chiller Stop-to-	☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	The Stand-by secondary chilled water pump remains OFF.	☐	☐	Start Cycle Timer set-point _____ min Starting Wait for Evaporator Flow Timer set-point _____ min New Wait for Evaporator Flow Timer set-point _____ min Primary Pump P-3 ON delay _____ min Primary Pump P-4 ON delay _____ min Lead Secondary pump status_____ Stand-by Secondary pump status _____	☐	☐
Record issues				Issue Log Item: Initial / Date		
4. Command both chillers CH-1 and CH-2 to OFF.	Chiller 1 is disabled.	☐	☐	The specifications do not describe the relationship between pump status and chiller status. Please record any differences from the Expected Results noted during test. Starting Max Chiller Stop-to-Start Cycle Timer setpoint_____min	☐	☐
	Chiller 2 is disabled.	☐	☐		☐	☐
	Primary pump P-3 remains ON for (insert time delay).	☐	☐		☐	☐
	Primary pump P-4 remains ON for (insert time delay).	☐	☐		☐	☐
	The Lead secondary chilled water pump STOPS.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	The Stand-by secondary chilled water pump remains OFF.	☐	☐	New Max Chiller Stop-to-Start Cycle Timer set-point _____ min Starting Wait for Evaporator Flow Timer set-point _____ min New Wait for Evaporator Flow Timer set-point _____ min Primary Pump P-3 ON delay _____ min Primary Pump P-4 ON delay _____ min Lead Secondary pump status_____ Stand-by Secondary pump status _____	☐	☐
Record issues				Issue Log Item: Initial / Date		
5. Adjust the Max Chiller Stop-to-Start Cycle Timer to 3 minutes.	Chiller 1 is disabled.	☐	☐	The specifications do not describe the relationship between pump status and chiller status. Please record any differences from the Expected Results noted during test. Starting Max Chiller Stop-to-Start Cycle Timer setpoint_____min	☐	☐
	Chiller 2 is disabled.	☐	☐		☐	☐
	Primary pump P-3 remains ON for (insert time delay).	☐	☐		☐	☐
	Primary pump P-4 remains ON for (insert time delay).	☐	☐		☐	☐
	The Lead secondary chilled water pump STOPS.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	The Stand-by secondary chilled water pump remains OFF.	☐	☐	New Max Chiller Stop-to-Start Cycle Timer set-point _____ min Starting Wait for Evaporator Flow Timer set-point _____ min New Wait for Evaporator Flow Timer set-point _____ min Primary Pump P-3 ON delay _____ min Primary Pump P-4 ON delay _____ min Lead Secondary pump status_____ Stand-by Secondary pump status _____	☐	☐
Record issues				Issue Log Item: Initial / Date		
6. Reset the Wait for Evaporator Flow Timer set-point to be 2 minutes.	Chiller 1 is disabled.	☐	☐	The specifications do not describe the relationship between pump status and chiller status. Please record any differences from the Expected Results noted during test. Starting Max Chiller Stop-to-Start Cycle Timer setpoint_____min	☐	☐
	Chiller 2 is disabled.	☐	☐		☐	☐
	Primary pump P-3 remains ON for (insert time delay).	☐	☐		☐	☐
	Primary pump P-4 remains ON for (insert time delay).	☐	☐		☐	☐
	The Lead secondary chilled water pump STOPS.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	The Stand-by secondary chilled water pump remains OFF.	☐	☐	New Max Chiller Stop-to-Start Cycle Timer set-point _____ min Starting Wait for Evaporator Flow Timer set-point _____ min New Wait for Evaporator Flow Timer set-point _____ min Primary Pump P-3 ON delay _____ min Primary Pump P-4 ON delay _____ min Lead Secondary pump status_____ Stand-by Secondary pump status _____	☐	☐
Record issues				Issue Log Item: Initial / Date		
7. Switch the Secondary pumps to Auto Lead Designation option.	Chiller 1 is disabled.	☐	☐	The specifications do not describe the relationship between pump status and chiller status. Please record any differences from the Expected Results noted during test. Starting Max Chiller Stop-to-Start Cycle Timer setpoint_____min New Max Chiller Stop-to-	☐	☐
	Chiller 2 is disabled.	☐	☐		☐	☐
	Primary pump P-3 remains ON for (insert time delay).	☐	☐		☐	☐
	Primary pump P-4 remains ON for (insert time delay).	☐	☐		☐	☐
	The Lead secondary chilled water pump STOPS.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	The Stand-by secondary chilled water pump remains OFF.	☐	☐	Start Cycle Timer set-point _____ min Starting Wait for Evaporator Flow Timer set-point _____ min New Wait for Evaporator Flow Timer set-point _____ min Primary Pump P-3 ON delay _____ min Primary Pump P-4 ON delay _____ min Lead Secondary pump status_____ Stand-by Secondary pump status _____	☐	☐
Record issues				Issue Log Item: Initial / Date		
8. Assign the Lead chiller to CH-1 and Lag to CH-2.	Primary pump P-3 STARTS.	☐	☐	Runtime for P-6_____ hours	☐	☐
	After the Wait for Evaporator Flow Timer expires, Chiller CH-1 STARTS.	☐	☐	Runtime for P-7 _____ hours	☐	☐
	The secondary pump with the least amount of runtime is designated Lead and STARTS.	☐	☐	Lead Secondary Pump P-_____	☐	☐
Record issues				Issue Log Item: Initial / Date		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
9. Manually command the Lead chiller to run.	Primary pump P-3 STARTS.	☐	☐	Runtime for P-6_____ hours Runtime for P-7 _____ hours Lead Secondary Pump P-_____	☐	☐
	After the Wait for Evaporator Flow Timer expires, Chiller CH-1 STARTS.	☐	☐		☐	☐
	The secondary pump with the least amount of runtime is designated Lead and STARTS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
10. Manually command the Lag chiller to run.	Primary pump P-4 starts.	☐	☐		☐	☐
	After Wait For Evaporator Flow Timer expires, Chiller CH-2 starts.	☐	☐		☐	☐
	The Lead secondary chilled water pump continues to modulate.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
11. Manually command the Lead chiller to stop.	Chiller CH-1 is de-energized.	☐	☐	Primary Pump P-3 ON delay _____ min	☐	☐
	Primary pump P-3 remains ON for (insert time delay).	☐	☐		☐	☐
	Chiller CH-2 remains ON.	☐	☐		☐	☐
	Primary pump P-4 remains ON.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
12. Manually command the Lag chiller to stop.	Chiller CH-2 is de-energized.	☐	☐	It is not clear whether the Lead secondary pump stops when no chillers are ON or not until the chilled water system has officially been disabled. Please record any variations witnessed in the field. Primary Pump P-4 ON delay _____ min	☐	☐
	Primary pump P-4 remains ON for (insert time delay).	☐	☐		☐	☐
	The Lead secondary chilled water pump STOPS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
VERIFICATION OF AUTOMATIC CHILLER CONTROL						
13. Via the CSM's Control Mode, set the chilled water system to Automatic Control.	After 2 minutes, the chilled water system is enabled.	☐	☐	CH-1 Runtime_____ CH-2 Runtime_____ Lead Chiller CH-_____ Primary Pump P-_____ is ON. Lead Secondary Pump P-_____is ON.	☐	☐
	The Lead secondary chilled water pump STARTS.	☐	☐		☐	☐
	The chiller with the least amount of run-time is enabled and labeled as Lead.	☐	☐		☐	☐
	The primary pump associated with the Lead chiller starts.	☐	☐		☐	☐
	After the Wait for Evaporator Flow Timer, the Lead chiller is energized.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
14. Set chiller sequencing to be according to runtime.	After 2 minutes, the chilled water system is enabled.	☐	☐	CH-1 Runtime_____	☐	☐
	The Lead secondary chilled water pump STARTS.	☐	☐	CH-2 Runtime_____	☐	☐
	The chiller with the least amount of run-time is enabled and labeled as Lead.	☐	☐	Lead Chiller CH-_____ Primary Pump P-_____ is ON.	☐	☐
	The primary pump associated with the Lead chiller starts.	☐	☐	Lead Secondary Pump P-_____is ON.	☐	☐
	After the Wait for Evaporator Flow Timer, the Lead chiller is energized.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
15. Set the chilled water schedule to enable system in 2 minutes at the BAS.	After 2 minutes, the chilled water system is enabled.	☐	☐	CH-1 Runtime_____	☐	☐
	The Lead secondary chilled water pump STARTS.	☐	☐	CH-2 Runtime_____	☐	☐
	The chiller with the least amount of run-time is enabled and labeled as Lead.	☐	☐	Lead Chiller CH-_____ Primary Pump P-_____ is ON.	☐	☐
	The primary pump associated with the Lead chiller starts.	☐	☐	Lead Secondary Pump P-_____is ON.	☐	☐
	After the Wait for Evaporator Flow Timer, the Lead chiller is energized.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
16. Simulate a Lead chiller failure.	Lead chiller de-energizes.	☐	☐		☐	☐
	Lead chiller failure alarm generated at the CSM panel.	☐	☐		☐	☐
	Lead chiller failure alarm generated at BAS.	☐	☐		☐	☐
	The Lag chiller is enabled.	☐	☐		☐	☐
	The primary pump for the Lead chiller STOPS.	☐	☐		☐	☐
	The primary pump for the Lag chiller STARTS.	☐	☐		☐	☐
	The Lag chiller is energized.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
17. Simulate a Lag chiller failure.	Lag chiller de-energizes.	☐	☐		☐	☐
	Lag chiller failure alarm generated at the CSM panel.	☐	☐		☐	☐
	Lag chiller failure alarm generated at BAS.	☐	☐		☐	☐
	The primary pump for the Lag chiller STOPS.	☐	☐		☐	☐
	The Lead secondary pump STOPS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
18. Reset the Lead chiller failure condition.	The Lead secondary pump STARTS.	☐	☐	Lead chiller CH-_____ Lead Secondary Pump P-_____	☐	☐
	The Lead chiller is enabled.	☐	☐		☐	☐
	The primary pump for the Lead chiller STARTS.	☐	☐		☐	☐
	After the Wait for Evaporator Flow Timer expires, the Lead chiller energizes.	☐	☐		☐	☐
	Chiller failure alarm clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
19. Manually reset the Lead chiller failure alarm at the CSM panel.	The Lead secondary pump STARTS.	☐	☐	Lead chiller CH-_____ Lead Secondary Pump P-_____	☐	☐
	The Lead chiller is enabled.	☐	☐		☐	☐
	The primary pump for the Lead chiller STARTS.	☐	☐		☐	☐
	After the Wait for Evaporator Flow Timer expires, the Lead chiller energizes.	☐	☐		☐	☐
	Chiller failure alarm clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
20. Reset the Lag chiller failure condition.	Chiller failure alarm clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
21. Manually reset the Lag chiller failure alarm at the CSM panel.	Chiller failure alarm clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
22. Set the chiller sequencing time of day schedule to disable chilled water system in 2 minutes at the BAS.	After 2 minutes, the Lead chiller de-energizes and is disabled.	☐	☐		☐	☐
	After a delay, the primary pump for the Lead chiller stops.	☐	☐		☐	☐
	The Lead secondary pump STOPS.	☐	☐		☐	☐
	The Lag chiller and its primary pump remain OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
23. Switch the Secondary Lead Pump Designation back to its original selection criteria (Manual/Auto)		☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
VERIFICATION OF CHILLER CAPACITY STAGING CONTROL						
24. Designate chiller CH-2 to be the "First on" chiller through the Chiller Sequencing feature.	The chilled water system is enabled.	☐	☐	Steps 24-?? assume that the (Decoupler Line Temperature) < (Chilled Water Supply Temperature + Decoupler Stage-Up Temperature Differential) Lead Secondary Pump P-_____	☐	☐
	The Lead secondary pump STARTS.	☐	☐		☐	☐
	Chiller CH-2 is enabled.	☐	☐		☐	☐
	Primary pump P-4 starts.	☐	☐		☐	☐
	After the Wait for Evaporator Flow Timer, Chiller CH-2 is energized.	☐	☐		☐	☐
Record issues				Issue Log Item:	☐	☐
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
25. Via the "Operator Scheduled Override" option, enable the chilled water system.	The chilled water system is enabled.	☐	☐	Steps 24-?? assume that the (Decoupler Line Temperature) < (Chilled Water Supply Temperature + Decoupler Stage-Up Temperature Differential) Lead Secondary Pump P-_____	☐	☐
	The Lead secondary pump STARTS.	☐	☐		☐	☐
	Chiller CH-2 is enabled.	☐	☐		☐	☐
	Primary pump P-4 starts.	☐	☐		☐	☐
	After the Wait for Evaporator Flow Timer, Chiller CH-2 is energized.	☐	☐		☐	☐
Record issues				Issue Log Item:	☐	☐
				Initial / Date		
26. Reset the Chiller Stage-up Differential to be 30F.	Primary pump P-4 is ON.	☐	☐	Starting Chilled Water Supply Temperature set-point _____ F Ending Chilled Water Supply Temperature set-point _____ F	☐	☐
	CH-2 is at full load.	☐	☐		☐	☐
	CH-1 remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
27. Reset the Chiller Stage Delay Time variable to be 60 minutes.	Primary pump P-4 is ON.	☐	☐	Starting Chilled Water Supply Temperature set-point _____ F Ending Chilled Water Supply Temperature set-point _____ F	☐	☐
	CH-2 is at full load.	☐	☐		☐	☐
	CH-1 remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
28. Decrease the Chilled Water Supply Temperature set-point in 1F increments below the current chilled water supply temperature until Lead chiller is at full load.	Primary pump P-4 is ON.	☐	☐	Starting Chilled Water Supply Temperature set-point _____ F Ending Chilled Water Supply Temperature set-point _____ F	☐	☐
	Primary pump P-4 is ON.	☐	☐		☐	☐
	CH-1 remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
29. Adjust the Chiller Stage-up Differential to be 2F.	Chiller CH-2 remains at full load.	☐	☐		☐	☐
	Lag chiller CH-1 remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
30. Adjust the Chilled Water Supply Temperature set-point to be 5F below the current chilled water supply temperature.	Chiller CH-2 remains at full load.	☐	☐		☐	☐
	Lag chiller CH-1 remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
31. Reset the Chiller Stage Delay Time variable to be 2 minutes.	After 2 minutes, the Lag chiller CH.	☐	☐	New Chilled Water Supply Temperature set-point _____ F	☐	☐
	Primary pump P.	☐	☐		☐	☐
	After the Wait for Evaporator Flow Timer expires, CH.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
32. Reset the Chiller Stage Delay Time variable to be 60 minutes.	Chillers CH-1 and CH-2 remain ON.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
33. Adjust the Active Capacity set-point to be less than (Spare Capacity Factor * Sum of All Spare Capacity of All Running Chillers).	Chillers CH-1 and CH-2 remain ON.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
34. Reset the Chiller Stage Delay Time variable to be 2 minutes.	After 2 minutes, Chiller CH.	☐	☐	New Active Capacity set-point _____	☐	☐
	After a time delay, primary pump P.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
VERIFICATION OF CHILLER FLOW STAGING CONTROL						
35. Adjust the Chilled Water Supply Temperature set-point to be 1F above the current chilled water supply temperature.	CH-2 is not at full load.	☐	☐		☐	☐
	CH-1 remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
36. Reset the Chiller Stage Delay Time variable to be 60 minutes.	CH-2 is not at full load.	☐	☐		☐	☐
	CH-1 remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
37. Adjust the Decoupler Stage-Up Temperature Differential Set-Point so the following is true: (Current Decoupler Line Temperature + Decoupler Stage-Up Temperature Differential Set-Point) > Current chilled water supply temperature	CH-2 is not at full load.	☐	☐		☐	☐
	CH-1 remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
38. Reset the Chiller Stage Delay Time variable to be 2 minutes.	After 2 minutes, the Lag chiller CH.	☐	☐		☐	☐
	Primary pump P.	☐	☐		☐	☐
	After the Wait for Evaporator Flow Timer expires, chiller CH.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
39. Override the Active Capacity input on CH-1 to be less than (Spare Capacity Factor*Sum of All Spare Capacity of All Remaining Chillers)	After 2 minutes, the Lag chiller remains ON.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
40. Adjust the Chiller Stage Delay Time variable to be 60 minutes.	Both the Lead and Lag chillers remain ON.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
41. Adjust the Decoupler Stage-Down Flow Rate Factor set-point to be greater than (the Current Decoupler Flow Rate/Current Lag Chiller Flow Rate).	Both the Lead and Lag chillers remain ON.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
42. Adjust the Chiller Stage Delay Time variable to be 2 minutes.	After 2 minutes, the Lag Chiller CH.	☐	☐		☐	☐
	After a time delay, primary pump P.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
43. Return the Chiller Stage Delay Time variable to its original value.	System resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
44. Return the Decoupler Stage-Down Flow Rate Factor set-point back to its original value.	System resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
45. Release the Active Capacity input override for CH-1.	System resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
46. Return the Decoupler Stage-Up Temperature Differential set-point back to its original value.	System resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
47. Return the chilled water supply temperature set-point back to its original value.	System resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
48. Return the Chiller Stage-Up Differential Temperature set-point back to its original value.	System resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
49. Return the Chiller Sequencing option back to original selection.	System resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
VERIFICATION OF AUTOMATIC PUMP SPEED CONTROL						
50. Decrease the differential pressure set-point by 20%.	The Lead secondary chilled water pump speed decreases.	☐	☐	It is the understanding of the test writer that there are two secondary pumps each sized at 100% of the load. The test is written around a Lead/Stand-by configuration. If in the field it is determined that this is not the correct operation, the test steps will need to be field modified . Starting Differential Pressure setpoint_____psi Adjusted Differential Pressure Setpoint:_____psi	☐	☐
	The Stand-by secondary chilled water pump is OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
51. Increase the differential pressure set-point by 20%.	The Lead secondary chilled water pump speed increases.	☐	☐	New Differential Pressure Set-Point:_____	☐	☐
	The Stand-by pump remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
52. Manually reassign secondary pump designations, Lead and Stand-by.	No changes are noted. The old Lead pump remains ON. The old Stand-by pump remains OFF.	☐	☐	The sequence states the only under certain conditions will the system implement the new Lead pump if the chilled water system is already enabled. This step is to show that this is not one of those conditions.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
53. Switch the pumps back to their original designation.	No changes are noted.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
54. Reset the Pump Status Check Delay Time variable to 30 seconds.	The Lead secondary pump stops	☐	☐		☐	☐
	After 30 seconds, the Stand-by secondary pump starts.	☐	☐		☐	☐
	A Pump Failure alarm sounds at the CSM panel.	☐	☐		☐	☐
	A Pump Failure alarm sounds at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
55. Simulate a loss of power pump failure at the Lead secondary chilled water pump.	The Lead secondary pump stops.	☐	☐		☐	☐
	After 30 seconds, the Stand-by secondary pump starts.	☐	☐		☐	☐
	A Pump Failure alarm sounds at the CSM panel.	☐	☐		☐	☐
	A Pump Failure alarm sounds at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
56. Decrease the differential pressure set-point by 20%	The Stand-by secondary chilled water pump speed decreases.	☐	☐	New Differential Pressure set-point _____ psi.	☐	☐
	The Lead secondary chilled water pump remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
57. Increase the differential pressure set-point by 20%	The Stand-by secondary chilled water pump speed increases.	☐	☐	New Differential Pressure set-point _____ psi.	☐	☐
	The Lead secondary chilled water pump remains OFF.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
58. Simulate a loss of power pump failure at the Stand-by secondary chilled water pump.	The Stand-by secondary pump STOPS.	☐	☐	Intent is to show that in cases with failure of both secondary chilled water pumps, the entire chilled water system is disabled.	☐	☐
	The Lead secondary pump is OFF.	☐	☐		☐	☐
	A “No Chilled Water Flow” alarm sounds at the CSM panel.	☐	☐		☐	☐
	A Pump Failure alarm sounds at the BAS.	☐	☐		☐	☐
	Both chillers de-energize.	☐	☐		☐	☐
	The primary pumps STOP.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
59. Restore power to the Stand-by secondary chilled water pump.	The system remains disabled.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
60. Manually reset Standby Pump Failure alarm at the CSM panel.	The Stand-by Pump Failure alarm is cleared at the BAS.	☐	☐		☐	☐
	The chilled water system is enabled.	☐	☐		☐	☐
	The Stand-by secondary pump STARTS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
61. Restore power to the Lead secondary chilled water pump.	The Lead secondary chilled water pump STARTS.	☐	☐	The sequence is unclear if this is a condition where the previously stopped Lead pump would be brought back into service automatically. Please note variations seen in the field.	☐	☐
	The Stand-by secondary chilled water pump STOPS.	☐	☐		☐	☐
	The Pump Failure alarm clears at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
62. Manually reset the Lead Pump Failure alarm at the CSM panel.	The Lead secondary chilled water pump STARTS.	☐	☐	The sequence is unclear if this is a condition where the previously stopped Lead pump would be brought back into service automatically. Please note variations seen in the field.	☐	☐
	The Stand-by secondary chilled water pump STOPS.	☐	☐		☐	☐
	The Pump Failure alarm clears at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
63. Return the differential pressure set-point back to its original value.	System resumes normal operation.	☐	☐	Ending Differential Pressure Set-Point:_____ Ending Pump Status Check Delay Time variable _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
64. Reset the Pump Status Check Delay Time variable back to its original value.	System resumes normal operation.	☐	☐	Ending Differential Pressure Set-Point:_____ Ending Pump Status Check Delay Time variable _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
65. Switch Secondary Lead/Stand-by pump designation selection back to its original method (Auto/Manual)	System resumes normal operation.	☐	☐	Ending Differential Pressure Set-Point:_____ Ending Pump Status Check Delay Time variable _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
66. Ensure all control points are set to original values and/or conditions.	System resumes normal operation.	☐	☐	Ending Differential Pressure Set-Point:_____ Ending Pump Status Check Delay Time variable _____	☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
RETURN TO INITIAL CONDITIONS						
67. Record test stop time	Recorded.	☐	☐	Time: (am / pm)	☐	☐
Record issues				Issue Log Item:		
				Initial / Date		

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

SAMPLE

Test Notes and Lessons Learned

SAMPLE

Back to page L-1

Back to Cx Plan Appendix C

Modular Indoor Central Station Air Handling Unit Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:

Operational Assumptions:

Associated air handling equipment and ducts has been tested and is operating correctly.

