Oakland ARTCC (ZOA)
Fremont, California

Control Wing Basement Renovation and Chillers/Cooling Tower Replacement (Major Mechanical) Project

Final Design Submittal
Preliminary Commissioning Plan

July 8, 2015

JACOBS

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1 Introduction:

1.1 Commissioning Overview

Commissioning is a team-oriented, systematic process of assuring by verification and documentation from the design phase into the occupancy phase that facility systems perform interactively in accordance with the design documentation and in accordance with the Federal Aviation Administration's (Owner) operational needs including training of operational personnel. The commissioning process facilitates and coordinates the traditionally separate functions of system documentation, equipment start-up, performance testing, and operator training.

Elements of Building Commissioning Include:

1. Commissioning-focused design reviews.
2. Commissioning-focused equipment of submittal reviews.
3. Sequence of operation reviews.
4. Review of design and construction modifications and incorporation into the commissioning plan.
5. Project-specific Construction Verification Checklists, Functional Performance Tests and Integrated Systems Tests.
6. Clear and thorough documentation of the design intent, installation, and O&M requirements.
7. Training oversight for the operators and facility maintenance staff.
8. An unbiased, objective view of the built systems, equipment installation, operation, and functional performance.
9. Post occupancy testing and evaluation.

1.2 Commissioning Authority (CxA)

The CxA guides the Commissioning Team (CxT) through the commissioning process. The CxA does not direct or accept the work. Roles and responsibilities of the CxT members are described in this plan.

1.3 Commissioning Plan:

The Commissioning Plan describes the responsibilities of various key personnel involved in the design, construction, and Commissioning process and procedures. The Commissioning Plan outlines the Commissioning Process to ensure building systems are installed according to contract documents, and operate within the performance guidelines set out in the contract documents. All parties shall ensure the building systems and equipment are installed, started, tested and documented to meet the FAA's needs and to ensure that training for operations and maintenance personnel are being implemented.

1.4 Project Description:

This project is a site adaptation at the Oakland ARTCC (ZOA) in Fremont, CA of two standard designs; Control Wing Basement Modernization Standard Design and Chillers/Cooling Towers Modernization Standard Design (Control Wing Basement and Chillers/Cooling Towers together are also referred to as the Major Mechanical Sustain Project).

This Design, of which this Preliminary Commissioning Plan is a part, provides construction documents to show how these Standard Designs are to be adapted at the ZOA facility taking into consideration ZOA-unique site conditions and requirements. These Construction Documents will be issued for competitive bidding by contractors qualified to perform the work. This Preliminary Commissioning Plan is to be updated and completed by the CxA, including insertion of actual selected and installed equipment information.

The Chiller/Cooling Tower Standard Design Modernization Project provides for replacement of mechanical system components, including chillers, cooling towers, chilled water pumps and condenser water pumps serving the ARTCC main building. The Control Wing Basement Modernization project provides for replacement of mechanical system components, including air handling units, serving the Electronic Equipment Room B120 and Host Mechanical Room B119.

The following project specification sections are also included in this ZOA Control Wing Basement and Major Mechanical Commissioning Plan:

1. Section 01 78 23 – Operation and Maintenance Data.
2. Section 01 79 00 – Demonstration and Training.
3. Section 01 91 13 – General Commissioning Requirements.

This Major Mechanical and Cooling Tower Modernization Commissioning Plan addresses and provides Commissioning for:

1. Outdoor Air Handling Units: AHU-109 and AHU-390.
2. Computer Room Air Handling Units: AHU-21, 105 and AHU-106
3. Chillers: CH-200 and CH-300.
4. Existing Chillers: CH-100 and CH-400.
5. Cooling Towers: CT-1A, CT-1B, CT-1C and CT-1D.
6. Pumps: P-1A, P-1D, P-3A, P-3B and P-3C.
7. Existing Pumps: P-1B and P-1C
8. Exhaust Fans: EF-310 and EF-1.
9. Existing Exhaust Fan: EF-310B.
10. Refrigerant Leak Monitor.
11. Water Leak Detection Systems, which monitor under floor area in Control Wing Basement and Host Mechanical Room and overhead piping in Chiller Room.
12. New BACnet based DDCS controls for the new mechanical equipment.
13. New Fire Protection and Fire Alarm systems (expansions of existing systems).