The test begins while the room is in the occupied mode.

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

SAMPLE

Re-Test 1		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 2		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Deferred/Seasonal Test		**Start Date**	**End Date**	**Initials**
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

SAMPLE

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

Supplies Required for Testing (To be provided by the contractor)

Tools / Supplies	
Laptop with TC Program	Infrared Thermometer Gun
PID Loop Tuning Software	Humidity Tester
Aerosol for Smoke and Freeze stat Test	Basic Tool Pouch
Radio Communications	Flashlight

System Readiness Summary Checklist

Description	Yes	No	Date
System Readiness Checklist has been completed	☐	☐	
System Ready for Test	☐	☐	
Required Personnel Available	☐	☐	
Required Tools/Test Equipment/Supplies Available	☐	☐	
Required Safety Equipment Available	☐	☐	

SAMPLE

Set-Points, Limits, and Schedules

☐ AHU can be assigned a schedule. ☐ Schedule can be programmed daily.

☐ If system runs 24 hours a day, check here. If not, fill in the occupied mode schedule below.

	AM												PM											
Day	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Sun																								
Mon																								
Tues																								
Wed																								
Thurs																								
Fri																								
Sat																								
Holi																								

Parameter	Setpoint		Adjustable Range	
	Design	**Actual**	**Design**	**Actual**
Outside Air Temperature (°F)				
Preheat valve full open outside air temperature (°F)				
Discharge Air Temperature (°F)				
Night Setback Temperature (°F)				
Night Setback Differential				
Mixed Air Temperature (°F)				
Minimum Start-up Fan Speed (%)				
Time at Minimum Fan Speed for Start-up (min)				
Average Zone Humidity (%RH)				
Maximum supply air humidity (%RH)				
Discharge Air Static Pressure (in H_2O)				
High Static Alarm (in H_2O)				
Low Static Alarm (in H_2O)				
System Shutdown High Static Limit (in H_2O)				

SAMPLE

Parameter	Setpoint		Adjustable Range	
	Design	Actual	Design	Actual
Damper Position				

Initial Ambient Conditions

Ambient Conditions			
Outside Air Temp		Outside Air RH %	
Precipitation			

Trend Data Required To Support Testing

Check if trend point chart(s) and Frequency Graph(s) are provided per trend requirements shown below.

Trend Log Setup #1 – Temperature						
Pre-Testing	Post Testing	Point	Frequency	Duration	Initial Value	Provided
☐	☐	Outside Air Temperature (°F)				☐ Yes ☐ No
☐	☐	Preheat valve full open outside air temperature (°F)				☐ Yes ☐ No
☐	☐	Discharge Air Temperature (°F)				☐ Yes ☐ No
☐	☐	Night Setback Temperature (°F)				☐ Yes ☐ No
☐	☐	Night Setback Differential				☐ Yes ☐ No
☐	☐	Mixed Air Temperature (°F)				☐ Yes ☐ No
Record Issues				Issue Log Item Number:		

SAMPLE

Check if trend point chart(s) and Frequency Graph(s) are provided per trend requirements shown below.

Trend Log Setup #2 – Global						
Pre-Testing	**Post Testing**	**Point**	**Frequency**	**Duration**	**Initial Value**	**Provided**
☐	☐	System Flow Rate				☐ Yes ☐ No
☐	☐	Flow Rate Set Point				☐ Yes ☐ No
☐	☐	Water Quality				☐ Yes ☐ No
☐	☐	Damper Position				☐ Yes ☐ No
☐	☐	System Pressure				☐ Yes ☐ No
☐	☐	Pressure Set Point				☐ Yes ☐ No
Record Issues				Issue Log Item Number:		

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**

C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL PRELIMINARY DATA AND INSPECTION						
1. Record the current values for all the required trending points in Trend Log table above.	Recorded.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
2. Confirm equipment is operating normally as assumed above. If not make adjustments within the Building Automation System (BAS)	Confirmed.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
RETURN / EXHAUST FAN SECTION						
3. Command the Return / Exhaust Fan to stop "OFF"	Return / Exhaust Fan is off.	☐	☐		☐	☐
	Return / Exhaust Fan VFD commanded to 0%.	☐	☐		☐	☐
	Return / Exhaust Fan Status device indicates fan is OFF.	☐	☐		☐	☐
	Fan isolation damper closed.	☐	☐		☐	☐
	Outside air damper is closed.	☐	☐		☐	☐
	Return air damper is 100% open.	☐	☐		☐	☐
	Exhaust air damper is closed.	☐	☐		☐	☐
	Humidifier is off and commanded to 0%.	☐	☐		☐	☐
	Face & bypass remain under BAS control.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Preheat valve remains under BAS control.	☐	☐		☐	☐
	Cooling valve is closed.	☐	☐		☐	☐
	R.A. quantity confirmed by airflow measuring station.	☐	☐	R.A. Quantity Observed _____ CFM	☐	☐
	E.A. quantity confirmed by airflow measuring station.	☐	☐	E.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Command the Return / Exhaust Fan "ON"	Outside air damper opens.	☐	☐	Minimum Return / Exhaust Fan VFD minimum speed:_____ Ramp Up time to achieve minimum speed:_____	☐	☐
	Wall mounted outside, return, and exhaust air unit mounted dampers open fully.	☐	☐		☐	☐
	Return / Exhaust damper opens.	☐	☐		☐	☐
	Return / Exhaust Fan VFD shall be commanded to run at minimum speed.	☐	☐		☐	☐
	Return / Exhaust Fan Status device indicates the unit is ON while operating at a minimum speed.	☐	☐		☐	☐
	Return / Exhaust Fan speed modulates to maintain return / exhaust differential pressure set-point.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Cooling valve is under BAS control.	☐	☐		☐	☐
	Humidifier valve is under BAS control.	☐	☐		☐	☐
	Preheat valve is under BAS control.	☐	☐		☐	☐
	Face and bypass dampers is under BAS control.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
ECONOMIZER SECTION (3-DAMPER SECTION)						
5. Minimum O.A. damper (2-position) commanded closed	Damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum O.A. damper is closed.	☐	☐		☐	☐
	Minimum O.A. quantity confirmed by airflow measuring station.	☐	☐	O.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
6. Minimum O.A. damper (2-position) commanded open	Damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum O.A. damper is open.	☐	☐		☐	☐
	Minimum O.A. quantity confirmed by airflow measuring station.	☐	☐	O.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
7. O.A. damper (modulating) commanded closed	Damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates O.A. damper is closed.	☐	☐		☐	☐
	O.A. quantity confirmed by airflow measuring station.	☐	☐	O.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
8. O.A. damper (modulating) commanded to 100% open	Damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum O.A. damper is open.	☐	☐		☐	☐
	O.A. quantity confirmed by airflow measuring station.	☐	☐	O.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. O.A. damper (modulating) commanded to 50% open	Damper opens half way without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum O.A. damper is open.	☐	☐		☐	☐
	O.A. quantity confirmed by airflow measuring station.	☐	☐	O.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
10. R.A. damper (modulating) commanded closed	Damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates R.A. damper is closed.	☐	☐		☐	☐
	R.A. quantity confirmed by airflow measuring station.	☐	☐	R.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
11. R.A. damper (modulating) commanded to 100% open	Damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum R.A. damper is open.	☐	☐		☐	☐
	R.A. quantity confirmed by airflow measuring station.	☐	☐	R.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
12. R.A. damper (modulating) commanded to 50% open	Damper opens half way without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum R.A. damper is open.	☐	☐		☐	☐
	R.A. quantity confirmed by airflow measuring station.	☐	☐	R.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
13. M.A. damper (modulating) commanded closed	Damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates M.A. damper is closed.	☐	☐		☐	☐
	M.A. quantity confirmed by airflow measuring station.	☐	☐	M.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
14. M.A. damper (modulating) commanded to 100% open	Damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum M.A. damper is open.	☐	☐		☐	☐
	M.A. quantity confirmed by airflow measuring station.	☐	☐	M.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
15. M.A. damper (modulating) commanded to 50% open	Damper opens half way without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum M.A. damper is open.	☐	☐		☐	☐
	M.A. quantity confirmed by airflow measuring station.	☐	☐	M.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
16. Release all damper overrides.	Dampers return to normal operating positions.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
MIXING BOX SECTION (2-DAMPER SECTION)						
17. O.A. damper commanded fully closed	Damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates O.A. damper is closed.	☐	☐		☐	☐
	O.A. quantity confirmed by airflow measuring station.	☐	☐	O.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
18. O.A. damper commanded fully open	Damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum O.A. damper is open.	☐	☐		☐	☐
	O.A. quantity confirmed by airflow measuring station.	☐	☐	O.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
19. O.A. damper commanded 50% open	Damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum O.A. damper is open.	☐	☐		☐	☐
	O.A. quantity confirmed by airflow measuring station.	☐	☐	O.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
20. R.A. damper commanded fully closed	Damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates R.A. damper is closed.	☐	☐		☐	☐
	R.A. quantity confirmed by airflow measuring station.	☐	☐	R.A. Quantity Observed _____ CFM	☐	☐
Record Issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
21. R.A. damper commanded fully open	Damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum O.A. damper is open.	☐	☐		☐	☐
	O.A. quantity confirmed by airflow measuring station.	☐	☐	R.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
22. R.A. damper commanded 50% open	Damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates minimum O.A. damper is open.	☐	☐		☐	☐
	O.A. quantity confirmed by airflow measuring station.	☐	☐	R.A. Quantity Observed _____ CFM	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
23. Release all damper overrides.	Dampers return to normal operating positions	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-FILTER SECTION						
24. Activate the filter high pressure differential switch by applying pressure to the high side of the switch.	Dirty filter alarm indicated at BAS.	☐	☐	Filter Pressure at alarm _____ in. WC	☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
25. Release pressure from high side of switch and return to its normal condition.	Dirty filter alarm cleared at BAS.	☐	☐	Filter Pressure at alarm _____ in. WC	☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
ENTHALPY WHEEL						
26. Command enthalpy wheel to stop.	Enthalpy wheel rotation stops.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
27. Command enthalpy wheel rotate at its maximum speed.	Enthalpy wheel rotation begins, and in the correct direction.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
28. Command enthalpy wheel rotate at 50% of its maximum speed.	Enthalpy wheel rotation slows to 50% of its maximum speed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
FACE AND BYPASS DAMPERS						
29. Face and bypass dampers commanded fully open.	Face damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates face damper is fully open.	☐	☐		☐	☐
	Bypass damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates bypass damper is fully open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
30. Face damper commanded to fully closed	Damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates face damper is closed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
31. Face damper commanded to 50% open	Damper opens half way without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates damper is open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
32. Face damper commanded fully open. Bypass damper commanded fully closed.	Face damper opens fully.	☐	☐		☐	☐
	Status device indicates face damper is fully open.	☐	☐		☐	☐
	Bypass damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
33. Bypass damper commanded to 50% open	Damper opens half way without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates damper is open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
34. Release all damper overrides.	Dampers return to normal operating positions.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
DRAW-THRU COIL SECTION						
35. Command preheat coil control valve to 100% open.	Preheat coil valve fully opens.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
36. Command preheat coil control valve to close fully.	Preheat coil valve fully closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
37. Command preheat coil control valve to 50% open.	Preheat coil control valve opens to 50%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
38. Remove power from the preheat control valve actuator.	Preheat coil control valve moves to its fail safe position (fully open).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
39. Release overrides on preheat coil valve.	Preheat coil control valve returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
40. Command chilled water coil control valve to 100% open.	Chilled water coil valve fully opens.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
41. Command chilled water coil control valve to close fully.	Chilled water coil valve fully closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
42. Command chilled water coil control valve to 50% open.	Chilled water coil control valve opens to 50%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
43. Remove power from the chilled water control valve actuator.	Chilled water coil control valve moves to its fail safe position (fully closed).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
44. Release override on chilled water coil valve.	Chilled water coil control valve returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
HORIZONTAL COIL SECTION						
45. Command preheat coil control valve to 100% open.	Preheat coil valve fully opens.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
46. Command preheat coil control valve to close fully.	Preheat coil valve fully closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
47. Command preheat coil control valve to 50% open.	Preheat coil control valve opens to 50%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
48. Remove power from the preheat control valve actuator.	Preheat coil control valve moves to its fail safe position (fully open).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
49. Release overrides on preheat coil valve.	Preheat coil control valve returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
50. Command chilled water coil control valve to 100% open.	Chilled water coil valve fully opens.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
51. Command chilled water coil control valve to close fully.	Chilled water coil valve fully closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
52. Command chilled water coil control valve to 50% open.	Chilled water coil control valve opens to 50%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
53. Remove power from the chilled water control valve actuator.	Chilled water coil control valve moves to its fail safe position (fully closed).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
54. Release override on chilled water coil valve.	Chilled water coil control valve returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
SUPPLY FAN SECTION						
55. Command the Supply Fan to stop "OFF"	Supply Fan is off.	☐	☐		☐	☐
	Supply Fan VFD commanded to 0%.	☐	☐		☐	☐
	Supply Fan Status device indicates fan is OFF.	☐	☐		☐	☐
	Fan isolation damper closed.	☐	☐		☐	☐
	Outside air damper is closed.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Return air damper is 100% open.	☐	☐		☐	☐
	Exhaust air damper is closed.	☐	☐		☐	☐
	Humidifier is off and commanded to 0%.	☐	☐		☐	☐
	Face & bypass remain under BAS control.	☐	☐		☐	☐
	Preheat valve remains under BAS control.	☐	☐		☐	☐
	Cooling valve is closed.	☐	☐		☐	☐
	S.A. quantity confirmed by airflow measuring station.	☐	☐	S.A. Quantity Observed _____ CFM	☐	☐
Record issue				Issue Log Item:		
				Initial / Date		
56. Command the Supply Fan "ON"	Outside air damper opens.	☐	☐	Minimum Return / Exhaust Fan VFD minimum speed:_____ Ramp Up time to achieve minimum speed:_____	☐	☐
	Wall mounted outside, return, and exhaust air unit mounted dampers open fully.	☐	☐		☐	☐
	Supply damper opens.	☐	☐		☐	☐
	Supply Fan VFD shall be commanded to run at minimum speed.	☐	☐		☐	☐
	Supply Fan Status device indicates the unit is ON while operating at a minimum speed.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Supply Fan speed modulates to maintain supply duct pressure set-point.	☐	☐		☐	☐
	Cooling valve is under BAS control.	☐	☐		☐	☐
	Humidifier valve is under BAS control.	☐	☐		☐	☐
	Preheat valve is under BAS control.	☐	☐		☐	☐
	Face and bypass dampers is under BAS control.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
BLOW-THRU COIL SECTION						
57. Command reheat coil control valve to 100% open.	Reheat coil valve fully opens.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						
58. Command reheat coil control valve to close fully.	Reheat coil valve fully closes.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
Record issues				Issue Log Item:		
				Initial	Date	
59. Command reheat coil control valve to 50% open.	Reheat coil control valve opens to 50%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
60. Remove power from the reheat control valve actuator.	Reheat coil control valve moves to its fail safe position (fully open).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
61. Release overrides on reheat coil valve.	Preheat coil control valve returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
62. Command chilled water coil control valve to 100% open.	Chilled water coil valve fully opens.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
63. Command chilled water coil control valve to close fully.	Chilled water coil valve fully closes.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
Record issues				Issue Log Item:		
				Initial	Date	
64. Command chilled water coil control valve to 50% open.	Chilled water coil control valve opens to 50%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
65. Remove power from the chilled water control valve actuator.	Chilled water coil control valve moves to its fail safe position (fully closed).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
66. Release override on chilled water coil valve.	Chilled water coil control valve returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
FINAL FILTER SECTION						
67. Activate the filter high pressure differential switch by applying pressure to the high side of the switch.	Dirty filter alarm indicated at BAS.	☐	☐	Filter Pressure at alarm _____ in. WC	☐	☐
Record issues				Issue Log Item:		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS		R	C
				Initial	Date		
68. Release pressure from high side of switch and return to its normal condition.	Dirty filter alarm cleared at BAS.	☐	☐	Filter Pressure at alarm _____ in. WC		☐	☐
Record issues				Issue Log Item:			
				Initial	Date		
HUMIDIFIER VALVES							
69. Command humidifier isolation valve to fully close. Command humidifier control valve fully open.	I s o l a t i o n v a l v e c l o s e s .	☐	☐			☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	H umidifier control valve fully opens.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	No steam enters supply air stream.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
70. Command humidifier control valve fully closed.	Humidifier control valve fully closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
71. Command humidifier isolation valve fully open.	Humidifier isolation valve fully opens.	☐	☐		☐	☐
	No steam is enters supply air stream.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
72. Command humidifier control valve 50% open.	Humidifier control valve opens 50%.	☐	☐		☐	☐
	Steam begins entering supply air stream.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
73. Command humidifier control valve 100% open.	Humidifier control valve opens 100%.	☐	☐		☐	☐
	Steam flow into supply air stream increases.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
74. Remove power from the humidifier control valve and isolation valve.	Humidifier isolation valve moves to its fail safe position (fully closed).	☐	☐		☐	☐
	Humidifier control valve moves to its fail safe position (fully closed).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
75. Release override on humidifier valves.	Humidifier valves return to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
MULTIZONE COIL SECTION						
76. Command hot deck heating coil control valve to 100% open.	Heating coil valve fully opens.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
77. Command hot deck heating coil control valve to close fully.	Heating coil valve fully closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
78. Command hot deck heating coil control valve to 50% open.	Heating coil control valve opens to 50%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
79. Remove power from the hot deck heating coil control valve actuator.	Heating coil control valve moves to its fail safe position (fully open).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
80. Release overrides on hot deck heating coil valve.	Preheat coil control valve returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
81. Command cold deck coil control valve to 100% open.	Chilled water coil valve fully opens.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
82. Command cold deck coil control valve to close fully.	Chilled water coil valve fully closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
83. Command cold deck coil control valve to 50% open.	Chilled water coil control valve opens to 50%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
84. Remove power from the cold deck control valve actuator.	Chilled water coil control valve moves to its fail safe position (fully closed).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
85. Release override on cold deck coil valve.	Chilled water coil control valve returns to normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the follwong page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
MULTIZONE DAMPERS						
86. Command hot and cold deck multizone dampers fully open.	Hot deck damper opens fully without binding for complete travel distance.	☐	☐	Number of Zones: _____ (Complete steps for each set of zones)	☐	☐
	Status device indicates hot deck damper is fully open.	☐	☐		☐	☐
	Cold deck damper opens fully without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates cold deck damper is fully open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
87. Cold deck damper commanded to fully closed	Damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates damper is closed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
88. Cold deck damper commanded to 50% open	Damper opens half way without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates damper is open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
89. Cold deck damper commanded fully open. After face damper confirmed open, bypass damper commanded fully closed.	Cold deck damper opens fully.	☐	☐		☐	☐
	Hot deck damper closes tightly without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates hot deck damper is closed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
90. Hot deck damper commanded to 50% open	Damper opens half way without binding for complete travel distance.	☐	☐		☐	☐
	Status device indicates damper is open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
91. Release all damper overrides.	Dampers return to normal operating positions.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

(Test continues on the following page.)