Due to the interactions between both existing and new equipment in, the chilled water and condenser water systems and the critical nature of that equipment, that equipment Functional Performance Testing shall be performed on both existing and new equipment. The components of the chilled water system and the condenser water system will be commissioned as a single, complete and integrated system.

It is anticipated that some issues may be found with the existing chilled water/condenser water equipment, which is not being replaced as part of the scope for this project. The CxA will document these issues, evaluate their severity, develop recommendations and present them to the FAA so that the FAA can make an informed decision concerning resolution of these issues.

1.5 Abbreviations:

The following are common abbreviations used in this document.

- ARTCC – Air Route Traffic Control Center
- ATC – Automatic Temperature Control Contractor
- AWR – Automation Wing Renovation
- DDCS – Direct Digital Control System
- CxA – Commissioning Authority
- COTR – Contracting Officer's Technical Representative (FAA)
- Cx – Commissioning
- CxPD – Commissioning Plan Document
- CxT – Commissioning Team
- DDC – Direct Digital Controls
- DDH – Design Data Handbook
- DM – Design Project Manager (Jacobs)
- EC – Electrical Contractor
- ESU – Environmental Support Unit Supervisor (FAA)
- GC – General Contractor
- FPTs – Functional Performance Tests
- MC – Mechanical Contractor
- NIST – National Institute of Standards and Technology
- NBS – National Bureau of Standards
- O/O – Owner/Operator (FAA)
- O&M – Operations and Maintenance
- OPR – Owner's Project Requirements
- PFVCs – Pre-Functional Verification Checklists
- RE – Resident Engineer (FAA)
- RFI – Request for Information
- TAB – Test, Adjust and Balance
- TBD – To Be Determined

2 Roles and Responsibilities:

2.1 FAA Owner/Operator Responsibilities:

The Federal Aviation Administration (FAA)

The FAA defines the overall vision for the use of the facility, establishes Owner's Project Requirements and Commissioning objectives, establishes the construction budget, and ultimately accepts and operates the finished facility.

The FAA appoints the Resident Engineer as the FAA'S technical representative. The RE is the primary day-to-day FAA point of contact. The RE is responsible to ensure work is completed in accordance with the contract document requirements and that the FAA's design intent is met upon completion. The RE is the single point of contact for coordinating work with the FAA operations and accepting submittals, deliverables and completed work.

2.2 Project Design Manager (DM) Responsibilities:

The DM has the overall responsibility for executing the design in accordance with the OPR and DDH. The design team, which is led by the DM, is composed of the engineers who prepared the contract documents that reflect the Owner's Project Requirements.

The DM's role in the construction phase includes dealing with design conformance issues identified during the Commissioning process and to assist in the implementation process. The DM's role as it relates to Commissioning during the construction phase also includes submittal reviews, RFI responses, witnessing certain tests and periodic site visits. DM tasks may be delegated to the Construction Administrator (CA) during the construction phase. The DM does not play a large role in day-to-day performance verification or quality control.

The DM:

1. Translates the FAA's project requirements into technical design intent.
2. Prepares thorough, accurate, and clear contract documents based upon the OPR and DDH.
3. Edits and incorporates Commissioning Specifications (as necessary) and incorporates commissioning-related information into Construction Specifications.
4. Reviews, comments, and advises the CxA in the development of the Construction Verification Checklists, Functional Performance Tests, and the Integrated Systems Tests.
5. Reviews and maintains clarifications or interpretations of the design intent as required.
6. Consults on and resolves any design related issues or problems that arise during the construction.
7. Coordinates review and distribution of technical submittals relating to systems and equipment scheduled to be commissioned.
8. Coordinates review and distribution of correspondence regarding RFIs relating to systems and equipment scheduled to be commissioned.
9. Updates the OPR.
10. Documents and distributes changes relating to systems and equipment scheduled to be commissioned.