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
FREEZESTAT AND SYSTEM STARTUP						
92. Apply aerosol spray to the serpentine temperature sensor (Freezestat).	Low temperature limit trips.	☐	☐		☐	☐
	Supply fan VFD commanded to 0%.	☐	☐		☐	☐
	Supply fan shuts down.	☐	☐		☐	☐
	Outside air damper fully closes.	☐	☐		☐	☐
	Fire smoke dampers close.	☐	☐		☐	☐
	Humidifier is off and commanded to 0%.	☐	☐		☐	☐
	Face and bypass damper modulates.	☐	☐		☐	☐
	Preheat valve fully opens.	☐	☐		☐	☐
	Cooling valve closed.	☐	☐		☐	☐
	Low limit temperature alarm generated at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
93. Command the system Off	The system remains in the shutdown sequence.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
94. Disconnect the power to the local control panel	Control panel is off.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
95. After 2-5 minutes reconnect power to the control panel (Control Panel Power Loss)	Control panel becomes operational upon restoration of power.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
96. Command the system back ON (System Startup)	System remains shut down.	☐	☐	System requires manual reset of tripped device before air handling unit is restarted.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
97. Manually reset the Freezestat (System startup)	Outside air damper opens.	☐	☐	Minimum supply fan speed:_____	☐	☐
	Return air damper modulate as normal.	☐	☐	Duration fan at minimum speed:_____	☐	☐
	Supply fan VFD shall be commanded to run.	☐	☐		☐	☐
	Supply fan turns ON at minimum speed for specified length of time.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Supply fan speed modulates to maintain differential pressure set-point.	☐	☐		☐	☐
	Cooling valve is under BAS control.	☐	☐		☐	☐
	Humidifier valve is under BAS control.	☐	☐		☐	☐
	Preheat valve is under BAS control.	☐	☐		☐	☐
	Face and bypass dampers is under BAS control.	☐	☐		☐	☐
	Low limit temperature alarm clears at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
SUPPLY FAN FAILURE						
98. At the local power disconnect or HOA switch, open the power loop to stop the fan. (Supply Fan Failure)	The supply fan turns off.	☐	☐		☐	☐
	Supply fan failure alarm is generated at the BAS.	☐	☐		☐	☐
	Fan isolation damper closed.	☐	☐		☐	☐
	Outside air damper is closed.	☐	☐		☐	☐
	Humidifier valve is closed.	☐	☐		☐	☐
	Cooling coil valve is closed.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Preheat valve is under BAS control.	☐	☐		☐	☐
	Face & Bypass damper is under BAS control.	☐	☐		☐	☐
	Return/Exhaust Fan shuts down.	☐	☐		☐	☐
	Wall mounted supply, return air isolation, unit mounted outdoor air dampers close fully.	☐	☐		☐	☐
	Unit mounted return air dampers open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
99. At the local power panel reconnect the disconnect or HOA switch, close the power loop to start the fan/fans. (Supply Fan Failure)	Outside air damper is open.	☐	☐		☐	☐
	Wall mounted supply, return air isolation, unit mounted outdoor air dampers open.	☐	☐		☐	☐
	Unit mounted return air dampers remain open.	☐	☐		☐	☐
	The supply fan turns ON.	☐	☐		☐	☐
	Supply fan failure alarm clears at the BAS.	☐	☐		☐	☐
	Humidifier valve is under BAS control.	☐	☐		☐	☐
	Cooling coil valve is under BAS control.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Preheat valve is under BAS control.	☐	☐		☐	☐
	Face & Bypass damper is under BAS control.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
RETURN/EXHAUST FAN FAILURE						
100 At the local power disconnect or HOA switch, open the power loop to stop the return/exhaust fan.	The return/exhaust fan turns off.	☐	☐		☐	☐
	Fan isolation damper closed.	☐	☐		☐	☐
	Current sensing relay indicates a loss of current from the component.	☐	☐		☐	☐
	Return/Exhaust fan failure alarm generated at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
101 At the local power disconnect or HOA switch, close the power loop to stop the return/exhaust fan.	The return/exhaust fan turns on.	☐	☐		☐	☐
	Current sensing relay senses current from the component.	☐	☐		☐	☐
	Return/Exhaust fan failure alarm cleared at the BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
HIGH DUCT STATIC PRESSURE LIMIT SWITCH						
102 Adjust the system shutdown high limit discharge air static pressure limit switch set-point to be just below the current discharge air static pressure or use a pump bulb and gauge to simulate high static conditions and record the setting. (High Pressure System Shutdown Alarm)	High static limit switch alarm is generated at BAS.	☐	☐	System Shutdown High Limit Switch Set-point: _____	☐	☐
	The supply fan turns off.	☐	☐		☐	☐
	Unit is indexed to Unoccupied Mode.	☐	☐		☐	☐
	Smoke dampers are closed.	☐	☐		☐	☐
	Outside air damper is closed.	☐	☐		☐	☐
	Humidifier valve is closed.	☐	☐		☐	☐
	Cooling coil valve is closed.	☐	☐		☐	☐
	Preheat valve is under BAS control.	☐	☐		☐	☐
	Face & Bypass damper is under BAS control.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
103 Return the system shutdown high pressure limit switch set-point back to its original value or release the pump bulb pressure simulation	High pressure alarm is cleared at BAS.	☐	☐		☐	☐
	System does not restart.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
104 Manually reset the high pressure limit switch.	System restarts and resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
LOW DUCT STATIC PRESSURE LIMIT SWITCH						
105 Adjust the system shutdown low limit discharge air static pressure limit switch set-point to be just below the suction side static pressure or use a pump bulb and gauge to simulate low static conditions and record the setting. (Low Pressure System Shutdown Alarm)	Low static limit switch alarm is generated at BAS.	☐	☐	System Shutdown Low Limit Switch Set-point: _____	☐	☐
	The supply fan turns off.	☐	☐		☐	☐
	Unit is indexed to Unoccupied Mode.	☐	☐		☐	☐
	Smoke dampers are closed.	☐	☐		☐	☐
	Outside air damper is closed.	☐	☐		☐	☐
	Humidifier valve is closed.	☐	☐		☐	☐
	Cooling coil valve is closed.	☐	☐		☐	☐
	Preheat valve is under BAS control.	☐	☐		☐	☐
	Face & Bypass damper is under BAS control.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
106 Return the system shutdown low pressure limit switch set-point back to its original value or release the pump bulb pressure simulation	Low pressure alarm is cleared at BAS.	☐	☐		☐	☐
	System does not restart.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
107 Manually reset the low pressure limit switch.	System restarts and resumes normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
DUCT SMOKE DETECTION						
108 Apply aerosol smoke to the duct smoke detectors (Smoke Detection)	Smoke detection alarm is sent to the BAS.	☐	☐		☐	☐
	The supply fan turns off.	☐	☐		☐	☐
	Wall mounted supply, return air isolation, unit mounted outdoor air dampers close fully.	☐	☐		☐	☐
	Unit mounted return air dampers open.	☐	☐		☐	☐
	Outside air damper is closed.	☐	☐		☐	☐
	Humidifier valve is closed.	☐	☐		☐	☐
	Cooling coil valve is closed.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Preheat valve is under BAS control.	☐	☐		☐	☐
	Face & Bypass damper is under BAS control.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
109 Manually reset the smoke detector. (Smoke Detection)	Smoke detection alarm clears.	☐	☐		☐	☐
	Wall mounted supply, return air isolation, unit mounted outdoor air dampers open fully.	☐	☐		☐	☐
	Unit mounted return air dampers remain open.	☐	☐		☐	☐
	Outside air damper opens.	☐	☐		☐	☐
	Supply fan VFD shall be commanded to run.	☐	☐		☐	☐
	Supply fan turns ON at minimum speed for a specified length of time.	☐	☐		☐	☐
	Supply fan speed modulates to maintain differential pressure set-point.	☐	☐		☐	☐
	Humidifier valve is under BAS control.	☐	☐		☐	☐
	Cooling coil valve is under BAS control.	☐	☐		☐	☐
	Preheat valve is under BAS control.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Face & Bypass damper is under BAS control.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
FUNCTIONAL TESTS – UNOCCUPIED NIGHT SETBACK – SETUP MODE						
110 Modulate the outside air temperature for AHU # to be below 80°F	Return air damper closes to 10% minimum position.	☐	☐		☐	☐
	Outside air damper opens to 90% maximum position.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
111 Modulate the outside air temperature for AHU # to be above 80°F	Outside air damper closes to 10% minimum position.	☐	☐		☐	☐
	Return air damper opens to 90% maximum position.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
112 Adjust the discharge air temperature set-point to be 5°F lower than the current discharge air temperature for AHU #	(If the outside air temp is between 40°F and 80°F and the room space temp is above 90°F).	☐	☐	Room temperature set point:___°F Discharge air temperature set-point: _____°F	☐	☐
	Return air dampers and outside air dampers modulate in opposition to one another to maintain the 60°F set point.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
(Temperature Control Cooling)	Barometric relief dampers will relieve excess air from the boiler room.	☐	☐		☐	☐
	Heating coil valves open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
113 Adjust the discharge air temperature set-point to be 10°F lower than the current discharge air temperature for AHU # (Temperature Control Cooling)	(If the outside air temp is below 90°F and the oom space temp is above 90°F).	☐	☐	Room temperature set point:___°F Discharge air temperature set-point _____°F.	☐	☐
	Return air dampers modulate open.	☐	☐		☐	☐
	Outside air dampers modulate closed.	☐	☐		☐	☐
	Barometric relief dampers will relieve excess air from the boiler room.	☐	☐		☐	☐
	Heating coil valve closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
114 If the outside air temperature is above 40°F, override the outside air temperature reading to be 35°F for AHU #. Otherwise, skip this step. (At the end of this step, release the outside air temperature override)	Preheat valve is fully open.	☐	☐	This would indicate a situation where we could potentially simultaneously heat and cool. Please clarify the sequence that protects the system from simultaneously heating and cooling.	☐	☐
	Cooling valve is open.	☐	☐		☐	☐
	Face & bypass is modulated to maintain minimum air temperature set-point.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
115 Reset the discharge air temperature set-point to the original value for AHU #. (Temperature Control Cooling)	The system resumes "normal" operations.	☐	☐	Ending discharge air temperature set-point _____°F	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
116 Adjust the discharge air temperature, for AHU # set-point to be 5°F lower than the current discharge air temperature (Temperature Control Cooling)	(If the outside air temp is below 90°F and the boiler room space temp is above 90°F).	☐	☐	Boiler space temperature set point:___°F Discharge air temperature set-point _____°F	☐	☐
	Return air dampers modulate closed.	☐	☐		☐	☐
	Outside air dampers modulate open.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Barometric relief dampers will relieve excess air from the boiler room.	☐	☐		☐	☐
	Heating coil valves open	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
117 Adjust the discharge air temperature set-point to be 10°F lower than the current discharge air temperature for AHU # (Temperature Control Cooling)	(If the outside air temp is below 90°F and the boiler room space temp is above 90°F).	☐	☐	Discharge air temperature set-point _____°F	☐	☐
	Return air dampers modulate open.	☐	☐		☐	☐
	Outside air dampers modulate closed.	☐	☐		☐	☐
	Barometric relief dampers will relieve excess air from the boiler room.	☐	☐		☐	☐
	Heating coil valve closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
118 If the outside air temperature is above 40°F, override the outside air temperature reading to be 35°F for AHU #. Otherwise, skip this step. (At the end of this step, release the outside air temperature override)	Preheat valve is fully open.	☐	☐	This would indicate a situation where we could potentially simultaneously heat and cool. Please clarify the sequence that protects the system from simultaneously heating and cooling.	☐	☐
	Cooling valve is open	☐	☐		☐	☐
	Face & bypass is modulated to maintain minimum air temperature set-point.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
119 Reset the discharge air temperature set-point to the original value for AHU #. (Temperature Control Cooling)	The system resumes “normal” operations.	☐	☐	Ending discharge air temperature set-point _____F	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
FUNCTIONAL TESTS – UNOCCUPIED NIGHT SETBACK – SETUP MODE						
120 Set discharge air temperature to less than 35°F.	Supply fan stops.	☐	☐	Initial Space Temp: _____ Space set point:_____	☐	☐
	Outside air damper closes.	☐	☐		☐	☐
	Return air damper opens.	☐	☐		☐	☐
	Alarm sent to BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
121 Reset discharge air temperature to original settings	Supply fan starts up.	☐	☐	New space temperature set point: _____	☐	☐
	Outside air damper opens.	☐	☐		☐	☐
	Return air damper modulates as normal.	☐	☐		☐	☐
	Alarm cleared from BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
122 Adjust the discharge air static pressure above the 0.02" w.c. set point in comparison to the outdoors --or-- Increase the discharge air static pressure set-point just under the high limit alarm discharge air static pressure set-point **Choose whichever results in a lower adjusted set-point and prevents high static alarm from sounding (Pressure Control)	The supply fan VFD increases the frequency and speeds up the fan to meet the new discharge air static pressure set-point.	☐	☐	Pressure of Outside: _____ Static Pressure of Space: _____ New Static Set-point:_____ Frequency @ New Set-point:_____%	☐	☐
Record issues				Issue Log Item:	☐	☐
				Initial / Date		
123 Adjust the high limit alarm discharge air static pressure set-point to be just below the current discharge air static pressure (High Pressure Alarm)	High static pressure alarm is generated.	☐	☐	New High Limit Static Alarm Set-point:_____	☐	☐
	Air handling system continues to run under BAS control.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
124 Adjust the discharge air static pressure below the 0.02" w.c. set point in comparison to the outdoors --or-- Decrease the discharge air static pressure set-point just under the high limit alarm discharge air static pressure set-point **Choose whichever results in a higher adjusted set-point and prevents low static alarm from sounding (Pressure Control)	The supply fan VFD decreases the frequency and slows the fan to meet the new discharge air static pressure set-point.	☐	☐	Pressure of Outside: _____ Static Pressure of Space: _____ New Static Set-point:_____ Frequency @ New Set-point:_____%	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
125 Adjust the low limit discharge air static pressure set-point to be just above the current discharge air static pressure (Low Pressure Alarm)	Low static pressure alarm is generated.	☐	☐	New Low Limit Static Set-point:_____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
126 Return the low limit pressure alarm set-point back to its original value	The system resumes “normal” operation.	☐	☐	Low limit pressure alarm set-point:_____ Discharge air static pressure set-point:_____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
127 Return the discharge air static pressure set-point back to its original value	The system resumes “normal” operation.	☐	☐	Low limit pressure alarm set-point:_____ Discharge air static pressure set-point:_____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
VERIFICATION OF UNOCCUPIED OPERATION						
128 Override the occupancy to unoccupied	The supply fan is off.	☐	☐		☐	☐
	The outside air damper is closed.	☐	☐		☐	☐
	Return air damper opens.	☐	☐		☐	☐
	The cooling coil valve is closed.	☐	☐		☐	☐
	The preheat valve is closed.	☐	☐		☐	☐
	Face and bypass damper is at full bypass.	☐	☐		☐	☐
	The humidifier valve is closed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
129 Adjust the zone temperature set-point to 5F greater than the current temperature	The outside air damper is open.	☐	☐	Zone temperature set-point _____F	☐	☐
	Return air dampers are open.	☐	☐		☐	☐
	Supply fan VFD shall be commanded to run.	☐	☐		☐	☐
	The supply fan turns on at minimum speed for a specified length of time.	☐	☐		☐	☐
	Supply fan speed modulates to maintain differential pressure set-point.	☐	☐		☐	☐
	The preheat valve modulates to meet the new set-point.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Face and bypass dampers are at full face.	☐	☐		☐	☐
	Cooling coil valve is closed.	☐	☐		☐	☐
	Humidifier valve is closed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
130 Adjust the zone temperature set-point to equal the current temperature	The supply fan turns off.	☐	☐	Zone temperature set-point _____F	☐	☐
	The outside air damper closes.	☐	☐		☐	☐
	Face and bypass dampers remain under BAS control.	☐	☐		☐	☐
	The cooling coil valve is closed.	☐	☐		☐	☐
	The humidifier valve is closed.	☐	☐		☐	☐
	Unit is indexed back to the Unoccupied Mode.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						
131 Reset the schedule to occupied	The system resumes “normal” operation.	☐	☐	Ending zone temperature set-point _____F	☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
Record issues				Issue Log Item:		
				Initial	Date	
132 Reset the zone temperature set-point back to the original value	The system resumes “normal” operation.	☐	☐	Ending zone temperature set-point _____F	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
VERFICATION OF EXHAUST FAN						
133 Set the airflow set point below the current air flow CFM	Alarm is sent to BAS.	☐	☐		☐	☐
	Fan shuts off.	☐	☐		☐	☐
	The discharge damper closes.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						
134 Reset the air flow	Alarm clears.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
set point to original set point though the BAS	The discharge damper opens.	☐	☐		☐	☐
	The fan starts only when the damper is proved fully open.	☐	☐		☐	☐
Record issues				Issue Log Item:	☐	☐
				Initial / Date		
135 Set static pressure set point above current static pressure	Low suction alarm is sent to BAS.	☐	☐		☐	☐
	Fan shuts off.	☐	☐		☐	☐
	Damper modulates open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
136 Reset the air flow set point to original set point though the BAS	Alarm clears.	☐	☐		☐	☐
	The discharge damper stays open.	☐	☐		☐	☐
	The fan starts only when the damper is proved fully open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
(Test continues on the following page.)						
137 Reset the air flow	Alarm clears.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
set point to original set point though the BAS	The discharge damper stays open.	☐	☐		☐	☐
	The fan starts only when the damper is proved fully open.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
RETURN TO INITIAL CONDITIONS						
138 Record test stop time	Recorded.	☐	☐		☐	☐
Record issues				Issue Log Item:	☐	☐
				Initial / Date		

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

SAMPLE

Test Notes and Lessons Learned

SAMPLE

Back to page L-1

Back to Cx Plan Appendix C

Direct Digital Control System for HVAC Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:

The Direct Digital Control System (DDC) will interface with all other major items of mechanical electrical and plumbing equipment. This is a test of the overall DDC and its network. A person with full administrative access to the DDC is required to be present. Individual controllers are expected to be networked to the operator work station, but also have local portals for programming and field maintenance. This is a test of the overall DDC as a network and not the individual points of control. A corrective action report will be developed, and the step will be tested again after the problem has been fixed. No deferred or retesting is neither expected nor scheduled. NOTE: DDC, Operator work station, OWS, network server, and WEB server, are intended to represent the system challenged in this FPT.

Specific testing of individual HVAC or Electrical systems is done within functional test procedures (FPT's) appropriately focused on those systems. Those equipment tests confirm field devices, components and specific subsystems are responsive and values are correct for the specific MEP systems that the DDC controls. This Test does not include those aspects of control.

Operational Assumptions:

All HVAC and Electrical systems controlled and monitored by the DDC are operating normally at the beginning of the test, using their normal electric power source. Individual controllers, input and output objects and related devices and applications like loop control have been fully tested at each controller.

Associated major mechanical systems, wiring and piping have been tested and are operating correctly.

There are no unusual or critical system alarms.

AHU's, RTU's, exhaust fans and hood exhausts have been operating normally for an hour.

Heating system is on.

Chilled water is circulating. Seasonal exception possible.