2.3 Resident Engineer (RE) Responsibilities:

The RE is the Government representative responsible for accepting the work. The CxA will work closely with the RE regarding HVAC equipment and system performance, and will make recommendations to the RE regarding acceptance.

The RE shall:

1. Assemble the Commissioning Team (CxT).
2. Attend design, construction, and commissioning related meetings.
3. Coordinate site visits and testing with the CxA.
4. Monitor/review PFVC's to ensure the results are documented as the checklists are completed.
5. Monitor controls point-to-point checks performed by the controls contractor and ensure the results are documented as the checks are completed.
6. Oversee all or part of testing of the control system and approves it for use by TAB, before TAB is executed.
7. Receive TAB plans and reports. Coordinates their review.
8. Participate at their discretion in Functional Performance Testing.
9. Coordinate training with the maintenance staff and the General Contractor and approves training plans.
10. Coordinate submission and review of the Operations and Maintenance documentation and approve Operations and Maintenance documentation.
11. Review and approve GC maintenance schedules for equipment operated by the GC prior to acceptance.
12. Review and approve the preparation of the final O&M manuals. Ensure required O&M manuals, instructions and demonstrations are provided to the FAA's designated operating staff.
13. Review equipment warranties to ensure that the FAA's responsibilities are clearly defined.

2.4 General Contractor (GC) Responsibilities:

The GC has overall responsibility and authority to ensure compliance with and coordination of the Contract Documents. This responsibility includes the following:

1. Comply with the Construction Documents.
2. Coordinate meetings, schedules, and Commissioning activities with the CxA.
3. Facilitate communications among installers and suppliers and other CxT members, and foster the necessary cooperative action.
4. Involve installers in the Commissioning Process.
5. Obtain O&M documentation for updating commissioning checklists.
6. Ensure Pre-Functional Verification Checklists (PFVCs) are completed and associated work performed, prior to scheduling of FPTs.
7. Ensure Functional Performance Tests (FPTs) are performed and checklists completed.
8. Notify the RE and CxA a minimum of two weeks in advance of scheduled HVAC equipment and system start-ups, and PFVC's.
9. Implement corrective actions.
10. Coordinate specified training.
11. The GC shall coordinate with the RE and CxA. Coordination shall include, but not be limited to the following:
    a. CxA site visits,
    b. Planning,

c. Scheduling,
d. Communication with the CxT,
e. Corrective actions, and
f. Specified training.

2.5 Commissioning Authority (CxA) Responsibilities:

The primary role of the CxA is to develop and coordinate the execution of a testing plan, document performance, and confirm proper system functionality in accordance with the DDH and with Contract Documents. The CxA facilitates the overall Commissioning process.

The CxA is not responsible for design concept, design criteria, compliance with codes, design or general construction scheduling, cost estimating, or construction management. These are responsibilities of the GC and the DM. The CxA will assist with problem solving, and resolving non-conformance, or deficiencies issues.

The Commissioning Authority (CxA) shall:

1. Develop a Commissioning Plan which describes in general the extent of the Commissioning Process to accomplish the design intent and coordinate with the construction schedule.
2. Coordinate Commissioning activities in a logical, sequential and efficient manner.
3. Kicks off the commissioning effort. Conducts an initial CxT meeting to describe the process, review roles and responsibilities, set expectations, establish communication and coordinate the work.
4. Schedule and lead commissioning meetings as needed with the Commissioning Team.
5. Develop Pre-Functional Verification Checklists (PFVCs) and Functional Performance Tests (FPTs) based on the Contract Documents, manufacturers O&M information, and accessibility requirements for O&M. Bring to the attention of the DM, GC, and RE identified deficiencies and coordination problems with systems/equipment to be commissioned.
6. Reviews completed PFVCs to ensure the results are documented properly as the checklists are completed and to evaluate any issues which are documented in the PFVCs.
7. Track testing non-conformance(s). Participate in re-testing as necessary, until satisfactory performance is achieved.
8. Compile and maintain organized and complete Commissioning records.
9. Review approved submittals applicable to the systems being commissioned to assist in development of testing checklists.
10. Review requests for information and change orders for impact on commissioning.
11. Establish test plans and schedules with the Commissioning Team.
12. Coordinate with the RE & GC to monitor Functional Performance Testing for commissioned systems and assemblies. Witness and document Functional Performance Tests performed by the Contractor for all commissioned systems and assemblies.
13. The Functional Performance Testing will include operating the system and components through each of the written sequences of operation, and other significant modes and sequences, including start-up, shutdown, unoccupied mode, manual mode, staging, miscellaneous alarms, power failure and interlocks with other systems or equipment. Sensors and actuators shall be calibrated by the installing contractors, and spot-checked by the commissioning provider during Functional Performance Testing. Coordinate retesting as necessary until satisfactory performance is achieved. Tests on respective HVAC equipment shall be executed, if possible, during both the heating and cooling seasons. However, some overwriting of control values to simulate conditions may be required. Functional Performance Testing shall be done using conventional manual methods and

readouts, to provide a high level of confidence in proper system function, as deemed appropriate by the FAA.

14. Witness Inspection and Testing of Fire Alarm System and Fire Suppression System by Authority Having Jurisdiction (AHJ).
15. Maintain a master issues log and a separate record of Functional Performance Testing. Report all issues to the RE as they occur. Provide written progress reports and test results with recommended actions.
16. If requested by the CxT attend selected planning and job-site meetings to obtain information on construction progress.
17. Review the TAB execution plan.
18. As a part of the FPTs, monitors control point-to-point checks performed by the controls contractor and ensures the results are documented as the checks are completed.
19. Review FPTs and analyze data to verify performance.
20. Coordinate the resolution of design non-compliance and deficiencies identified in all phases of commissioning.
21. Recommend acceptance of tested systems and equipment commissioned to the RE.
22. Provide a final Commissioning Report that will include;

    a. An executive summary;
    b. List of participants and roles;
    c. Brief project description;
    d. Overview of Commissioning and testing scope
    e. General description of testing and verification methods.

    For each piece of commissioned equipment, the report will contain the disposition of the Commissioning Authority regarding the adequacy of the equipment. Outstanding non-compliance and deficiencies shall be specifically listed. Appendices shall contain acquired documentation of all completed PFVCs, FPTs, deficiency lists, site visit reports, general findings and unresolved issues.

2.6 Subcontractors Commissioning Responsibilities:

1. Cooperate with the CxT to facilitate the successful completion of the Commissioning process.
2. Assign a representative to the CxT, and submit the person's name to the RE and CxA, within one month of the Award of the Contract. The representative shall have the authority to make decisions on behalf of the contractor as they relate to the Commissioning processes. The representative shall establish communications among contractor and suppliers and all other CxT members, and shall foster the necessary cooperative action.
3. Attend CxT meetings, and ensure action items arising from these meetings are responded to as required to allow the Commissioning Process to proceed on schedule.
4. Ensure cooperation and participation of specialty subcontractors as applicable.
5. Ensure participation of major equipment manufacturers as appropriate in start-up, testing and training activities.
6. Notify the GC a minimum of two weeks in advance of scheduled equipment and system start-ups, and PFVC's so the RE may witness.
7. Inspect, check and confirm that the correct and complete installation of all systems, sub-systems and component start-up for each system PFVC's are performed. Document the results of inspections and checks on the checklists and sign them. If deficient or incomplete work is discovered, ensure corrective action is taken and re-check until the results are satisfactory and the system is ready for safe start-up.
8. Provide all tools/equipment and personnel required to perform all checks and tests.

9. Provide Operations and Maintenance Documentation in accordance with the construction specifications.
10. Provide equipment inventory information in accordance with the specifications.
11. Develop and execute orientation and training in accordance with contract documents.
12. Provide personnel to assist the CxA during system verification and FPTs. Operate equipment and systems for FPTs in accordance with the Commissioning Plan and as directed by the CxA. If improper functionality, incomplete work, or other deficiencies affecting system performance are discovered, the CxA will stop the FPTs. Those responsible for deficient or incomplete work will be responsible to ensure corrections necessary for full and complete system operation as specified are completed.