SAMPLE

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	Explanation:			

SAMPLE

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

Supplies Required for Testing (To be provided by the contractor)

Tools / Supplies	
Canned smoke for smoke detector testing	Calibrated temperature sensing devise
Aerosol Freeze Spray If OA is above 30ºF	manometer/magnahelic 0.1" gage for duct P/filter dP
manometer w/ 0.001"wc/ 0.25 Pa gage for space dP	Calibrated humidity sensing devise

DDC Network Information

Manufacturer		**Model Number**	
Serial Number		**Other Features**	
Notes:			

SAMPLE

DDC Controller Information

Manufacturer		**OWS Model Number**	
Building Network Controller Model		**Advanced Application Model**	
Application Specific Controller Model		**Gateways or other protocol translation**	
Notes:			

System Readiness Summary Checklist

Description	Yes	No	Date
System is ready for testing.	☐	☐	
All control system functions and interlocking systems are programmed and operable per contract documents, including final set-points and schedules with debugging, loop tuning and sensor calibrations completed.	☐	☐	
Punch list items, loop tuning and calibration complete.	☐	☐	
DDC-operator work station (OWS), display and communication are operational (Optional printer temporarily added for record copy).	☐	☐	
Installation per design documents & change orders.	☐	☐	
O&M manuals delivered and available on site	☐	☐	
Field-marked As-Built system schematics available.	☐	☐	
Network devices and physical connections are operating.	☐	☐	
Specified contractor training completed.	☐	☐	
Components/subsystems clearly and correctly Identified.	☐	☐	
Mechanical systems that interface with DDC are connected and operational.	☐	☐	
System is ready for testing.	☐	☐	
All control system functions and interlocking systems are programmed and operable per contract documents, including final set-points and schedules with debugging, loop tuning and sensor calibrations completed.	☐	☐	

SAMPLE

Description	Yes	No	Date
Punch list items, loop tuning and calibration complete.	☐	☐	
DDC-operator work station (OWS), display and communication are operational (Optional printer temporarily added for record copy).	☐	☐	
Installation per design documents & change orders.	☐	☐	
O&M manuals delivered and available on site.	☐	☐	
Field-marked As-Built system schematics available.	☐	☐	

Required Instrument Accuracy and Calibration Tolerances:

Initial/Date	Sensor	Calibrating Instrument Accuracy (+/-)	Required Calibration Tolerance (+/-)
	Cooling coil, chilled and condenser water temps	0.25F	0.4F
	AHU wet bulb or dew point	1.0F	2.0F
	Hot water coil and boiler water temp	1.0F	1.5F
	Outside air, space air, duct air temps	0.25F	0.4F
	Relative humidity	2% RH	5% RH
	Watt-hour, voltage & amperage	2% of reading	1% of design
	Pressures, air, water and gas	2% of reading	3% of design
	Building differential pressure	1% of full span	0.01 in. WC
	Variable frequency drive	2 Hz	2 Hz
	Flow rates, water	4% of reading	4% of design
	Flow rates, air	3% of reading	10% of design[1]
	Air velocity rates	3% of reading	10% of design

SAMPLE

Set-Points, Limits, and Schedules

☐ AHU can be assigned a schedule. ☐ Schedule can be programmed daily.

☐ If system runs 24 hours a day, check here. If not, fill in the occupied mode schedule below.

	AM												PM											
Day	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Sun																								
Mon																								
Tues																								
Wed																								
Thurs																								
Fri																								
Sat																								
Holi																								

Parameter	**Setpoint**		**Adjustable Range**	
	Design	**Actual**	**Design**	**Actual**
Outside Air Temperature (°F)				
Preheat valve full open outside air temperature (°F)				
Discharge Air Temperature (°F)				
Night Setback Temperature (°F)				
Night Setback Differential				
Mixed Air Temperature (°F)				
Minimum Start-up Fan Speed (%)				
Time at Minimum Fan Speed for Start-up (min)				
Average Zone Humidity (%RH)				
Maximum supply air humidity (%RH)				
Discharge Air Static Pressure (in H_2O)				
High Static Alarm (in H_2O)				
Low Static Alarm (in H_2O)				
System Shutdown High Static Limit (in H_2O)				
Damper Position				

SAMPLE

Initial Ambient Conditions

Ambient Conditions			
Outside Air Temp		**Outside Air RH %**	
Observations			

Trend Data Required To Support Testing

Check if trend point chart(s) and Frequency Graph(s) are provided per trend requirements shown below.

Trend Log Setup #1 - Temperature					
Pre-Testing	**Post Testing**	**Point**	**Frequency**	**Duration**	**Provided**
☐	☐	Data Collection Frequency	Minimum 10 minute		☐ Yes ☐ No
☐	☐	Trend Log Duration	Minimum one week		☐ Yes ☐ No
☐	☐	Trend Log Start Date/Time	Minimum two days before		☐ Yes ☐ No
☐	☐	Trend Log Format	Distinct color/symbol/point		☐ Yes ☐ No
☐	☐	Point #1	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #2	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #3	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #4	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #5	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #6	Any point in any panel		☐ Yes ☐ No
Record Issues				Issue Log Item Number:	

SAMPLE

Trend Log Setup #2 - Temperature					
Pre-Testing	**Post Testing**	**Point**	**Frequency**	**Duration**	**Provided**
☐	☐	Data Collection Frequency	Minimum 10 minute		☐ Yes ☐ No
☐	☐	Trend Log Duration	Minimum one week		☐ Yes ☐ No
☐	☐	Trend Log Start Date/Time	Minimum two days before		☐ Yes ☐ No
☐	☐	Trend Log Format	Distinct color/symbol/point		☐ Yes ☐ No
☐	☐	Point #1	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #2	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #3	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #4	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #5	Any point in any panel		☐ Yes ☐ No
☐	☐	Point #6	Any point in any panel		☐ Yes ☐ No
Record Issues				Issue Log Item Number:	

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.)

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**

C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PREPARE FOR DDC PERFORMANCE TESTING						
1. Record start time NOTE: a printer is not specified so if none is available "print" means "display" indicated report.	Recorded DDC, OWS, Web Server are alternate names for the hardware and software	☐	☐	Start Time:_____(am/pm)	☐	☐
Record issues				Issue Log Item: Initial / Date		
2. Observe that the DDC existing data groups represent various rooms and required data is represented	Sensor / status values are represented on various group displays.	☐	☐	Point by Point conformance, end to end continuity, proper action and calibration have been completed in the PFC and startup. This step is only to verify that the basic system is operational at test with no obvious problems.	☐	☐
	Temperature.	☐	☐		☐	☐
	Humidity.	☐	☐		☐	☐
	Light intensity.	☐	☐		☐	☐
	Air flow dP analog.	☐	☐		☐	☐
	Air flow dP status.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
3. Demonstrate data updating at least once a minute	Data is updated on DDC every 60 seconds or sooner.	☐	☐	**The DDC workstation and operation is not given, need more information on how DDC works or how it is setup.** Expect to see various values like temperature or pressure changing on screen due to normal operation.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Demonstrate method to calibrate sensors.	Single Sensor value can be changed after entering PIN at BAS.	☐	☐		☐	☐
	Calibration report of all sensors is presented at BAS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
5. Create and print (display) a report of temp, and room dP in one minute intervals.	Report prints (displays if printer not provided) with data logged at one minute intervals.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
6. Initiate an alarm.	Alarm is presented on the Graphic it relates	☐	☐		☐	☐
	An alarm message pops up or provides notification	☐	☐		☐	☐
	A record of the event is listed in a history log.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
VERIFICATION OF OPERATION WITH POWER INTERRUPTION						
7. Turn off power circuit to BAS Wait 10 seconds	Verify OWS and related equipment shuts down as if during a power failure.	☐	☐	Indicate the date and time that power was disconnected: _____	☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
8. Restore normal Power	System reboots.	☐	☐	Indicate the time that power was re-connected: _____ The operator has the option to add notes while acknowledging an alarm.	☐	☐
	Network connections are established.	☐	☐		☐	☐
	Time stamps are correct.	☐	☐		☐	☐
	Outage alarms report.	☐	☐		☐	☐
	Alarms return to normal.	☐	☐		☐	☐
	Acknowledged alarms are recorded with time stamp of ACK and user ID.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Notes can be included with acknowledge action.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. Acknowledge Alarms	System reboots.	☐	☐	Indicate the time that power was re-connected: _____ The operator has the option to add notes while acknowledging an alarm.	☐	☐
	Network connections are established.	☐	☐		☐	☐
	Time stamps are correct.	☐	☐		☐	☐
	Outage alarms report.	☐	☐		☐	☐
	Alarms return to normal.	☐	☐		☐	☐
	Acknowledged alarms are recorded with time stamp of ACK and user ID.	☐	☐		☐	☐
	Notes can be included with acknowledge action.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
10. Verify networked controllers (building, Advanced App, App specific) continued to operate in simulated outage OWS DDC	Each controller reports normal when DDC is restored to normal power.	☐	☐		☐	☐
	Each controller has continued to operate with programmed values not default values.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
INSTALLATION INTEGRITY						
11. Present on the Operator Work Station (OWS) Monitor a list of devices connected to the network.	The data management system network interface module and server monitor (and printer) are ON.	☐	☐	Note the printer is not required.	☐	☐
	Each field interface device, intelligent controller or special application processor reports it is connected and in normal operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
12. Change presentation to display the details of any HVAC system.	The graphic is displayed within 5 seconds.	☐	☐	Normal condition may not show a specific label, but alarms should have a clear differentiation. Indicate the time required from initiating the request until the values are displayed: _____ Seconds	☐	☐
	Every data point, object displays its name, set point value, and current condition within 10 seconds of the request.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
13. Initiate any historic trend report for presentation on the display.	A graphic representation of the data value history is presented on the monitor.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
14. Print this report.	The printer works.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
15. Use a Laptop computer to connect to system by various methods.	Display is similar to OWS.	☐	☐		☐	☐
	Basic monitoring and control are similar to OWS.	☐	☐		☐	☐
	Connects by wall stat.	☐	☐		☐	☐
	Connects by controller port.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Connects by Ethernet network port.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
16. Log off laptop access.	User is identified as a device while logged into system.	☐	☐		☐	☐
	Log off is recorded.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		
VERIFICATION OF WORKSTATION COMPONENTS						
17. Verify minimum hardware /software requirements of the operator workstation. Note original spec was not clear about desktop so spec reflects expectation of the Laptop	Support 64 client devices.	☐	☐	Provide a general description of the BACnet conformance, and Record exceptions of the actual system provided in the following space:	☐	☐
	10-100 MBPS 802.3 LAN.	☐	☐		☐	☐
	BACnet Controller Protocol.	☐	☐		☐	☐
	Operating system is Windows NT Workstation 4, 2000 or later.	☐	☐		☐	☐
	Processor speed is 600Mhz or higher.	☐	☐		☐	☐
	Processor is at least Intel Pentium III class.	☐	☐		☐	☐
	Hard drive capacity is 60 gigabytes of greater.	☐	☐		☐	☐
	System memory is 256 Meg or greater.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Indicate number of serial parallel and USB ports available.	☐	☐		☐	☐
	Monitor is 17” diagonal, .28 dot pitch, and 740x1024 resolution.	☐	☐		☐	☐
	Indicate CD or CD/RW capability or better.	☐	☐		☐	☐
	Mouse and Keyboard.	☐	☐		☐	☐
	56kb v.90 Modem.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
PASSWORD AND ACCESS CONTROL						
18. An individual with administrator authority will demonstrate multiple levels of password protection.	Create 1 new user and 3 new passwords.	☐	☐	The three levels need to provide 1 - Monitoring only, 2 - Command and control adjustment, 3 - Program development and password assignment.	☐	☐
	Verify there are at least 3 levels of access for different passwords assigned.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
19. Administrator shall demonstrate ability to delete two of the new Users.	Verify that the deleted User and PW's no longer have access.	☐	☐		☐	☐
	Verify the one still works.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
20. Simultaneously logon to the system using 4 different users.	System allows simultaneous access to 4 individual users.	☐	☐	Number of network devices on network during user test ____.	☐	☐
	Record the number of devices in operation during the instance of 4 users.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
VERIFICATION OF GRAPHIC PRINTOUT						
21. Display the building exterior graphic on the OWS.	Verify the graphic depicts architectural components that resemble the building.	☐	☐		☐	☐
	Verify the graphic shows the building title.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
22. Print this graphic screen and attach to this test.	Printer provides graphic with dynamic values.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
23. Penetrate the building graphic to display building section graphic.	Verify the building graphic accurately depicts the floors of the building.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
24. Print this graphic screen and attach to this test.	Key elements like AHU locations and their status should be displayed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
25. Penetrate the building section graphic to display a system level graphic. A real time linked to the value presented in text is required at some point in the penetration from building view to individual device detail.	Verify that there are heating/cooling zones identified.	☐	☐	Presentation of error-from-setpoint by color gradation, alarm messages, or similar displays should be noted below as useful visual presentation of system operation.	☐	☐
	Verify there are temperatures shown in association with each zone.	☐	☐		☐	☐
	Verify that all controlled variables are shown on the graphic.	☐	☐		☐	☐
	Verify that graphic includes system components (i.e. Pumps, fans, coils, dampers, sensors, etc.)	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
26. Print a representative graphic screen and attach to this test.	Printer provides graphic with dynamic values.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
27. Display each mechanical system graphic.	Verify that each graphic system resembles the control submittal diagrams.	☐	☐		☐	☐
	Verify that each graphic is schematic and not simple line diagrams.	☐	☐		☐	☐
	Verify that each graphic consists of a system.	☐	☐		☐	☐
	Verify the each graphic depicts sensors and instruments in their correct location.	☐	☐		☐	☐
	Verify that each graphics point values update dynamically.	☐	☐		☐	☐
	There is an indication the display is active and real time, or non responsive.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
28. Attach one graphic printout to this test.	Printer provides graphic with dynamic values.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
RUNTIME ACCUMULATION (TOTALIZATION)						
29. From the OWS, Display the supply Fan runtime for several types of digitally controlled equipment expected to run during the test. AHU, Pumps, and Chillers are examples.	Verify they all go to zero hours run time.	☐	☐	Current runtime hours = _____ (note any exceptions)	☐	☐
	Record the time of day.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
30. Set runtimes to zero.	Display changes to show 0.0.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
31. Verify the selected equipment is running. Start the equipment, if any are not.	All units are running.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
32. Wait 30 minutes.	Record the time of day.	☐	☐	Current runtime hours = _____	☐	☐
	Selected device is stopped.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
33. Stop one of the controlled equipment types started above.	Record the time of day.	☐	☐	Current runtime hours = _____	☐	☐
	Selected device is stopped.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
34. Wait two hours.	Record the current runtime hours.	☐	☐	Current runtime hours = _____	☐	☐
	Record the time of day.	☐	☐	(note any exceptions)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
35. Return to this step at the end of the test.	Record the current runtime hours.	☐	☐	Current runtime hours = _____	☐	☐
	Record the time of day.	☐	☐	(note any exceptions)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
36. Display the runtime for equipment selected above.	Record the current runtime hours.	☐	☐	Current runtime hours = _____	☐	☐
	Record the time of day.	☐	☐	(note any exceptions)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
37. Compare the results of beginning and end of test run time values.	Did the runtime increment by indicated time of day?	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
38. Note the runtime value for the equipment stopped during the test.	Did the runtime value freeze at the last running value?	☐	☐	Total runtime hours = _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
VERIFICATION OF TRENDING						
39. Program a trend of outdoor air temperature, and supply air temps from two AHU's in two different controllers.	Set trend interval to 1 minute.	☐	☐	Record the AHU's used for this test AHU-___ _____ AHU-___ _____	☐	☐
	Set samples stored to 360.	☐	☐		☐	☐
	Start trending.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
40. Wait for 30 minutes. *(While waiting other test steps can be executed.)*	30 minutes of trend data is stored in the field controller.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
41. Display logged values as they would be exported to Excel file.	30 minutes of numerical data is sent to the printer.	☐	☐		☐	☐
	Attach hardcopy to test.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
42. Display trend data graphically.	30 minutes of graphical data is sent to the printer.	☐	☐		☐	☐
	Attach hardcopy to test.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
43. Upload trend data to workstation file.	Controller data is stored on OWS hard drive.	☐	☐	Record trend file name _____	☐	☐
	Controller continues to accumulate trend data.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
44. Transfer all trend data to Microsoft Excel / Text file. Print file and attach to this test.	Trends are successfully transferred to a Microsoft Excel / Text file.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
DAYLIGHT SAVINGS TIME & LEAP YEAR ADJUSTMENT						
45. Change the time of day to 23:58.	At midnight the date becomes February 29th.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
46. Change date to February 28, 2008.	At midnight the date becomes February 29th.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
47. Change the time of day to 01:58. Change the date to March 8, 2008.	At 2:00am the time jumps ahead to 3:00am.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
48. Change the time of day and date to current values.	Time and date are accurate.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
VERIFICATION OF POINT OVERRIDE						
49. Override an analog output point.	Override command is accepted.	☐	☐		☐	☐
	Override value is displayed at OWS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
50. Override an analog input point.	Override command is accepted.	☐	☐		☐	☐
	Override value is displayed at OWS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
51. Override a binary input point.	Override command is accepted.	☐	☐		☐	☐
	Override value is displayed at OWS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
52. Override a binary output point.	Override command is accepted.	☐	☐		☐	☐
	Override value is displayed at OWS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
53. Override a virtual point.	Override command is accepted.	☐	☐		☐	☐
	Override value is displayed at OWS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
54. Release all overrides.	Points return to normal state.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
55. Return to Run Time Accumulation from earlier in FPT.	Earlier test step that required a delay is now executed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
VERIFICATION OF ALARMS						
56. Ensure the printer programmed to receive system alarms is online.	Printer is powered.	☐	☐		☐	☐
	Printer is online to OWS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
57. Send an alarm limit summary to the printer. NOTE: If no limits are installed create three in different controllers for test purpose.	Verify that analog points have high and low limits programmed per specification.	☐	☐		☐	☐
	Attach hardcopy to this test.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
58. Override an AHU discharge air temperature (DAT) above its high limit value.	High limit alarm is displayed on screen at the OWS and printed within 5 minutes.	☐	☐		☐	☐
	Graphic DAT symbol on OWS changes color to indicate alarm value.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
59. Clear AHU discharge air temperature override.	High limit alarm returns to normal and is printed within 5 minutes.	☐	☐		☐	☐
	Graphic display of point returns to original color.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
60. Notify Fire department of planned test.	AHU stops AHU Smoke alarm is reported to the OWS.	☐	☐		☐	☐
	AHU Smoke alarm and AHU OFF is reported to the OWS.	☐	☐		☐	☐
	AHU Smoke alarm and AHU OFF is reported to Fire Systems DDC display in Lobby.	☐	☐		☐	☐
	Alarm is printed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
61. Silence building wide horn alarm system for this test.	AHU stops AHU Smoke alarm is reported to the OWS.	☐	☐		☐	☐
	AHU Smoke alarm and AHU OFF is reported to the OWS.	☐	☐		☐	☐
	AHU Smoke alarm and AHU OFF is reported to Fire Systems DDC display in Lobby.	☐	☐		☐	☐
	Alarm is printed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
62. Initiate a duct smoke detector alarm.	AHU stops AHU Smoke alarm is reported to the OWS.	☐	☐		☐	☐
	AHU Smoke alarm and AHU OFF is reported to the OWS.	☐	☐		☐	☐
	AHU Smoke alarm and AHU OFF is reported to Fire Systems DDC display in Lobby.	☐	☐		☐	☐
	Alarm is printed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
63. Clear smoke alarm.	AHU remains off.	☐	☐		☐	☐
	Return to normal message is received at the OWS.	☐	☐		☐	☐
	Return to normal message is received at the DDC fire alarm panel.	☐	☐		☐	☐
	Return to normal message is printed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
64. Restart AHU.	Return to normal ON is reported at OWS and Fire Alarm Display.	☐	☐		☐	☐
	Change of status is printed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
65. Reconnect building fire alarm annunciation.	System operates normally.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
66. Notify fire department, owner, and O&M staff that test is over.	System operates normally.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
67. Attach hardcopy of alarms.	Printer records / verifies results of alarm test.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
START / STOP FEEDBACK DELAY						
68. Override the chilled water pump status input to OFF from the OWS.	Display or graphic of the chilled water system shows override status of pump feedback point.	☐	☐	Note the normal cycle time before values are updated on the display _____ sec/min	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
69. Manually start the chilled water pump from the OWS.	Verify that a status alarm is received and record the delay in seconds.	☐	☐	Alarm delay time = _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
70. Manually stop the chilled water pump from the OWS.	Verify the status alarm automatically resets and record the delay.	☐	☐	Alarm reset delay = _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
SCHEDULING						
71. Display a schedule summary of all equipment at the OWS.	Display shows that equipment like Supply Fans have a schedule as defined in the sequence of operation.	☐	☐	The schedule may call for start and stop or Day and Night transitions If the owner has not defined a specific schedule then this test succeeds if only the ability to schedule is proven.	☐	☐
	Schedule has provisions for seven-days a week.	☐	☐		☐	☐
	Schedule has provisions for holiday entry one full year in advance.	☐	☐		☐	☐
	Schedule information is displayed in “spreadsheet” format.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
72. Display an optimized start stop schedule showing OAT, space temperatures and equation for start advance.	Program and initiator exists.	☐	☐	The intent of this test step is to verify how the system will "anticipate" occupancy schedules in order to reach occupied space conditions no later than the scheduled time. At time of test record the: Outside air temperature: ____'F Critical Space temperature: _____'F Optimum start time range: _____min	☐	☐
	Fans and related sensors are assigned to the program.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
73. Select any fan scheduled to be running.	Fan stops on loss of power.	☐	☐		☐	☐
	Alarm reports to BAS.	☐	☐		☐	☐
	When power is restored fan is restarted automatically because it is still in the scheduled run time.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
74. Disconnect power simulating an outage.	Fan stops on loss of power.	☐	☐		☐	☐
	Alarm reports to BAS.	☐	☐		☐	☐
	When power is restored fan is restarted automatically because it is still in the scheduled run time.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
75. After one minute restore power.	Fan stops on loss of power.	☐	☐		☐	☐
	Alarm reports to BAS.	☐	☐		☐	☐
	When power is restored fan is restarted automatically because it is still in the scheduled run time.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
76. Print a hardcopy of the listed summary reports.	Attach hard copy to this test form.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
SOFTWARE COMMUNICATIONS						
77. Disconnect power from any controller. This is the "first" controller for this test. NOTE: If controllers are on local UPS only the loss of power will be reported. If so then turn off the power to communication device.	Loss of communication is reported to the OWS.	☐	☐	Controller Address = _____ Controller Location = _____ Controller Model = _____ Time delay before reported _____Sec	☐	☐
	Loss of communication is printed at OWS.	☐	☐		☐	☐
	Time delay for report does not exceed 1 minute.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
78. Verify other controllers continue to operate normally.	Access to data values and execution of commands is not affected by loss of one network controller.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
79. Program a scheduled event (a fan starts) to happen in the immediate future in the controller second on the network from the first.	Loss of communication is reported to the OWS.	☐	☐	The panels may be in the same physical location or far apart, it is the location on the network cable that is important. If a Hub style network they should be on the same Hub. Controller Address = _____ Controller Location =_____ Controller Model = _____	☐	☐
	Loss of communication is printed.	☐	☐		☐	☐
	The controller between two failed controllers continues to operate.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
80. Disconnect power from the "second" controller before the scheduled event.	Loss of communication is reported to the OWS.	☐	☐	The panels may be in the same physical location or far apart, it is the location on the network cable that is important. If a Hub style network they should be on the same Hub. Controller Address = _____ Controller Location =_____ Controller Model = _____	☐	☐
	Loss of communication is printed.	☐	☐		☐	☐
	The controller between two failed controllers continues to operate.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
81. Wait for the time of the scheduled event to pass by at least two minutes.	Communication normal message is received at the OWS.	☐	☐	Note time power restored to controllers First Controller _____ Second Controller _____ Note time stamp controllers report Return to DDC system First Controller _____ Second Controller _____	☐	☐
	Communication normal message is printed.	☐	☐		☐	☐
	DDC monitor.	☐	☐		☐	☐
	Both controllers recover and operate on the network as before the outage.	☐	☐		☐	☐
	Data exchanged to synchronize clocks.	☐	☐		☐	☐
	Update changes will include execution of the event scheduled during outage, and report the analog alarm.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
82. Reconnect the network wiring to both controllers. (note record the time each one is powered on)	Communication normal message is received at the OWS.	☐	☐	Note time power restored to controllers First Controller _____ Second Controller _____	☐	☐
	Communication normal message is printed.	☐	☐		☐	☐
	DDC monitor.	☐	☐		☐	☐
	Both controllers recover and operate on the network as before the outage.	☐	☐	Note time stamp controllers report Return to DDC system	☐	☐
	Data exchanged to synchronize clocks.	☐	☐	First Controller _____	☐	☐
	Update changes will include execution of the event scheduled during outage, and report the analog alarm.	☐	☐	Second Controller _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
83. Attach hardcopy of alarms.	Printer record verifies results of alarm test.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
84. Verify operations are restored as normal.	Operations are normal.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
GLOBAL PARAMETER MODIFICATION						
85. From the OWS sample control points to identify that required control parameters (line code variables) exist for each controller. This is not an all point review, but does require validation of each controller.	All controllers are reporting normally.	☐	☐	All controllers should be on line and should update their clock time to be synchronous to the master clock.	☐	☐
	Each controller includes a list of control parameters including set points, PID gains and delays, dead band range, schedules, and alarm limits are available for the points associated with the controller.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
86. Change the time value of the central clock and the temperature value of the common Outside Air.	All Controller Equipment Programs show the revised time.	☐	☐	Not all controllers will use a central OAT. If they do not show the revised value verify they are using some other specific measured value as an exception to the universal OAT.	☐	☐
	All Controller Equipment Programs show changed OAT.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
87. Restore correct values for time and OAT.	System returns to normal operation within 5 minutes.	☐	☐		☐	☐
	Controller parameters match OWS.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
DISTRIBUTED PARAMETER MODIFICATION MANUAL AND AUTOMATIC REST						
88. Connect directly by laptop or other handheld communication device to a field controller.	Normal operation continues.	☐	☐		☐	☐
	A list of values including set points, PID gains and delays, dead band range, schedules, and alarm limits are available for evaluation and modification.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
89. From the direct connect field interface provide a list of control parameters for all controlled equipment connected to this panel.	Normal operation continues.	☐	☐		☐	☐
	A list of values including set points, PID gains and delays, dead band range, schedules, and alarm limits are available for evaluation and modification.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
90. List the Boiler System Reset input parameters.	The hot water supply set point is reduced.	☐	☐	The intent of this step is to verify that the DDC system can be modified globally from a local field control panel.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
91. Change the listed Outside Air Temp values above actual.	The hot water supply set point is reduced.	☐	☐	The intent of this step is to verify that the DDC system can be modified globally from a local field control panel.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
92. Restore normal control values.	Boiler water returns to value before the test.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
93. Disconnect the network cable from the field controller.	Panel continues to operate, an alarm “loss of panel” reports to OWS.	☐	☐	Check passwords, default set points and schedules on loss of network.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
94. The previous 6 steps can be repeated for a sample controller in other zones.	The sample controller selected represents all controllers on network. OR	☐	☐	IF there is some reason to suspect differences in communication from different areas to DDC then repetition of the preceding 12 steps for each of those areas would be useful.	☐	☐
	Additional controllers were tested and each controller succeeded as described above.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
PROGRAM TRANSFER						
95. Change a parameter to create a unique file and Initiate an upload of the application program from any controller from OWS.	Verify the program is successfully uploaded and stored at the OWS.	☐	☐	Controller Address _____ Controller Location _____ Controller Model _____ PC file name _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
96. Correct the parameter changed and Initiate a download of the application program file uploaded in the previous step.	Verify the program is successfully downloaded to the controller.	☐	☐		☐	☐
	Verify the controller is properly functioning after the download.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
97. Restore physical set point or other logical changes to pre test conditions.	System operates normally.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
98. Return to Run Time Accumulation earlier in FPT.	Earlier test step that required a delay is now executed.	☐	☐	This is a reminder for closure of steps initiated in Run Time Accumulation.	☐	☐
	Record runtime in test step above.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
99. Restore normal power to DDC from UPS test, if not already done.	Record action results in steps above.	☐	☐	This is a reminder for closure of steps initiated in “Installation Integrity” and “Trending” sections above.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
100 Stop Trend log and print files when done.	Record action results in steps above.	☐	☐	This is a reminder for closure of steps initiated in “Installation Integrity” and “Trending” sections above.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
RETURN TO NORMAL CONDITIONS						
101 Record test stop time	Recorded	☐	☐	Time_____(am/pm)	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