3 Commissioning Process:

The purpose of the Commissioning Process is to provide the FAA with assurance that building systems and equipment have been installed in accordance with Contract Documents, and operate within performance guidelines specified.

The Commissioning Authority will provide the FAA with an unbiased, objective view of the built systems and equipment installation, operation, and functional performance.

The Commissioning Process **does not** remove or reduce the responsibility of the installing contractor to provide a finished product, installed and fully functional in accordance with the contract documents.

Commissioning is intended to confirm and approve system start-up and aid in the orderly completion and transfer of building systems and equipment for use by the FAA. The CxA is the leader of the Commissioning Team, planning and coordinating Commissioning activities in conjunction with the RE, DM, and GC.

3.1 Commissioning Specifications:

The Design Manager (DM) has sole responsibility for the technical specifications. CxA will review the Contract Documents to ensure inclusion of information describing the GC and contractor's responsibilities related to Commissioning, and to coordinate commissioning related specifications with the DM.

The commissioning specifications include Sections 01 78 23 Operations and Maintenance Data, 01 79 00 Demonstration and Training, and 01 91 13 General Commissioning Requirements. Commissioning related requirements are also included in the Contract Documents. Commissioning requirements include but are not limited to:

1. Identification of the Commissioning Authority, and its role and responsibilities.
2. A summary of the roles and responsibilities of all other team members
3. A list of all building systems, equipment and interfaces to be commissioned.
4. Sample PFVCs for each type of new system being commissioned. PFVCs will not be issued for existing equipment.
5. Sample FPT to illustrate format that will be used.
6. Commissioning responsibilities of the GC and contractors, whose scope of work includes building systems and equipment to be commissioned by the Commissioning Authority. These responsibilities apply to all sub-contractors, sub-trades and suppliers associated with work on building systems and equipment to be commissioned.
7. Requirements for training the FAA's ARTCC Environmental Support Unit. This includes instruction sessions with input from equipment manufacturers and site demonstrations by applicable contractors. A site walk through will be conducted to indicate various locations of equipment and ancillary items such as shut off valves, disconnect switches, timers, special controls, etc.
8. Documentation requirements, such as submittal data, manufacturers' operations and maintenance data, and contact information for all relevant contractors and suppliers.
9. Commissioning Meetings.
10. Commissioning Issues Log.
11. Commissioning Field Reports.
12. Cross-references included in other sections of the specification where contractor or trade-specific Commissioning requirements are applicable.

13. Language assigning financial responsibilities for failed tests or tests aborted due to incomplete installation to the appropriate parties.

3.2 Review of the Commissioning Plan:

The FAA RE, DM, and GC will review the Commissioning Plan with the CxA. The approved document will be distributed to Commissioning Team members for their information and action.

3.3 Support for Commissioning:

The Commissioning Authority provides leadership by communicating goals for the Commissioning Process, including verification of roles and responsibilities of team members, and clearly defining and documenting pass/fail criteria. Each Commissioning Team member shares responsibility to support the Commissioning Process and achieve a quality installation.

3.4 Commissioning Meetings:

The CxA will coordinate with the RE and GC to schedule Commissioning Meetings during site visits as needed. Dates, times and prerequisites for upcoming Commissioning checks, start-ups, or tests will be established. Issues will be raised and problems identified with required action decided, and a date for completion determined. Commissioning Team members are responsible for attending Commissioning Meetings and for completing assigned action items by the assigned dates. Cooperation is critical to successful Commissioning.

3.5 Coordination Planning:

The sequence and timing of Commissioning activities will be incorporated into the overall project schedule. The Commissioning Authority identifies the required Commissioning activities. Coordination requires input from the RE, DM, and GC, and contractors. Cooperation among the parties facilitates integration of Commissioning into the total construction program. The RE and GC will coordinate day to day commissioning activities. The RE and CxA will coordinate CxA site visits.

3.6 Submittal Review:

Submittal reviews will be performed by the Government and DM. The CxA will be provided copies of approved submittals as they are applicable to the systems being commissioned.

3.7 Installation Monitoring :

Contractors, sub-contractors, and suppliers are responsible for supplying materials and installation of work in accordance with standard industry practices, contract documents, and the project schedule. Commissioning is not a substitute for Quality Control.

Early planning and scheduling activities in the construction phase of the Commissioning Process are intended to create a coordinated and realistic schedule, and thus avoid delays. PFVCs in the Commissioning Plan are particularly valuable. As scheduled start-up time approaches, the checklists prioritize items for the contractor's attention. Checklists for upcoming start-ups are reviewed at Commissioning Meetings to confirm readiness, and incomplete items will become issues for tracking and resolution. It is critical that the PFVCs be complete and approved PRIOR to the related FPT to ensure deficiencies are minimized to avoid unnecessary delay in construction and acceptance.

3.8 Construction Issues Tracking:

The GC and subcontractors are responsible for the overall construction process, including the necessary scheduling and coordination. The CxA will maintain a "Commissioning Issues Log" document to ensure that issues encountered during the Commissioning process are documented, followed up, and kept visible until resolved.

It is the responsibility of the appropriate team member to address and resolve all applicable items in a timely manner, to avoid impacts on schedule and acceptance testing.

3.9 Project Schedule Updates:

The FAA, DM, GC and CxA will periodically review the updated project schedule to ensure that all required Commissioning activities are incorporated, time allowances are adequate, and installation sequences are logical and properly coordinated with other construction activities.

3.10 CxA Site Visits:

The CxA will observe the installation periodically to assess construction compliance with the Design Intent Document (DID), Contract Documents and prevailing industry standards. It is anticipated the CxA will make four site visits.

The first site visit will be a one day visit shortly after the GC mobilizes. The purpose of the site visit will be to assemble the CxT and conduct a kick off meeting. The meeting will include a review of the commissioning process, commissioning requirements, roles and responsibilities and major commissioning issues and milestones. During the kick off meeting schedule, coordination, communication and process management will be discussed. Also any construction or design issues will be discussed.

The second site visit will be a one or two day visit at the start of the TAB effort. The purpose of the site visit will be to witness some of the TAB work, survey the completed HVAC systems and coordinate with the site concerning Functional Performance Testing and it's potential impact on the facility.

The third site visit will be a two week visit when HVAC equipment installation is complete. The purpose will be to direct and witness Functional Performance Tests and to verify completion of PFVC checks and startup tests. It is anticipated that some, if not all of this testing will be performed at night due to the critical nature of the systems involved.

The fourth site visit will be a week visit to perform system re-testing based on the results of the FPTs performed during the second site visit. It is anticipated that some, if not all of this testing will be performed at night due to the critical nature of the systems involved.

3.11 Pre-Functional Verification Checklists (PFVCs):

PFVCs ensure systems and equipment are installed properly, conform to the Contract Documents and are ready for safe start-up. The responsibility for carrying out these checks, as well as any corrective action, lies with the GC. The CxA will prepare PFVCs for the new equipment and issue the PFVCs to the RE prior to startup of the equipment being commissioned. PFVCs will not be issues for existing equipment. Completion of checklists items does not indicate acceptance or responsibility by the CxA or FAA.

Checks developed for the project will include steps that are typically required and verification inspection checks that must be carried out and documented prior to and during start-up and performance testing. Commissioning checklists and the equipment list will be developed and updated as the design progresses and as specific manufacturers and models of equipment are submitted by the GC and approved for installation.

Start-Up Checks:

Typically used to refer to the static testing or check out of systems or equipment to ensure proper and complete operation and readiness for FPT. Start-up checks are incorporated into the PFVCs and include items such as verifying proper voltage, motor rotation, etc. The start-up procedures and/or checks are typically obtained from manufacturers O&M manuals and Contract Documents and are performed by the authorized manufacturer's start-up representative. These are done prior to Functional Performance Testing.