Sensor Verification

All field-installed sensors and gages on this piece of equipment shall be observed for appropriate readings during the execution of the HVAC systems FPT.

Confirm the following devices and values are provided in the DDC graphics

Device	Parameter	Presents on graphic	Trend Log	Limit Alarm / failure
Electric Meter		Yes /NO	Yes /NO	Yes /NO fault
	kW (demand level)	Yes /NO value& level 1 alarm	Yes /NO value	Yes /NO level 1
		Yes /NO alarm L2		Yes /NO level 2
		Yes /NO alarm L3	Peak history	Yes /NO level 3
	kWh (use history)	Yes /NO	Yes /NO daily	Yes /NO
			Yes /NO monthly	Yes /NO
			Yes /NO annual	Yes /NO
Water		Yes /NO	Yes /NO	Yes /NO fault
	100 Gallons	Yes /NO	Yes /NO daily	Yes /NO peak high
			Yes /NO monthly	Yes /NO peak low
			Yes /NO annual	
Gas		Yes /NO	Yes /NO	Yes /NO fault
	100 CCF	Yes /NO	Yes /NO daily	Yes /NO peak high
			Yes /NO monthly	Yes /NO peak low
			Yes /NO annual	
OUTSIDE Air T		Yes /NO	Yes /NO daily	Yes /NO fault
			Yes /NO monthly	
			Yes /NO annual	

SAMPLE

Device Verification

The actuators or devices listed equipment shall be observed for appropriate action during the execution of the HVAC systems FPT.

Device	Presents on graphic	Trend Log	Limit Alarm / failure

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

SAMPLE

Test Notes and Lessons Learned

SAMPLE

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Grounding & Bonding for Electrical Systems Functional Performance Test

Equipment ID	[Equipment ID]
Building	{Building]
Location	[Room]

System Description

Description:
Operational Assumptions:

SAMPLE

Test Dates and Results

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

SAMPLE

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

Test Equipment Required (to be provided by the Contractor)

Test Name	Equipment Description
Bolt Torque	Calibrated torque wrench
Contact Resistance	Four-probe Digital Low Resistance Ohmmeter (DLRO)
Voltage/Continuity	DVM
Fall of Potential	Fall-of-Potential Ground Resistance Tester

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**

C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Verify equipment identification.	Equipment identification and plan location matches shop drawings and specifications.	☐	☐		☐	☐
	Field wiring terminations match record drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
2. Confirm that system is installed per contract documents with indicated connections to each unit of electrical equipment	Connections to equipment ground buses per drawings.	☐	☐		☐	☐
	Connections to equipment enclosures/cases per drawings.	☐	☐		☐	☐
	Connections to wire mesh fence per drawings.	☐	☐		☐	☐
	Gate grounding jumper installed per drawings.	☐	☐		☐	☐
	Connections to main cold water pipes per drawings and specs.	☐	☐		☐	☐
	Connections to dry type transformers per drawings and specs.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Measured diameter of bare copper conductor corresponds to diameter of specified conductors.	☐	☐		☐	☐
	Conduits with grounding bushings and full-size bonding conductors.	☐	☐		☐	☐
	All busses mounted on standoff neoprene insulators.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
3. Observe condition of ground ring before backfill and/or cover applied.	No visible damage to cable.	☐	☐		☐	☐
	Cable depth a minimum of 3’0”.	☐	☐		☐	☐
	Ground rod configuration and depth as shown on drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following pagel.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
4. Observe main ground wall mounted grounding bar.	Dimensions as specified ____ long, 4” x ¼”.	☐	☐		☐	☐
	Standoff distance 5” from wall as shown on drawings.	☐	☐		☐	☐
	Connections are welded or bolted as per the approved submittals and construction drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
5. Observe electrical closet ground buses	Buses: Copper, ¼” x 2” x10” minimum, length as shown on drawings.	☐	☐		☐	☐
	Buses mounted on standoff neoprene insulator - standoff distance 1” from wall as shown on drawings.	☐	☐		☐	☐
	Bus length to accommodate 100% spare.	☐	☐		☐	☐
	Connections are welded or bolted as per the approved submittals and construction drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
6. Observe telecom closet ground buses	Buses: Copper, ¼" x 2" x8" provided by each telecom backboard.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
7. Inspect compression type and exothermically welded connections	Cables do not rotate with respect to each other or to steel column, etc. (All connections are solid).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
8. Inspect grounding connection at service entrance	Connection point is per (not beyond service disconnect) NEC 250-23.	☐	☐		☐	☐
	Neutral is solidly grounded at service disconnect, and at no point beyond.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. Verify equipment grounding conductor termination.	Grounding connections are made with non-reversible connections.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
10. Verify tightness of accessible bolted electrical connections with calibrated torque wrench.	Bolted torque should comply with NETA Table 100.12 unless manufacturer specified values are listed on the equipment.	☐	☐	Record data in Contact Integrity Table Bolt Torque	☐	☐
	If Contractor's Test Reports are received and used in lieu of 100% testing, perform random checks of tightness of bolted electrical connections. Randomly Test 10% of connections. If any are not tight, test 100%.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
GROUNGING ELECTRICAL INTEGRITY						
11. Perform resistance test of <u>non-accessible</u> bolted electrical system connections using a Digital Low Resistance Ohmmeter (DLRO) and non-bolted electrical system connections using a DVM.	Resistance shall be less than 500 micro-ohms.	☐	☐	Note: For connections that are inaccessible or unable to be verified by torque (ex: welded connections), conduct a DLRO measurement of connection resistance across connection from closest accessible point on each side. Record Data in Contact Integrity Table – DLRO/DVM	☐	☐
	Compare connection resistance to values of similar connections. Values should be within 10% of each other.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
12. Verify the ground system is complete (connections to building steel, water main etc.) and tested prior to performing the final "system" fall of potential.	Connections verified	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
13. Perform and evaluate a Fall-of-Potential test on the grounding system.	The curve should be "flat" between Y_1 and Y_2	☐	☐	The fall of potential test consists of plotting the ratio of V/I-R as a function of probe spacing. A value of impedance is obtained at Y, Y_1 and Y_2. This impedance is plotted as a function of distance, and the value in ohms at which this plotted curve appears to level out is taken as the impedance value of the ground under test. If the curve is not flat between Y_1 and Y_2 additional impedance measurements must be taken. Position the potential probe at several additional distances between the electrode and current probe Z. Record distances and plots the impedance to obtain the flat area of the curve. Attach a copy of the Fall-of-Potential contractor's test report on all individual ground rods. Record values in Fall of Potential Table.	☐	☐
	The resistance value at distance Y is effective resistance of the electrode or system.	☐	☐		☐	☐
	Results are less than or equal to 10 ohms.	☐	☐		☐	☐
		☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

Test Equipment Used:

Test Name	Manufacturer	Model Number	Serial Number	Calibration (Date)

SAMPLE

Connection Integrity Data

Conductor Description		Torque Verified		DLRO/DVM		Continuity Verified	Date
From (A)	To (B)	(A)	(B)	(A)	(B)		

SAMPLE

Fall of Potential Data

Electrode ID	Distance (Y1)	Distance Y	Distance (Y2)	Distance (Z)	Resistance	AT	RH	Date

AT=Ambient Temperature

RH = Relative Humidity

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

SAMPLE

Test Notes and Lessons Learned

SAMPLE

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TABLE 100.12.1

Bolt-Torque Values for Electrical Connections

US Standard Fasteners (a)

Heat-Treated Steel – Cadmium or Zinc Plated (b)

Grade	**SAE 1&2**	**SAE 5**	**SAE 7**	**SAE 8**
Head Marking				
Minimum Tensile (Strength) (lbf/in^2)	64K	105K	133K	150K
Bolt Diameter (Inches)	**Torque (Pound-Feet)**			
1/4	4	6	8	8
5/16	7	11	15	18
3/8	12	20	27	30
7/16	19	32	44	48
1/2	30	48	68	74
9/16	42	70	96	105
5/8	59	96	135	145
3/4	96	160	225	235
7/8	150	240	350	380
1.0	225	370	530	570

Notes:

(a) Consult manufacturer for equipment supplied with metric fasteners.

(b) Table is based on national coarse thread pitch.

SAMPLE

Low-Voltage Switchgear
Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:
Operational Assumptions:

SAMPLE

Test Datas and Results Summary

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

SAMPLE

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

Test Instruments (To Be Provided By the Contractor)

Recommended Test Equipment (or Equivalent):

Test	Equipment Description
Bolt Torque	Calibrated torque wrench
Wiring Impedance	Low impedance ac millammeter
Sound Level	Calibrated decibel meter

SAMPLE

System Readiness Summary Checklist

Description	Yes	No	Date
System Ready for Test	☐	☐	
Required Personnel Available	☐	☐	
Required Tools/Test Equipment/Supplies Available	☐	☐	
Required Safety Equipment Available	☐	☐	

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required)

C = Corrected (Check (✓) when correction verified)

Y= Checked and Passed

N = Not Passed

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Safe conditions (protective gear in-place, available & procedures observed)	Conditions verified.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
2. Verify switchgear installations	Isolation transformer installed with electrostatic shield between primary and secondary winding and connected to ground.	☐	☐		☐	☐
	Completed switchgear schedules.	☐	☐		☐	☐
	Appropriate anchorage.	☐	☐		☐	☐
	Required area clearances. 3 ft in front and 30 in wide.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	No physical damage.	☐	☐		☐	☐
	Breaker casing does not have cracks.	☐	☐		☐	☐
	Correct alignment.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
3. Inspect switchgear doors, panels, and sections	Free of Corrosion, dents, scratches, fit.	☐	☐		☐	☐
	No missing screws.	☐	☐		☐	☐
	No open unused knockouts.	☐	☐		☐	☐
	No missing hardware.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Verify switchgear configuration and nameplate data matches shop drawings, one-line diagram and specification	Volts:_____.	☐	☐		☐	☐
	Bus Amps: _____A.	☐	☐		☐	☐
	3ph, 4W.	☐	☐		☐	☐
	Frequency: 60hZ.	☐	☐		☐	☐
	Enclosure: _____.	☐	☐		☐	☐
	Transformer _____KVA.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Transformer _____V.	☐	☐		☐	☐
	Transformer class _____ insulation rating.	☐	☐		☐	☐
	Transformer 60Hz.	☐	☐		☐	☐
	Main Breaker Max. Rating. ____ Amp.	☐	☐		☐	☐
	Switchgear arrangement _____# of circuits.	☐	☐		☐	☐
	_____ Percent Spares.	☐	☐		☐	☐
	_____ Space.	☐	☐		☐	☐
	Neutral size _____.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
5. Verify switchgear equipment grounding	Solid neutral mounted in main circuit breaker compartment with main lugs, is insulated.	☐	☐		☐	☐
	Neutral is bonded to ground.	☐	☐		☐	☐
	Frame and enclosure connected to ground bus.	☐	☐		☐	☐
	Breaker and feeder equipment grounding conductors/conduit are connected to ground bus.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
6. After testing is performed on the switchgear, verify tightness of main connections	Primary feeder cable connections properly torqued and marked.	☐	☐	Bolted torque should comply with NETA Table 100.12 unless manufacturer specified values are listed on the equipment. Test Name: Feeder Termination Torque Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
CAUTION: Before performing the next steps, verify that all “Lock-Out / Tag-Out” safety precautions are in place.						
7. Operate each circuit breaker (5) times to ensure smooth operation	Breaker opens and closes in a smooth motion without binding.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
ELECTRICAL INTEGRITY						
8. Measure sound level of isolation transformer	25bB for 5kVA or less transformer.	☐	☐	Test Name: Sound level Reference Equip. Table	☐	☐
	30dB for 7.5 kVA transformer.	☐	☐		☐	☐
	35dB for 10 and 15kVA transformers.	☐	☐		☐	☐
	40dBfor 20 and 25kVA transformers.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. Perform continuity check on each branch circuit	Correct continuity is verified.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
10. Measure each isolated wiring impedance to ground	Impedance shall exceed 200,000 ohms.	☐	☐	Test Name: Wire Impedance Reference Equip. Table Record results as a reference for subsequent line-impedance evaluation. Record results in Data Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
FINAL INSPECTION						
11. At the conclusion of testing, inspect interior hardware and electrical terminations	All hardware in place and properly torqued.	☐	☐		☐	☐
	Compartments clear of tools and hardware.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

Test Equipment Used:

Test Name	Manufacturer	Model Number	Serial Number	Calibration (Date)

Panel Data

Parameter	Data
Equipment ID:	
Manufacturer:	
Model Number:	
Serial Number:	
Mfgr. Date:	
Bus Amps:	
Volts:	
Phase/Wire/Frequency:	
Enclosure NEMA Rating:	
Short Circuit Rating:	

SAMPLE

Feeder Termination Torque Data (Newton Meters or Foot-Pounds)

Bolt or Lug	A	B	C	N	G
Feeder Lugs					
Feeder Lugs					

Sound Level Data

Transformer	_____ KVA	Sound Level (Decibel)

Wire Impedance Data (200,000 OHMS)

Conductor		Torque Verified		DLRO/DVM		Continuity Verified	Date
From (A)	To (B)	(A)	(B)	(A)	(B)		

SAMPLE

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

Test Notes and Lessons Learned

Back to page L-1

Back to Cx Plan Appendix C

SAMPLE

Switchboards
Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:
Operational Assumptions:

SAMPLE

Test Dates and Results

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

SAMPLE

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

System Readiness Summary

Description	Yes	No	Date
System ready for test	☐	☐	
Required personnel available	☐	☐	
Required tools/test equipment/supplies available	☐	☐	
Required safety equipment available	☐	☐	

SAMPLE

TEST INSTRUMENTS (to be provided by the Contractor)

Test Equipment Required:

Test Name	Equipment Description
Contact Resistance	Four-probe Digital Low Resistance Ohmmeter (DLRO)
Insulation Resistance	Megger-battery or line-powered (Hand-crank not acceptable)
DI Electric Withstand	High Potential Tester
Bolt Torque	Calibrated torque wrench
Relay Operation	Variable AC Voltage source
Voltage/Continuity	DVM

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**

C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Safe conditions (protective gear in-place, available & procedures observed)	Conditions verified	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
2. Inspect the exterior of the switchboard	No evidence of damage.	☐	☐		☐	☐
	Surfaces are clean.	☐	☐		☐	☐
	All doors, panels, and hardware present.	☐	☐		☐	☐
	All doors swing freely, latch in open and closed positions.	☐	☐		☐	☐
	Feeder cable/bus routing doesn't obstruct access for operation or maintenance.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
3. Verify anchoring	Anchor bolts are provided in locations shown on manufacturer's drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Verify ratings and configuration. Nameplate data match shop drawings and specifications	Volts: 480/277V.	☐	☐		☐	☐
	Amps: 4000A.	☐	☐		☐	☐
	3ph, 4W.	☐	☐		☐	☐
	Frequency: 60hZ.	☐	☐		☐	☐
	Interrupting Rating: 65kAIC.	☐	☐		☐	☐
	Enclosure: NEMA 1.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
5. Verify permanent labels are installed	Equipment labeled with name plates which are black engraved surface on white core for normal power circuits and red engraved surface on white core for emergency power circuits.	☐	☐		☐	☐
	Labels include unit number, voltage, and origin of service.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
6. TVSS provided as required by drawings	Conductor length is as short as possible.	☐	☐		☐	☐
	Conductor bends are minimized.	☐	☐		☐	☐
	Conductors are no longer than 24 inches.	☐	☐		☐	☐
	Installed on load side of main circuit breaker.	☐	☐		☐	☐
	Indicator lights are functional.	☐	☐		☐	☐
	Surge event operation counter reads zero.	☐	☐		☐	☐
	TVSS is equipped with remote monitoring contacts.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
7. Inspect the control wiring for proper support, routing, protection	Control wires are supported well clear of the path of movement of breakers and auxiliary device trays.	☐	☐		☐	☐
	All wires labeled both ends.	☐	☐		☐	☐
	Control wire termination connections tight and cannot be pulled from connection.	☐	☐		☐	☐
	The wire bundle at the door is supported clear of the hinge.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
8. Verify rating of all control circuit protective devices match shop drawings	Fuse and circuit breaker ratings match drawings.	☐	☐		☐	☐
	Device labels match drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. Verify control power transformer installation	Control power transformer installation per the schematic drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
10. Verify grounding	Connection from station ground grid to equipment ground bus. (possibly at multiple locations).	☐	☐		☐	☐
	Frames and enclosures bolted to ground buss.	☐	☐		☐	☐
	Breaker and feeder equipment grounding conductor/conduit are connected to the ground buss.	☐	☐		☐	☐
	Measured diameter of bare copper conductor corresponds to diameter of specified conductors.	☐	☐		☐	☐
	Neutral is bonded to ground at switchgear, not transformer.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
11. Verify provision and proper operation of integral rail mounted, breaker lifting device	Remove circuit breaker using device and confirm full operation.	☐	☐		☐	☐
	Confirm that lifter travels entire length of switchgear smoothly to the end of travel.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
12. Operate each circuit breaker (5) times to ensure smooth operation	Breaker opens and closes in a smooth motion without binding.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
ELECTRICAL INTEGRITY						
13. Disconnect PTs, CPTs, surge arrestors, and circuit breakers	Verify disconneted	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
14. Disconnect the main bonding jumpers at the switchgear	Verify disconnected	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
15. Perform an insulation resistance test at 1000VDC on each bus section, phase-to-phase and phase to ground with the circuit breakers connected in the closed position	Minimum insulation resistance shall be 100 Megohms.	☐	☐	Record results in Insulation Resistance Data Table. Test with all circuit breakers in the closed position Test for one minute in accordance with NETA Table 100.1. Feeder conductors should not be terminated	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
16. Perform an insulation resistance test at 1000 VDC on the neutral bus section to ground	Minimum insulation resistance shall be 100 Megohms.	☐	☐	Record results in Insulation Resistance Data Table Test for one minute in accordance with NETA Table 100.1.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
17. With the breaker in the closed position, measure the contact resistance of each phase of circuit breakers rated 400A and greater	Readings are within 50% of the average value.	☐	☐	Record results in Contact Resistance Data Table.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
18. Re-connect the main bonding jumpers and verify tightness with a calibrated torque wrench	Verify connections	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
19. Reconnect surge, arrestors, TVSS, CPT's, and PTs	Verify connections	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
20. Reconnect CT grounds	Verify connections	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
21. After testing is performed on the switchboard, verify tightness of field landed feeder terminations and bus-to-bus connections	Primary connections properly torqued and marked.	☐	☐	Record results in Feeder Termination Torque Data Table. Bolted torque should comply with NETA Table 100.12 unless manufacturer specified values are listed on the equipment. Secondary distribution feeder connections are not included in the test. Black marker marked across the head of the bolt and bus.	☐	☐
	Bus-to-bus connections properly torqued and marked.	☐	☐		☐	☐
	TVSS connections are properly torqued and marked.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
FUNCTIONAL TRIP TESTS						
22. Test the long time delay (seconds) and long time pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection.	Long delay current pick up and time delay per coordination study.	☐	☐	Record results in Current Injection Data Table.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
23. Test the short time delay (seconds) and short time pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection	Short delay current pick up and time delay per coordination study.	☐	☐	Record results in Current Injection Data Table.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
24. Test the instantaneous time delay (seconds) and instantaneous time pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection	Instantaneous pick up per coordination study.	☐	☐	Record results in Current Injection Data Table.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
25. Test the ground fault time delay (seconds) and ground fault time pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection.	Ground fault pick up per coordination study.	☐	☐	Record results in Current Injection Data Table.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
METERING						
26. Verify the nameplate matches the shop drawings	Model Number: ____.	☐	☐		☐	☐
	Meter supply voltage matches the AC control power supply.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
27. Verify all metering circuits	Components and wire labels match the drawings.	☐	☐		☐	☐
	Verify control power wiring to the meter.	☐	☐		☐	☐
	CT and PT locations, polarity, fusing, and wiring match the drawings.	☐	☐		☐	☐
	CT poles shall have shorting auxiliary contacts. Screws removed from CT shorting blocks.	☐	☐		☐	☐
	Confirm tightness of all (100%) CT wiring with screwdriver.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
28. Verify the correct parameters have been programmed into the meter	3ph, 4w, 1000:5 CT, 480:277V PT configuration has been entered into the meter.	☐	☐		☐	☐
	The correct PT ratio of 480:277 has been entered into the meter.	☐	☐		☐	☐
	The correct secondary L-N voltage 120V has been entered into the meter.	☐	☐		☐	☐
	The current transformer ratio 1000:5 has been correctly entered into the meter.	☐	☐		☐	☐
	Phase rotation is ___.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	The correct frequency 60 Hz has been entered into the meter.	☐	☐		☐	☐
	Password is ____.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
FINAL INSPECTION						
29. At the conclusion of testing, inspect interior hardware and electrical terminations	All hardware in place and properly torqued.	☐	☐		☐	☐
	Compartments clear of tools and hardware.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

Test Equipment Used:

Test Name	Manufacturer	Model Number	Serial Number	Calibration (Date)

Temperature: _____ Relative Humidity: _____

Insulation Resistance (1000 VDC)

Circuit Breaker (Closed)	A-B	B-C	C-A	A-G	B-G	C-G	N
1 Minute (Meg Ohms)							
Circuit Breaker (open)	A-A	B-B	C-C				
1 Minute (Meg Ohms)							

SAMPLE

Circuit Breaker Contact Resistance

Circuit Breaker	Phase A (Micro-Ohms)	Phase B (Micro-Ohms)	Phase C (Micro-Ohms)

SAMPLE

Feeder Termination Torque (Newton Meters or Foot-Pounds)

Feeder	Phase A	Phae B	Phase C	Neutral	Ground

Current Injection

Function	Actual Set.	Test Setting	Test Point	Nominal Val.	A	B	C
Breaker ID:							
LTD							
LDPU							
STD							
SDPU							
INSTPU							
GFD							
GFPU							

SAMPLE

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

Test Notes and Lessons Learned

SAMPLE

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TABLE 100.1

Insulation Resistance Test Values

Electrical Apparatus and Systems

Nominal Rating Of Equipment in Volts	Minimum Test Voltage, DC	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
1,000	1,000	100
2,500	1,000	500
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
34,500 and above	15,000	100,000

In the absence of consensus standards dealing with insulation-resistance tests, the Standards Review Council suggests the above representative values.

See Table 100.10 for temperature correction factors.

Test results are dependent on the temperature of the insulating material and the humidity of the surrounding environment at the time of the test.

Insulation-resistance test data may be used to establish a trending pattern. Deviations from the baseline information permit evaluation of the insulation.

SAMPLE

TABLE 100.12.1

Bolt-Torque Values for Electrical Connections

US Standard Fasteners (a)

Heat-Treated Steel – Cadmium or Zinc Plated (b)

Grade	SAE 1&2	SAE 5	SAE 7	SAE 8
Head Marking				
Minimum Tensile (Strength) (lbf/in2)	64K	105K	133K	150K
Bolt Diameter (Inches)	Torque (Pound-Feet)			
1/4	4	6	8	8
5/16	7	11	15	18
3/8	12	20	27	30
7/16	19	32	44	48
1/2	30	48	68	74
9/16	42	70	96	105
5/8	59	96	135	145
3/4	96	160	225	235
7/8	150	240	350	380
1.0	225	370	530	570

(a) Consult manufacturer for equipment supplied with metric fasteners.

(b) Table is based on national coarse thread pitch.

SAMPLE

Panelboards
Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:
Operational Assumptions:

SAMPLE

Test Dates and Results

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

SAMPLE

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Test Equipment Required (to be provided by the Contractor)

Test Name	Equipment Description
Bolt Torque	Calibrated torque wrench
Voltage/Continuity	DVM
Insulation Resistance	Battery or line-powered (Hand-crank not acceptable).
Variable Voltage Source	3-Phase variable voltage source

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**

C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Safe conditions (protective gear in-place, available & procedures observed)	Verify conditions	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
2. Verify panelboard installations	Completed panelboard schedules.	☐	☐		☐	☐
	Appropriate anchorage.	☐	☐		☐	☐
	Required area clearances. 3 ft in front and 30 in wide.	☐	☐		☐	☐
	No physical damage.	☐	☐		☐	☐
	Breaker casing does not have cracks.	☐	☐		☐	☐
	Correct alignment.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Feeder color-coding is: 480/277 V System as follows: Phase A: Brown Phase B: Orange Phase C: Yellow Neutral: Gray Ground: Green	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
3. Inspect panelboard doors, panels, and sections	Free of Corrosion, dents, scratches, fit.	☐	☐		☐	☐
	No missing hardware.	☐	☐		☐	☐
	No missing screws.	☐	☐		☐	☐
	No open unused knockouts.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Verify panelboard configuration and nameplate data matches shop drawings, one-line diagram and specification	Volts: 480/277V.	☐	☐		☐	☐
	Bus Amps: _____A.	☐	☐		☐	☐
	3ph, 4W.	☐	☐		☐	☐
	Frequency: 60hZ.	☐	☐		☐	☐
	Enclosure: NEMA 1.	☐	☐		☐	☐
	Main Breaker Max. Rating. ____ Amp.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
	Isolated Equipment Ground Bus if applicable.	☐	☐		☐	☐
	Panelboard arrangement - # of circuits.	☐	☐		☐	☐
	Neutral bus size (100%).	☐	☐		☐	☐
	Extra Gutter space as applicable.	☐	☐		☐	☐
	Shunt trip as indicated.	☐	☐		☐	☐
	TVSS as indicated.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
5. Verify panelboard equipment grounding	Solid neutral mounted in main circuit breaker compartment with main lugs, is insulated.	☐	☐		☐	☐
	Neutral is not bonded to ground.	☐	☐		☐	☐
	Frame and enclosure connected to ground bus.	☐	☐		☐	☐
	Breaker and feeder equipment grounding conductors/conduit are connected to ground bus.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
6. Operate each circuit breaker (5) times to ensure smooth operation	Breaker opens and closes in a smooth motion without binding.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
ELECTRICAL INTEGRITY						
7. Perform an insulation resistance test at 1000VDC, phase-to-phase and phase to ground, in accordance with NETA Table 100.1	Minimum insulation resistance shall be 100 Megohms.	☐	☐	Record results in Insulation Resistance Table.	☐	☐
	Results temperature corrected in accordance with NETA Table 100.14.	☐	☐	Perform the test on each bus section. Test for one minute in accordance with NETA Table 100.1.	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
8. Perform an insulation resistance test at 1000VDC on main breaker, phase-to-phase and phase to ground, connected to the bus in the CLOSED position, in accordance with NETA Table 100.1. Perform insulation resistance test (pole to pole) on main breaker with breaker in the open position	Minimum insulation resistance shall be 100 Megohms.	☐	☐	Record results in Insulation Resistance Table. Perform the test on each bus section. Test for one minute in accordance with NETA Table 100.1. Test Name: Insulation Resistance Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. At the conclusion of testing, inspect interior hardware and electrical terminations	All hardware in place and properly torqued.	☐	☐		☐	☐
	Compartments clear of tools and hardware.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
FUNCTIONAL TRIP TESTS						
10. Test the Long Time Delay (seconds) and Long Time Pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection	Long delay current pick up and time delay per coordination study.	☐	☐	Record results in Data Table. Test Name: Primary Current Inject. Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
11. Test the Short Time Delay (seconds) and Short Time Pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection	Short delay current pick up and time delay per coordination study.	☐	☐	Record results in the Circuit Breaker Current Injection Table. Test Name: Primary Current Inject. Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
12. Test the Instantaneous Time Delay (seconds) and Instantaneous Time Pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection	Instantaneous pick up per coordination study.	☐	☐	Record results in the Circuit Breaker Current Injection Table. Test Name: Primary Current Inject. Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
13. Test the Ground Fault Time Delay (seconds) and Ground Fault Time Pickup current (amperes) setting on device breakers rated 400A and greater, by using primary current injection.	Ground fault pick up per coordination study.	☐	☐	Record results in the Circuit Breaker Current Injection Table. Test Name: Primary Current Inject. Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
14. After testing is performed on the panelboard, verify tightness of main connections.	Primary feeder cable connections properly torqued and marked.	☐	☐	Record results in the Termination Torque Table. Bolted torque should comply with NETA Table 100.12 unless manufacturer specified values are listed on the equipment. Test Name: Bolt Torque Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

Test Equipment Used:

Test Name	Manufacturer	Model Number	Serial Number	Calibration (Date)

Data Tables

Temperature: _____ Relative Humidity: _____

Insulation Resistance (1000 VDC)

Circuit Breaker (Closed)	A-B	B-C	C-A	A-G	B-G	C-G	N
1 Minute (Meg Ohms)							
Circuit Breaker (open)	A-A	B-B	C-C				
1 Minute (Meg Ohms)							

SAMPLE

Current Injection

Function	Actual Set.	Test Setting	Test Point	Nominal Val.	A	B	C	Trip Setting (Sec.)
Circuit Breaker ID:								
LTD								
LDPU								
STD								
SDPU								
INSTPU								
GFD								
GFPU								

Termination Torque (Newton Meters or Foot Pounds)

Feeder	Phase A	Phase B	Phase C	Neutral	Ground

SAMPLE

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

Test Notes and Lessons Learned

SAMPLE

Back to page L-1

Back to Cx Plan Appendix C

Table 100.1

Insulation Resistance Test Values

Electrical Apparatus and Systems

Nominal Rating of Equipment in Volts	Minimum Test Voltage, DC	Recommended Minimum Insulation Resistance in Megohms
250	500	25
600	1,000	100
1,000	1,000	100
2,500	1,000	500
5,000	2,500	1,000
8,000	2,500	2,000
15,000	2,500	5,000
25,000	5,000	20,000
34,500 and above	15,000	100,000

See Table 100.14 for temperature correction.

In the absence of consensus standards dealing with insulation-resistance tests, the Standards Review Council suggests the above representative values.

Test results are dependent on the temperature of the insulating material and the humidity of the surrounding environment at the time of the test.

Insulation-resistance test data may be used to establish a trending pattern. Deviations from the baseline information permit evaluation of the insulation.

SAMPLE

Table 100.12

US Standard

Bolt Torques for Bus Connection

Heat-Treated Steel – Cadmium or Zinc Plated

Grade	**SAE 1&2**	**SAE 5**	**SAE 7**	**SAE 8**
Head Markings				
Minimum Tensile (P.S.I.)	**64K**	**105K**	**133K**	**150K**
Bolt Diameter in Inches	**Torque (Foot Pounds)**			
1/4	4.0	5.6	8.0	8.4
5/16	7.2	11.2	15.2	17.6
3/8	12.0	20.0	27.2	29.6
7/16	19.2	32.0	44.0	48.0
1/2	29.6	48.0	68.0	73.6
9/16	42.4	70.4	96.0	105.6
5/8	59.2	96.0	133.6	144.0
3/4	96.0	160.0	224.0	236.8
7/8	152.0	241.6	352.0	378.4
1.0	225.6	372.8	528.0	571.2

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.12, page 202.

SAMPLE

Table 100.12 (Cont.)

Bolt Torques for Bus Connections
Silicon Bronze Fasteners1
Torque (Foot Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	10
3/8	20	14
1/2	40	25
5/8	55	40
3/4	70	60

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.12, page 203.

SAMPLE

Table 100.12 (Cont.)

Bolt Torques for Bus Connections

Aluminum Alloy Fasteners2

Torque (Foot Pounds)

Bolt Diameter in Inches	Nonlubricated	Lubricated
5/16	15	8.0
3/8	20	11.2
1/2	40	20.0
5/8	55	32.0
3/4	70	48.0

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.12, page 203.

Table 100.12 (Cont.)

Bolt Torques for Bus Connections

Stainless Steel Fasteners3

Torque (Foot Pounds

Bolt Diameter in Inches	Uncoated
5/16	14
3/8	25
1/2	45
5/8	60
3/4	90

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.12, page 204.

SAMPLE

Table 100.14

Insulation Resistance

Correction Factors

For Conversion of Test Temperature to 20˚C

Temperature		Multiplier	
˚C	˚F	Apparatus Containing Immersed Oil Insulations	Apparatus Containing Solid Insulators
0	32	0.25	0.40
5	41	0.36	0.45
10	50	0.50	0.50
15	59	0.75	0.75
20	68	1.00	1.00
25	77	1.40	1.30
30	86	1.98	1.60
35	95	2.80	2.05
40	104	3.95	2.50
45	113	5.60	3.25
50	122	7.85	4.00
55	131	11.20	5.20
60	140	15.85	6.40
65	149	22.40	8.70
70	158	31.75	10.00
75	167	44.70	13.00
80	176	63.50	16.00

Reference: International Electrical Testing Association (NETA) ATS-1999, Table 100.14, page 206.

SAMPLE

Engine Generators
Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:
Operational Assumptions: Breaker Coordination study is available and includes the generator output breaker(s).