3.12 Functional Performance Tests (FPTs):

After reviewing the approved submittals, and the construction documents, the CxA authors the FPTs for each system-to-be-commissioned. Both new and existing equipment that is part of the chilled water system and the condenser water system shall be tested as part of the functional performance testing. The FPTs are based upon the construction documents, specifications and submittals. FPTs should progress from individual items of equipment and sub-systems, to complete systems, to integration between other systems, depending on the scope of the Commissioning Plan. This test progression helps to isolate the cause of problems as it verifies correct operation of smaller components of the installation before moving on to tests involving larger systems or integration between systems.

The GC is responsible for operating the systems as directed by the CxA. CxA directs, witnesses and documents the results of the FPTs of building systems to be Commissioned.

The Automatic Temperature Controls (ATC) contractor may have to override normal control operation or parameters to simulate specific test conditions, and set up trend-logs to provide a record of system responses to test actions. Completion of checklists items **does not** indicate acceptance or responsibility by the CxA or FAA.

3.13 Review of Test and Balance (TAB) Procedures:

Before executing their work, the TAB agency must submit to the DM, GC and CxA for review and approval a plan detailing the TAB procedures and instruments planned for use on the project. The plan shall include the formats in which results will be reported, including a preliminary TAB report representing the project's equipment design parameters on approved data sheets. The TAB agency shall also describe the operational conditions required before HVAC systems will be ready for balancing. During early construction the TAB agency provides comments from their review of contract documents pertaining to provisions for testing air and water flows, temperatures and pressures.

The TAB agency shall submit a tentative schedule for their work. The schedule includes site visits to evaluate the impacts of as-built conditions on the planned procedures and schedule, and to determine when the installation will be ready for on-site TAB work. The RE, DM and GC will review this information.

TAB Services:

The TAB agency is responsible for checking that prerequisites for the start of TAB services have been completed prior to initiating their fieldwork.

The TAB agency shall perform TAB services in accordance with the Contract Documents and the procedures submitted and approved at the beginning of the construction phase.

Where controls need to be calibrated against measured air or water flows, the ATC contractor must work with the TAB agency so that the related measurements and calibrations are coordinated, and the results documented.

TAB equipment used for testing and calibration shall be NIST/NBS traceable and calibrated with-in the preceding six-month period. Certificates of calibration must be submitted previous to any TAB testing.

TAB Report:

The TAB subcontractor shall complete and submit a preliminary TAB report to the RE. The RE will verify the TAB report both by reviewing the report and duplicating field tests. The TAB subcontractor shall provide necessary personnel and equipment to assist in verification. The TAB subcontractor shall address inconsistencies identified during verification or designer comments and resubmits the final TAB report to the RE for approval. A copy of the preliminary TAB report will be provided to the CxA prior to starting Functional Performance Tests.

3.14 HVAC Controls Installation:

The ATC contractor is responsible for documenting all aspects of the controls installation. At a minimum, the following as-built information will be included:

1. Data on all components included with the controls installation, including general description, parts lists, technical & applications data, and installation, calibration and maintenance information.
2. Schematic diagrams of the entire controls system as specified.
3. A complete points list, with records of point-to-point wiring, documented field locations and device test.
4. Complete written sequences of controls for all systems, with details of final values for all parameters and set points.
5. Clearly labeled control panels and devices as specified.

Controls Point-to-Point Checks:

The ATC contractor will carry out point-to-point control checks, and document the results on checkout sheets. These checks confirm control point wiring has been correctly installed and terminated, sensors have been calibrated, and field devices operate correctly. This involves physical observation of device responses by the ATC contractor to ensure they match control system displays. The RE will verify the results reported by the ATC subcontractor, and provide this information to the CxA for inclusion in the Commissioning Report. The RE will employ sampling techniques to document verification of point-to-point checkouts. Direct monitoring of the ATC checkout process facilitates conformance with the DID.

3.15 HVAC System Start-Ups:

The mechanical contractor is responsible for starting HVAC equipment and systems in accordance with the Contract Documents. No equipment shall be started until appropriate Cx plan documentation (including completed PFVCs) has been completed and the start-up time and date has been scheduled and approved in advance.