SAMPLE

Test Dates and Results

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

SAMPLE

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation**:			

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

SAMPLE

Test Equipment Required (to be provided by the Contractor)

Test Name	Equipment Description
Voltage/Continuity	DVM
Bolted Connection or Contact Resistance	Four-probe Digital Low Resistance Ohmmeter (DLRO)
Insulation Resistance	Battery or line-powered (Hand-crank not acceptable).
Primary Current Injection	Current Injection Test Device rated for 2X the ground fault pickup setting of the breaker
2 and 4 Hour Load Bank Test	Resistive load bank with capacity equal to or greater than rated load. Rated at 2% accuracy for voltage, current and KW.
Phase Rotation	Verify proper phasing
Volt. & Freq. Regulation	Computer to record voltage and frequency from the output of the generator control panel.
Decibel	Measure sound pressure
Back Pressure	Manometer with a scale of greater than 40” water
Bolt Torque	Calibrated torque wrench

System Readiness Summary Checklist

Description	Yes	No	Date
System Ready for Test	☐	☐	
Required Personnel Available	☐	☐	
Required Tools/Test Equipment/Supplies Available	☐	☐	
Required Safety Equipment Available	☐	☐	

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**
C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Safe conditions (protective gear in-place, available & procedures observed)	Verify conditions	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
2. Verify that the Engine, Generator, Battery, and Battery Charger nameplate data matches shop drawings and construction documents.	kW: _____.	☐	☐	Record results in data table.	☐	☐
	Rating: _____.	☐	☐		☐	☐
	Freq.: _____.	☐	☐		☐	☐
	Phase/Wire:_____.	☐	☐		☐	☐
	Power Factor: _____.	☐	☐		☐	☐
	Voltage Output: _____.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
3. Verify generator circuit breaker settings.	Circuit breaker size and phase: _____.	☐	☐	Record results in Data Table.	☐	☐
	Ground fault protection is disabled.	☐	☐	Ground fault indication and alarm is recommended	☐	☐
	Circuit breaker is set per the coordination study.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Inspect physical and mechanical condition.	No visible damage to generator or enclosure.	☐	☐		☐	☐
	Engine generator exterior is clean and dry.	☐	☐		☐	☐
	Generator control panel interior is clean and dry.	☐	☐		☐	☐

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
	Generator control panel mounted at an accessible height.	☐	☐		☐	☐
	Vibration isolation is installed at engine and at radiator.	☐	☐		☐	☐
	All external connections are made with flexible connections.	☐	☐		☐	☐
	Verify remote monitoring wiring is connected and labeled.	☐	☐		☐	☐
	Verify control wiring is connected and labeled.	☐	☐		☐	☐
	Feeder cable/bus routing doesn't obstruct access for operation or maintenance.	☐	☐		☐	☐
	Control wiring harness(es) does not rub against vibrating or moving parts.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
5. Verify anchoring	Anchor bolts are provided in locations shown on manufacturer's drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
6. Verify equipment grounding	Verify ground rod is installed with connection to engine generator frame.	☐	☐		☐	☐
	Generator neutral bonded to ground with conductor sized per NEC 250-20. -OR- For separately derived systems, generator neutral is NOT bonded to ground.	☐	☐		☐	☐
	Measured diameter of bare copper conductor corresponds to diameter of specified conductors.	☐	☐		☐	☐
	Ground strap from engine to frame.	☐	☐		☐	☐
	Ground strap from generator enclosure to frame.	☐	☐		☐	☐
	Ground bus provided in termination cabinet with properly terminated ground conductors.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
7. Verify lube oil levels are within manufacturer's recommended limits	Lube oil level is filled to proper level.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
8. Verify fuel system installation and integrity	Day tank is full of fuel (90% for diesel).	☐	☐		☐	☐
	Fuel level in day tank matches fuel gauge.	☐	☐		☐	☐
	Remote fueling station is installed and operating properly.	☐	☐		☐	☐
	There are not clearance issues with the remote fueling station.	☐	☐		☐	☐
	All alarms are operating properly from remote fueling station to Building Automation System (BAS).	☐	☐		☐	☐
	Fuel system is free of leaks.	☐	☐		☐	☐
	Flexible fuel lines are installed at engine.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
9. Verify cooling system installation and integrity	Coolant level is filled to proper level.	☐	☐	Record radiator name plate data in data table.	☐	☐
	Verify coolant system freeze protection level.	☐	☐		☐	☐
	Cooling system is free from leaks.	☐	☐		☐	☐
	Flexible coolant lines are installed between engine and radiator.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
10. Verify exhaust system installation and integrity	Exhaust system, silencer and flexible connector installed and supported.	☐	☐		☐	☐
	Exhaust system expansion is not transferred to engine components such as turbocharger.	☐	☐		☐	☐
	Silencer is equipped with condensate drain plug and turn valve.	☐	☐		☐	☐
	Exhaust system is equipped with rain cap.	☐	☐		☐	☐
	Exhaust system is properly insulated within building.	☐	☐		☐	☐
	Exhaust system has at least 9” clearance from combustible materials.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
ELECTRICAL INTEGRITY						
11. Verify operation of coolant line heater.	Verify that valves to the water jacket heater are open.	☐	☐	Record results in Data Table. Record supply voltages and amperage with heaters and pump in operation. Calculate heater and pump wattage based on line voltage and current. Verify wattage calculated is same as shop drawing data. Manufacturer's Specifications: Heater: Watts _____ Volts _____ Phase _____ Pump: Watts _____ Volts _____ Phase _____	☐	☐
	Verify thermostats switch at their setpoint temperatures (110°F).	☐	☐		☐	☐
	Verify pump runs continuously independent of heater operation.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
12. Verify operation of battery and starting system.	Loss of Power Alarm is operable.	☐	☐	Record results in Data Table. Record cell voltages for all cells with terminals available, total battery charging voltage and charging current. Manufacturer's Specifications: Nom. Batt. Voltage: _____ Rec. Float Charge Voltage: _____ Float Voltage: _____ Equalize Voltage: _____ Max over float Ampere Taper (Max to Min): _____ Nominal Output Voltage: _____ Input Voltage: _____ Ambient Temp: -40ºF to 122ºF	☐	☐
	Low Battery Volt Alarms at: 18.6V-25.7V.	☐	☐		☐	☐
	High Battery Volt Alarms at: 26.9V-36.3V.	☐	☐		☐	☐
	Power On led in on.	☐	☐		☐	☐
	Battery Heater Pad: 120VAC input.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
13. Verify operation of generator space heaters	Space heaters operate when generator is not running and not operating while generator is running.	☐	☐	Record results in Data Table. Record supply voltages and amperage with heater in operation. Calculate heater wattage based on line voltage and current. Verify wattage calculated is same as shop drawing data. Manufacturer's Specifications: Heater: Watts _____ Volts _____ Phase _____	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
14. Perform an insulation resistance test at 1000 VDC on generator windings.	Minimum insulation resistance value is 100 Megohoms.	☐	☐	Record results in Data Table. Take reading at 1 minute. Take reading at 10 minutes. Record ambient temperature and relative humidity. Test Name: Insulation Resistance. Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
15. With the breaker in the closed position, measure the contact resistance of each phase of the primary circuit.	Readings are within 50% of the lowest value.	☐	☐	Record results in Data Table. Test Name: Contact Resistance Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
16. Perform an insulation resistance test on the Generator Circuit Breaker at 1000VDC, phase-to-phase and phase to ground, connected to the bus in the closed position, in accordance with NETA Table 100.1.	Minimum insulation resistance shall be 100 Megohms.	☐	☐	Record results in Data Table. Test for one minute in accordance with NETA Table 100.1. Test Name: Insulation Resistance Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
17. Test the Long Time Delay (LTD) (seconds) and Long Time Pickup current (LDPU) (amperes) setting of the breaker, by using primary current injection.	Long delay current pick up and time delay per coordination study.	☐	☐	Record results in Data Table. Test Name: Primary Current Inject. Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
18. Test the Short Time Delay (STD) (seconds) and Short Time Pickup current (SDPU) (amperes) setting of the breaker, by using primary current injection.	Short delay current pick up and time delay per coordination study.	☐	☐	Record results in Data Table. Test Name: Primary Current Inject. Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
19. Test the Instantaneous Time Delay (ITD) (seconds) and Instantaneous Time Pickup current (INSTPU) (amperes) setting of the breaker, by using primary current injection.	Instantaneous pick up per coordination study.	☐	☐	Record results in Data Table. Test Name: Primary Current Inject. Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
20. Test the Ground Fault Delay (GFD) (seconds) and Ground Fault Pickup current (GFPU) (amperes) setting of the breaker, by using primary current injection.	Ground Fault pick up per coordination study.	☐	☐	Record results in Data Table. Test Name: Primary Current Inject. Reference Equip. Table	☐	☐
	For Paralleled Generators, verify Ground Fault protection is set to ALARM ONLY, and the breaker does not trip.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
ALARMS AND CONTROL PANEL TEST						
21. Verify control wiring between generator and ATS are correctly terminated.	Terminations match shop drawings.	☐	☐	Note: this step applies to field landed terminations only	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
22. Record all setpoints at Engine Generator Control Panel.	Data recorded	☐	☐	Manufacturer's checklist can be attached to this form in lieu of recording	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
23. Verify all warning/pre-alarms per manufacturer's instructions and verify operation and local annunciation at Engine Generator Control Panel.	Overcrank.	☐	☐	1-13 NFPA 110 Spec Section 16231	☐	☐
	Low Water Temp.	☐	☐		☐	☐
	High Water Temp.	☐	☐		☐	☐
	Low Oil Pressure.	☐	☐		☐	☐
	Overspeed.	☐	☐		☐	☐
	Low Coolant Level.	☐	☐		☐	☐
	EPS Supplying Load.	☐	☐		☐	☐
	Control switch not in Auto.	☐	☐		☐	☐
	High Battery Voltage.	☐	☐		☐	☐
	Low Battery Voltage.	☐	☐		☐	☐
	Battery Charger AC Failure.	☐	☐		☐	☐
	Lamp Test.	☐	☐		☐	☐
	Contacts for local and remote common alarm.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
24. Verify all shutdown conditions per manufacturer's instructions and verify operation and local annunciation at Engine Generator Control Panel.	Overcrank.	☐	☐	1-5 NFPA 110 Spec Section 16231	☐	☐
	High Water Temp.	☐	☐		☐	☐
	Low Oil Pressure.	☐	☐		☐	☐
	Overspeed.	☐	☐		☐	☐
	Low Coolant Level.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
25. Verify remote audible annunciation of all status, warning/pre-alarm, and shutdown conditions per manufacturer's instructions.	Overcrank.	☐	☐	1-9 NFPA 110 Spec Section 16231	☐	☐
	Low Water Temp.	☐	☐		☐	☐
	High Water Temp.	☐	☐		☐	☐
	Low Oil Pressure.	☐	☐		☐	☐
	Overspeed.	☐	☐		☐	☐
	Low Coolant Level.	☐	☐		☐	☐
	Control switch not in Auto.	☐	☐		☐	☐
	Contacts for local and remote common alarm.	☐	☐		☐	☐
	Audible alarm silencing switch.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
26. Verify installation of remote E-Stop	Located outside of generator room door. Near each exit/entrance to genset room. Located locally on the genset package.	☐	☐		☐	☐
	Cover not damaged, scratched, or broken.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
27. Verify remote annunciation of engine conditions at building automation system	Annunciator panel lights & alarms function by initiating test switch.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
28. With generator in a "cold start" condition, conduct a load performance test, by initiating a NORMAL failure and transfer of ATS's for time specified in the remarks column.	Engine starts and runs.	☐	☐	Record results in Data Table. Load generator for a maximum of 2 hrs using available building load and/or a load bank During test, verify exhaust, coolant, and fuel system is functioning properly. Test Name: 2 Hour Load Bank Test Reference Equip. Table	☐	☐
	Air intake louvers open fully.	☐	☐		☐	☐
	Exhaust damper opens fully.	☐	☐		☐	☐
	Fuel is not leaking.	☐	☐		☐	☐
	Coolant is not leaking.	☐	☐		☐	☐
	Lube oil is not leaking.	☐	☐		☐	☐
	Exhaust system expansion is not transferred to engine system components.	☐	☐		☐	☐
	Exhaust system is not leaking.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
29. Restore normal sources to ATS's (or turn off load bank) and transfer ALL load off of generator and allow to cool down for 5 minutes	Generator runs in cool down mode for 5 min.	☐	☐	Test Name: 2 Hour Load Bank Test Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
30. Disconnect emergency feeders to ATS and connect load bank directly to load side of generator	Verify cables are disconnected	☐	☐		☐	☐
Record issues				Issue Log Item:	☐	☐
				Initial / Date		
31. With a load bank connected to the load side terminals of the generator, start generator at local control panel with engine control switch	Engine starts and runs.	☐	☐	Test Name: 4 Hour Load Bank Test Reference Equip. Table	☐	☐
	Air intake louvers open fully.	☐	☐		☐	☐
	Exhaust damper opens fully.	☐	☐		☐	☐
	Fuel is not leaking.	☐	☐		☐	☐
	Coolant is not leaking.	☐	☐		☐	☐
	Lube oil is not leaking.	☐	☐		☐	☐
	Exhaust system expansion is not transferred to engine system components.	☐	☐		☐	☐
	Exhaust system is not leaking.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial / Date		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
32. Conduct a load performance test utilizing a load bank to achieve 100% rated load of generator for time specified in the remarks column.		☐	☐	Record results in Data Table. Load generator at 50% for 15 min. Load generator at 75% for 15 min. Load generator at 100% for 3.5 hrs During test, verify exhaust, coolant, and fuel system is functioning properly. Test Name: 4 Hour Load Bank Test Reference Equip. Table	☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
33. In conjunction with load performance test, verify voltage regulation by recording RMS voltage while increasing load on generator.	Voltage regulation is ±1%.	☐	☐	Record results in Data Table Record voltage at no load. Record voltage at 50% load. Record voltage at 75% load. Record voltage at 100% load. Calculate voltage regulation percentage. Test Name: Volt. & Freq. Regulation Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
34. In conjunction with load performance test, verify frequency regulation by recording frequency while increasing load on generator.	Frequency regulation is ±1%	☐	☐	Record results in Data Table Record frequency at no load. Record frequency at 50% load. Record frequency at 75% load. Record frequency at 100% load. Calculate voltage regulation percentage. Test Name: Volt. & Freq. Regulation Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
35. During load performance test, verify engine operation is within normal operating limits.	Engine parameters are within manufacturer's specifications.	☐	☐	Manufacturer's Specifications: RPM @ 60Hz: 1800 RPM Coolant Amb. Temp: 190ºF	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
36. During load performance test, verify correct phase rotation.	Phase rotation at generator matches NORMAL power source.	☐	☐	A(U), B(V), C(W) Test Name: Phase Rotation Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
37. During step 3, while generator is running at 100% load, measure sound level.	Measured sound pressure level in rooms directly adjoining the generator room, as well as above and below, if applicable.	☐	☐	Record results in Data Table. Test Name: Sound Level Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
38. While generator is running at 100% load, conduct Exhaust-System Back Pressure Test	Maximum backpressure at full-rated load is within manufacturer's written maximum allowable limits of 6.7 kPa or 26.9" H20 for the engine.	☐	☐	Record results in Data Table. Connect test instrumentation to exhaust line close to engine exhaust manifold. Test Name: Back Pressure Test Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
39. Decrease load to 0% and allow the generator to cool down for 5 minutes	Generator cools down.	☐	☐	Test Name: 4 Hour Load Bank Test	☐	☐
	No leaks from any system are found.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
40. After the cool down, once the prime mover has reached rated voltage and frequency, transfer full rated load onto the engine generator in a single block.	Engine continues to run without shutdown or overspeed trip and recovers to steady state voltage and frequency ranges within 5 seconds.	☐	☐	Test Name: Block Load Test	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
41. Decrease load to 0% and shutdown generator with local E-Stop.	Generator shuts down.	☐	☐		☐	☐
	Remote annunciator alarms with E-Stop.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
42. Disconnect fuel solenoid and simulate start to engine.	Engine cycle cranks a minimum of three 15-second cranking cycles with 15 seconds between cycles.	☐	☐		☐	☐
	At completion of third cycle engine stops cranking and "overcrank" shutdown alarm is annunciated locally and remotely.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
FINAL INSPECTION						
43. After testing is performed on the generator, verify tightness of field landed feeder terminations.	Primary feeder cable connections properly torqued and marked.	☐	☐	Record results in Data Table. Bolted torque should comply with NETA Table 100.12 unless manufacturer specified values are listed on the equipment. Secondary distribution feeder connections are not included in the test. Test Name: Bolt Torque Reference Equip. Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C)
44. Refill fuel tanks and verify 90% fuel levels	Fuel level indicator verifies 90% fuel level in day tank.	☐	☐		☐	☐
	Fuel level indicator verifies 90% fuel level in storage tank.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

NAMEPLATE DATA

Engine Nameplate (May be found in multiple nameplate locations)

Parameter	Data
Equipment ID	
Manufacturer	
Serial Number	
Model Number	
Date Manufactured	
Horsepower	
kW	

Generator Nameplate

Parameter	Data
Manufacturer	
Serial Number	
Model Number	
Date Manufactured	
Volts	
Amps	
KVA	
Frequency	
RPM	
KW	
PF	
Insulation Class:	

MPLE

Battery Nameplate

Parameter	Data
Manufacturer	
Serial Number	
Model Number	
Quantity	
Volts	
Cold Cranking Amps	

Battery Charger Nameplate

Parameter	Data
Manufacturer	
Serial Number	
Model Number	
Input Amps	
Input Volts	
Output Amps	
Output Volts	

SAMPLE

Circuit Breaker Name Plate Data

Parameter	Data
Manufacturer:	
Type/Model:	
Serial Number:	
Frame Size/Rating	
Interrupting Rating	
Voltage Rating	

Radiator Nameplate

Parameter	Data
Manufacturer	
Serial Number	
Model Number	
Date Manufactured	

Coolant Pump(s) & Heater(s)

Designation	Volts	Amps	Watts

SAMPLE

Battery System

Cell Volts	Charging Volts	Charging Amps

Space Heater(s)

Designation	Voltage	Amperage	Wattage

Test Equipment Used:

Test Name	Manufacturer	Model Number	Serial Number	Calibration(Date)

SAMPLE

Insulation Resistance (1000 VDC)

Generator Windings	A-B	B-C	C-A	A-G	B-G	C-G
1 Minute (Meg Ohms)						
10 Minutes (Meg Ohms)						
Circuit Breaker						
1 Minute (Meg Ohms)						

Circuit Breaker Contact Resistance

Phase	A	B	C
(Micro Ohms)			

Current Injection

Function	Actual Set.	Test Setting	Test Point	Nominal Val.	A	B	C
LTD							
LDPU							
STD							
SDPU							
INSTPU							
GFD							
GFPU							

SAMPLE

2 Hour Load Bank Test

Crank Time Until Prime Mover Start and Runs	
Time Required for Prime Mover to Come Up to Operating Speed	
Voltage Overshoot	
Frequency Overshoot	
Time Required to Achieve Steady State Operation	

Time		Load	RPM	Freq.	Amps	Volts	kW	Oil Press	Oil Temp	Exhaust Temp	Cool. Temp	Fuel Level	Batt. Chrg Rate
0 min		100 %											
5 min		100 %											
10 min		100 %											
15 min		100 %											
30 min		100 %											
45 min		100 %											
1 hour		100 %											
1 hour 15 min		100 %											
1 hour 30 min		100 %											
1 hour 45 min		100 %											
2 hour		100 %											

SAMPLE

4 Hour Load Bank Test

Time		Load	RPM	Freq.	Amps	Volts	kW	Oil Press	Oil Temp	Exhaust Temp	Cool. Temp	Fuel Level	Batt. Chrg Rate
0 min		50%											
5 min		50%											
10 min		50%											
15 min		75%											
30 min		75%											
45 min		100%											
1 hour		100%											
1 hour 15 min		100%											
1 hour 30 min		100%											
1 hour 45 min		100%											
2 hour		100%											
2 hour 15 min		100%											
2 hour 30 min		100%											
2 hour 45 min		100%											

SAMPLE

3 hour		100%											
3 hour 15 min		100%											
3 hour 30 min		100%											
3 hour 45 min		100%											
4 hour		100%											

Voltage & Frequency Regulation

Function	50% Load	75% Load	100% Load
Voltage (V)			
Frequency (hz)			

Phase Rotation –

(Circle Phase Rotation)

Normal Power	A B C	A C B
Emergency Power	A B C	A C B

SAMPLE

Sound Level

Location	Decibel (DB)

Back Pressure Test

System Exhaust Pressure	Location

Block Load Test

Recovery Time: _____

SAMPLE

Bolt Torque (Newton Meters or Foot Pounds)

Bolt/Lug	A	B	C	N	G
Normal					
Emergency Lugs					

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

SAMPLE

Test Notes and Lessons Learned

SAMPLE

Back to page L-1

Back to Cx Plan Appendix C

Automatic Transfer Switches
Functional Performance Test

Equipment ID	[Equipment ID]
Building	[Building]
Location	[Room]

System Description

Description:
Operational Assumptions:

SAMPLE

Test Dates and Results

Initial Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 1		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Re-Test 2		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

SAMPLE

Deferred/Seasonal Test		Start Date	End Date	Initials
Results (Check one) ☐ Pass ☐ Fail ☐ Partial Test w/Corrective Actions ☐ Complete Test w/Corrective Actions ☐ Other	**Explanation:**			

Test Participants

Organization	Name	Required	Optional
General Contractor		☐	☐
Mechanical Contractor		☐	☐
Electrical Contractor		☐	☐
TAB Contractor		☐	☐
Controls Contractor		☐	☐
Owner's O&M Staff		☐	☐

SAMPLE

Test Equipment Required (to be provided by the Contractor)

Test Name	Equipment Description
Bolt Torque	Calibrated torque wrench
Bolted Connection or Contact Resistance	Four-probe Digital Low Resistance Ohmmeter (DLRO)
Voltage/Continuity	DVM
Insulation Resistance	Battery or line-powered (Hand-crank not acceptable).
Relay Operation	Variable AC Voltage source

System Readiness Summary Checklist

Description	Yes	No	Date
System Ready for Test	☐	☐	
Required Personnel Available	☐	☐	
Required Tools/Test Equipment/Supplies Available	☐	☐	
Required Safety Equipment Available	☐	☐	

SAMPLE

Functional Performance Test –

Verify all components are ready before energizing or operating the system.

The Commissioning Agent will make and document any changes/addition/deletions to this test procedure required by current system conditions (i.e. weather, system load, utility availability, etc.).

R = Retest (Check (✓) retest required) **Y= Checked and Passed**
C = Corrected (Check (✓) when correction verified) **N = Not Passed**

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
PRE-TEST VISUAL MECHANICAL INSPECTION						
1. Safe conditions (protective gear in-place, available & procedures observed)	Verify conditions	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
2. Confirm that NORMAL and EMERGENCY sources match final design drawings.	Normal: MDS.	☐	☐	Source: Normal: _____ Emergency: _____	☐	☐
	Emergency: EDP.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
3. Verify equipment nameplate data matches one-line drawings, specifications, and/or shop drawings and record date on attached table.	Volts:_____.	☐	☐		☐	☐
	Amps:_____.	☐	☐		☐	☐
	4 pole, 4W.	☐	☐		☐	☐
	Frequency: 60hZ.	☐	☐		☐	☐
	Interrupting Rating:_____.	☐	☐		☐	☐
	Enclosure:_____.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
4. Verify permanent labels for transfer switch is installed.	Melamine plastic laminate, minimum 1/16” thick.	☐	☐	Spec Section 16075	☐	☐
	Black letters on white face.	☐	☐		☐	☐
	Secured with self tapping, stainless-steel (SS) screws or SS machine screws with nuts and flat and lock washers.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
5. Verify accessibility for maintenance.	Door opens freely and swings fully open.	☐	☐		☐	☐
	3'-6" minimum clearance in front of switch.	☐	☐		☐	☐
	Cables do not block access to indicators or adjustable components.	☐	☐		☐	☐
	Cables do not block access to manual transfer switch operator.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
6. Inspect physical and mechanical conditions.	No visible signs of damage.	☐	☐		☐	☐
	No visible dirt, metal chips or contamination.	☐	☐		☐	☐
	Appropriate source indicating lights are illuminated.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
7. Verify anchoring.	Anchor bolts are provided in locations shown on manufacturer's drawings.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
8. Verify the barriers and arc chutes are properly installed around contacts.	Barriers partially surround ATS contacts and are insulated.	☐	☐		☐	☐
	Arc chutes are installed around the contacts.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
9. Verify ATS is properly grounded.	Enclosure bonded to ground bus.	☐	☐		☐	☐
	Incoming (normal and emergency) and outgoing (load) feeder grounding conductors bonded to ground bus.	☐	☐		☐	☐
	Neutral bus/pole isolated from ground.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
10. Confirm that components of control system including terminal block, wiring, and Ni-Cad batteries are complete.	Verify components	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
11. Perform manual transfer operation with both NORMAL and EMERGENCY sources de-energized. Use detachable manual operator to transfer from NORMAL to EMERGENCY and back.	Switch should transfer smoothly and with full contact travel speed.	☐	☐		☐	☐
	Mechanical interlocking should prevent simultaneous closure of NORMAL and EMERGENCY sources.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
12. Perform manual bypass operation to each source.	Switch should transfer smoothly and with full contact travel speed.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
ELECTRICAL INTEGRITY						
13. Measure contact resistance on all poles in both closed positions.	Readings are within 50% of the average value, including the neutral pole.	☐	☐	Record results in Data Table. Spec Section 16415	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
14. Perform an insulation resistance test at 1000VDC on each bus section, phase-to-phase and phase to ground.	Minimum insulation resistance shall be 100 megohms.	☐	☐	Record results in Data Table. Test for one minute in accordance with NETA Table 100.1. Isolate ALL control wiring and electronic devices prior to testing. Test across open contacts for both NORMAL and EMERGENCY sources. Test phase-to-ground with all other phases grounded for both NORMAL and EMERGENCY sources. Spec Section 16415 Test Name: Insulation Resistance, Reference Equipment Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
15. Perform insulation resistance test at 1000 VDC to verify Automatic Transfer Switch is isolated from load when bypassed.	Insulation resistance shall equal or exceed 100 Megohms.	☐	☐	Record results in Data Table. Test for one minute in accordance with NETA Table 100.1. Isolate ALL control wiring and electronic devices prior to testing Test Name: Insulation Resistance, Reference Equipment Table	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
16. Verify the operation of four-line LCD display and character keyboard.	All data displays operate.	☐	☐	Record Password: _____	☐	☐
	All program parameters accessible.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
17. Verify "In Phase Monitoring" setting.	In phase monitoring is enabled.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
18. Verify all voltage, frequency, and time delay settings.	Use ATS microprocessor control system.	☐	☐	Record values in the "Actual Setpoint" column in the ATS Parameters and Setpoints table Spec Section 16415	☐	☐
	Device pick-up (PU) and drop-out (DO).	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
19. Verify all applicable local and remote annunciation by the monitoring system for various operating conditions.	Operating Conditions: NORMAL power available	☐	☐		☐	☐
	EMERGENCY power avail.	☐	☐		☐	☐
	ATS in NORMAL position.	☐	☐		☐	☐
	ATS in EMERGENCY position.	☐	☐		☐	☐
	LED indicating lights are operating.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
20. Verify proper phase rotation	Emergency source matches utility source.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
TRANSFER OPERATION TESTS						
21. Disconnect NORMAL power source to transfer switch.	Time delay on engine start equals setpoint.	☐	☐	Record results in Data Table.	☐	☐
	Start signal sent to engine generator.	☐	☐	Spec Section 16231	☐	☐
	Transfer time delay equals setpoint.	☐	☐		☐	☐
	Time delay in neutral equals setpoint.	☐	☐		☐	☐
	ATS transfers to Emergency source position.	☐	☐		☐	☐
	Total time to connect to Emergency source is no more than 10-seconds.	☐	☐		☐	☐

Record issues	Issue Log Item:	
	Initial	Date
(Test continues on the following page.)		

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
22. Restore Normal power source to Automatic Transfer Switch to verify setpoints.	Re-transfer time delay equals setpoint.	☐	☐	Record results in Data Table.	☐	☐
	ATS transfers to Normal source position.	☐	☐	Spec Section 16231	☐	☐
	Time delay in neutral equal setpoint.	☐	☐		☐	☐
	Engine cool down time delay equals setpoint.	☐	☐		☐	☐
	Engine shuts off after cool down delay times out.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
23. Repeat steps #21 and #22, except manually disconnect. EMERGENCY source, to simulate failure of the engine, after restoration of NORMAL power and before the re-transfer delay has expired.	Switch should re-transfer to Normal without delay on engine shutdown.	☐	☐	Spec Section 16231	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
24. Verify operation of ATS TEST switch.	Simulates failure of normal source.	☐	☐	Spec Section 16231	☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
BYPASS AND ISOLATION SWITCH OPERATION						
25. Verify Automatic Transfer Switch manual bypass and isolation switch operation with NORMAL source energized and load on ATS.	ATS mechanism is de-energized and power passes through the bypass/isolation switch path.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
26. Restore the Automatic Transfer Switch to its automatic mode by manually reversing the bypass and isolation switch operation.	ATS mechanism is energized and the bypass/isolation switch path is de-energized.	☐	☐		☐	☐
Record issues				Issue Log Item:		
				Initial	Date	
(Test continues on the following page.)						

SAMPLE

ACTION	REQUIRED REACTION	Y	N	COMMENTS	R	C
FINAL INSPECTION						
27. After testing is performed on the ATS, verify tightness of field landed feeder terminations (NORMAL, EMERGENCY, and LOAD feeders).	Feeder cable connections properly torqued and marked.	☐	☐	Record results in Data Table. Bolted torque should comply with NETA Table 100.12 unless manufacturer specified values are listed on the equipment. Test Name: Bolt Torque Reference Equip. Table	☐	☐
Record issues				Issue Log Item: Initial / Date		
28. Prior to energization, inspect interior hardware.	All hardware in place and properly torqued.	☐	☐		☐	☐
	Compartments clear of tools and hardware.	☐	☐		☐	☐
Record issues				Issue Log Item: Initial / Date		

SAMPLE

Test Equipment Used:

Test Name	Manufacturer	Model Number	Serial Number	Calibration(Date)

ATS NAMEPLATE DATA

Parameter	Data
Equipment ID	
Manufacturer	
Model	
Serial No.	
Catalog No	
Mfg. Date	
Current Rating	
Voltage Rating	
Poles:	
Closing & Withstand Amps	
NEMA Enclosure	

SAMPLE

Contact Resistance

Contacts	A	B	C	N
Normal				
Emergency				

Insulation Resistance

Phase to Phase	A – B	B - C	C – A
Normal			
Emergency			
Phase to Ground	**A - G**	**B - G**	**C – G**
Normal			
Emergency			
To Load (ATS in Bypass)	**A – LOAD**	**B – LOAD**	**C - LOAD**
Normal			
Emergency			

SAMPLE

PARAMETERS AND SETPOINTS

Voltage

Parameter	Actual Setpoint	Specification Setpoint	Range	Factory Default
Normal Over-Voltage Dropout				
Normal Over -Voltage Pickup				
Emergency Over-Voltage Dropout				
Emergency Over -Voltage Pickup				
Normal Under-Voltage Dropout				
Normal Under-Voltage Pickup				
Emergency Under-Voltage Dropout				
Emergency Under-Voltage Pickup				

Frequency

Parameter	Actual Setpoint	Specification Setpoint	Range	Factory Default
Normal Over-Frequency Dropout				
Normal Over -Frequency Pickup				
Emergency Over-Frequency Dropout				
Emergency Over -Frequency Pickup				
Normal Under-Frequency Dropout				
Normal Under-Frequency Pickup				
Emergency Under-Frequency Dropout				
Emergency Under-Frequency Pickup				

SAMPLE

Time Delay

Parameter	Actual Setpoint	Specification Setpoint	Range	Factory Default
Neutral Position Time Delay				
Normal Failure Time Delay (Gen Start)				
Emergency Failure Time Delay				
Transfer to Emergency Time Delay				
Return to Normal Time Delay				
Engine Cool Down				

Note: The "Actual Setpoint" column in the above table should be filled in during step 0

Feeder Termination Torque (Newton Meters or Foot-Pounds)

TORQUE FEEDERS	A	B	C	N	G
NORMAL					
EMERGENCY					
LOAD					

SAMPLE

Commissioning Agent Final Sign-Off

The signature of the Commissioning Agent below indicates that the Systems Functional Test Procedure was witnessed by the Commissioning Agent and the results have been documented on this form.

Printed Name	Signature	Initials	Date

Test Notes and Lessons Learned

SAMPLE

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Appendix M – Sample Systems Manual

The following tqble is a sample of the Table of Contents for a typical Systems Manual that should be prepared by the Commissioning Agent as part of the commissioning scope of work. The Table of Contents is intended to demonstrate the topics to be covered in the Manual and the types of supporting documentation that should be included. The overall objective is that the Systems Manual should provide the information necessary for the VA Facilities Staff to effectively and efficiently operate and maintain the various systems that are necessary to support the mission of the VAMC or other VA agency that occupies the facility.

Section	Description	Prepared by				
		Cx Agent	Contractor	Owner	Designer	Controls Contractor
Index of Systems Manuals	Table of Contents/Index of Systems Manuals					
Owner's Project Requirements	Final Version					
Basis of Design Documents	Final Version					
Facility Data:						
General Facility and System Description	Overall dimensions, number of floors, foundation types,, expected number of occupants, facility category code, special building features, photographs.					
Safety Hazards	List of residual hazards identified in the Requirements Hazard Analysis					
Floor plans (11x17)	Uncluttered floor plans that include only room numbers, type or function of space, and overall all facility dimensions.					
Utility Connection and Cutoff Plans	Provide utility site and floor plans that indicate the exterior and main interior connection and cutoff points for all utilities.					
Extended Warranty Information	List all warranties for products, equipment, components and sub-components whos duration exceeds one year.					

Section	Description	Prepared by				
		Cx Agent	Contractor	Owner	Designer	Controls Contractor
Equipment Listing	A table that lists major equipment shown on design equipment schedules, item descriptions, locations, model numbers, name/address/phone of manufacturer, supplier, contractor, sub-contractor.					
HVAC Filters	Table that lists the quantity, type, size and location of each HVAC filter.					
Ceiling Surfaces	Table that lists by room number, the type of ceiling surface, and area of ceiling surface. Include facility summary the total area for each type of ceiling surface.					
Lighting Fixtures	Table that lists by room number, type of lighting fixture, number of lighting fixtures, type of bulbs/tubes, and number of bulbs/tubes. Include a facility summary of the total number of fixtures for each type, and number of bulbs/tubes for each type.					
Plumbing fixtures	Table that lists by room number, the number and type of plumbing and bathroom plumbing fixtures (sinks, water closets, urinals, showers, and drinking fountains).					
Training requirements	List of recommended training related to Primary Systems operation, maintenance, and repair of each installed systems tat is available for the manufacturer of other source. Provide name/address/phone of point of contact.					

Section	Description	Prepared by				
		Cx Agent	Contractor	Owner	Designer	Controls Contractor
Recommended Operational Record-keeping procedures, forms, logs, rationale for each	Sample blank forms, logs, etc. with basic instructions for use					
System Information						
System Description	Narrative system description, including function, capacity, major components, etc.					
System Schematics, one-line diagrams, flow diagrams, etc.	Flow diagram indicating system liquid, air, or gas flow during normal conditions.					
Diagrammatic Plans	Floor plans indicating location of equipment and configuration of the system installation.					
Environmental Considerations	Listing of equipment that requires special operation, reporting, testing, analysis, or inspection to comply with federal, state, and local environmental laws.					
Safety Information	List of all personnel hazards and equipment safety precautions					
Valve List	List of all valves associated with system. Show valve type, identification number, function, location and normal operating position					
Start-up and Shut-down procedures	Step-by-step procedures to bring systems from static to operational configurations and from operating to shutdown status.					

Section	Description	Prepared by				
		Cx Agent	Contractor	Owner	Designer	Controls Contractor
Operating procedures/sequences for Normal, abnormal, and emergency modes	Discussion of the normal operation and control of the system. Emergency operating instructions in the event of equipment malfunctions, fire, explosions, spills, or other contingencies.					
Operating instructions for integrated systems	Discussion of operating procedures for multiple, integrated systems.					
Ongoing Optimization Guide	Procedures for analyzing and maintaining optimal system operations					
Schedule for calibrating senors and actuators						
Manufacturer's Data						
Operation and Maintenance Data	O&M data package per the technical specifications					
Manufacturer's Equipment Information	Drawings, illustrations and product data furnished for the equipment and systems components.					
Training Materials						
Commissioning Report						

Appendix N – Sample Final Commissioning Report

The following table is a sample of the Table of Contents, Executive Summary, and Final Report Narrative for a Final Commissioning Report for a large healthcare project. The Table of Contents identifies the Appendices that form the bulk of the report. These Appendices are copies of the commissioning documents prepared during the course of the project. The Executive Summary provides a high-level summary of the commissioning process for the progress. The report narrative provides more detailed discussion of the commissioning process and results achieved for the project. The end result of the Commissioning Report is that it provides a comprehensive document that describes the commissioning process, the results and all the detailed documentation necessary to verify the building systems operate in accordance with the VA requirements for the specific project.

Final Commissioning Report Outline & Contents	
Section	**Descriptions**
Table of Contents	
Executive Summary	1 -2 page summary of the Cx Report findings suitable for the client's executive leadership. Include up to 3 - 5 of the most significant issues identified during the Cx process.
Report Narrative	
Chapter 1: Introduction	Overview of the Cx process as implement for the project. Include a brief description of the project, when Sebesta became involved in the project, and a brief discussion of our scope of work.
Chapter 2: Commissioning Team	A listing of the names, role, contact information for each member of the commissioning team.
Chapter 3: Commissioning Plan & Specifications	A brief discussion of the Cx Plan and specifications. Include a reference to the appendix for the final Cx Plan.
Chapter 4: Design Phase Commissioning	A brief discussion of the Design Phase Commissioning activities, including any significant issues identified and resolved. Highlight any un-resolved design issues.
Chapter 5: Construction Phase Commissioning	A brief discussion of the Construction Phase Cx activities.
Chapter 6: Testing and Acceptance Phase Commissioning	A brief discussion of the Testing and Acceptance Phase Cx activities.
Chapter 7: Warranty Phase Commissioning	A brief discussion of the Warranty Phase Cx activities, if a combined Cx Report is being issued. If a separate Cx Report Amendment will be issued at the end of the Warranty Phase, include a statement to this effect. Also, include an indication of the proposed Cx activities and estimate schedule.

Final Commissioning Report Outline & Contents	
Section	**Descriptions**
Chapter 8: Commissioning Issues	A review of the most significant issues that have not been resolved, including recommendations for resolution. A discussion of significant resolved issues can be included to highlight the value added by the Cx Process.
Chapter 9: Best Practices	Recommendations for best practices for operating and maintaining the systems commissioned, where these best practices may not be intuitively obvious. For example - if a system has unusual operating parameters that should be highlighted to the facilities operators and managers.
Chapter 10: Trend Analysis	A review of some significant operating trends from the DDC system. These should illustrate any unresolved significant issues (if applicable) and should illustrate where major systems are operating properly.
Chapter 11: Summary & Conclusions	A brief summary of the Cx results and a statement that the facility meet/does not meet the owner's requirements.
Appendices:	
A: Abbreviations	List of abbreviations used in the Report and appendices
B: Contract Documents	Copy of the Commissioning Contract, Scope of Work, and Fee
C: Control Submittal	Copy of the Controls Submittal and commissioning review comments, including status of comments and resolution measures.
D: Commissioning Plan	Copy of the Final Commissioning Plan, including all revisions

Final Commissioning Report Outline & Contents	
Section	**Descriptions**
E: Commissioning Design Review Comments	Copies of Design Review Log including A/E responses, status and resolutions implemented.
F: Commissioning Submittal Review Comments	Copies of Submittal Log and commissioning review comments
G: Commissioning Field Reports	Copies of all Commissioning Field Reports, including Field Reports issued during Functional Testing.
H: Commissioning Master Issues Log	Latest version of the Cx Master Issues Log showing all issues, current status, and resolution measures implemented
I: Executed Equipment Startup Sheets	Copies of executed Equipment Startup Checklists and Enhanced Startup Checklists complete by the Contractor
I: Executed Pre-Functional Checklists	Copies of Pre-Functional Checklists completed by the Contractor
J: Executed Functional Performance Test Procedures	Copies of Functional Test Procedures marked with test results
K: Closeout Document Review	Review comments on O&M Manuals, Training Plans, Warranties, etc.
L: Re-Commissioning Recommendations	Recommendations for which systems should be re-commissioned and recommendation for re-commissioning schedule
M: Blank Pre-Functional Checklists	Blank Pre-functional checklists for us by Facilities Staff
N: Blank System Functional Performance Test Procedures	Blank test procedures for use by the Facilities Staff

Final Commissioning Report Outline & Contents	
Section	**Descriptions**
O: Other Commissioning Documents	Other commissioning-related documents not included in other appendices
Commissioning Report Amendment	Issued at the completion of the warranty phase after deferred testing and the warranty checkup have been completed.
Table of Contents	
Executive Summary	1 - 2 page summary of Warranty Phase Commissioning results suitable for the Client's Executive Leadership
Amendment Narrative:	
Chapter 1: Introduction	A brief overview of the warranty phase Cx activities
Chapter 2: Warranty Phase Commissioning	Overview of the Warranty Phase commissioning activities. Include a summary of observed systems operations, interviews with the O&M Staff and facilities users.
Chapter 3: Commissioning Issues	Update on the status of Significant Unresolved Issues discussed in the initial Cx Report. Include identification of any new issues identified with recommendations for resolution
Chapter 4: Summary & Conclusions	Overall summary and conclusion. Include a discussion of how any unresolved issues should be resolved and verified.
Appendices:	
A: Commissioning Field Reports	Field Report for the Warranty checkup, deferred and seasonal functional testing.
B: Commissioning Master Issues Log	Updated Cx Master Issues log annotated with the current status of unresolved issues, and identification of any new issues.

Final Commissioning Report Outline & Contents	
Section	**Descriptions**
C: Executed Functional Performance Test Procedures	Copies of functional test procedures from deferred and seasonal testing
D: Warranty Review and Potential Warranty Claims	Review of warranties and identification of any potential warranty claims.