Before starting equipment or systems, contractors must complete the relevant PFVCs. When the specification requires a manufacturer's certified technician, the technician, using the manufacturer's start-up procedure and documentation must perform the start-up. The RE will observe major start-ups. Abnormalities occurring or corrective actions taken during start-up of equipment or systems will be noted in the Commissioning start-up documentation. Conditions not in compliance with Contract Documents or manufacturer's recommendations will preclude operation of affected systems until such conditions are corrected. RE makes final decisions regarding a system's readiness for operation.

The RE will witness selected start-ups, and document the results using the start-up checklists and other provisions in the Commissioning Plan. When the manufacturer's technician does the start-up, a copy of the manufacturer's start-up report will be attached to the PFVC.

3.16 Deficiencies and Re-Test:

The GC will ensure equipment and systems as well as subcontractors and suppliers are ready for Commissioning tests, inspections and any necessary re-testing.

Incomplete work or deficiencies discovered in PFVCs, or FPTs will be corrected by the responsible subcontractors and re-tested to produce satisfactory results prior to proceeding to the next stage of the Commissioning process. The GC is responsible for deficient or incomplete work and will be responsible to ensure corrections necessary for full and complete system operation as specified are completed.

In the event the deficiencies cannot be completed within two initial tests, responsible subcontractor shall pay CxA's cost of retest plus any additional cost incurred for travel expenses for subsequent tests.

3.17 Acceptance:

The acceptance phase immediately follows the construction phase and FPTs of specified systems/equipment and completion of documentation. During the acceptance phase the FAA O&M staff receives the documentation and training necessary for effective operations and maintenance of building systems. The DM and RE evaluate new and/or modified systems relative to the DID and suitability for occupancy. Acceptance of building by the FAA initiates specified warranties. Commissioning clarifies requirements for initiation of the warranty period. The requirements for acceptance will be defined by the FAA.

4 Commissioning Protocols:

The following Commissioning Protocols shall be followed:

1. No communication from the CxA shall be interpreted as a work directive. Commissioning Issues Log updates resulting from testing will be provided to the GC through the FAA RE, but this does not imply that it is complete or that the identified deficiencies shall be acted upon or how to resolve them.
2. Design related Commissioning issues will be referred to the GC through the RE.
3. Equipment shall not be "temporarily" started (for heating or cooling), before PFVC items and manufacturers' pre-start procedures are completed, and moisture, dust and other environmental and building integrity issues have been addressed and a maintenance schedule set in place.
4. Equipment put in service for temporary use shall have a preventive maintenance schedule in place and approved by the RE. Maintenance shall be performed in accordance with manufacturer's recommended maintenance schedule and any precautionary measures necessary to protect equipment during the construction process.
5. Equipment that is operated by the GC to support the construction effort, such as providing conditioned air, shall be commissioned in accordance with this Specification before being placed in service. Temporary operation of permanent equipment shall be coordinated with the RE

    - Maintain equipment in accordance with manufacturer's procedures and schedules. Review maintenance requirements with the RE and adjust as necessary to account for the construction environment (high dust, humidity, etc.).
    - Maintain a maintenance record of each equipment item operated prior to acceptance. Submit copies to the RE on a monthly basis.
    - Prior to acceptance, replace belts, filters, lubricants and other consumables with new and re-perform PFVCs.

6. The control system and equipment it controls is not functionally tested until points have been calibrated and point-to-point checks are completed, PFVCs have been completed, and FPTs are completed.
7. TAB is not performed until the building envelope is completely enclosed and ceiling complete, unless return air is ducted.
8. TAB is not performed until the control system has been tested and approved by the RE for TAB work.

APPENDIX A

Participants Involved in the Cx Process:

1. Design Manager (DM):

Company: Jacobs
Address: 1100 North Glebe Road, Suite 500
Arlington, VA. 22201

Contact Person: Lynn Myers
Phone: 571-218-1245
Fax:
Other:
Email Address: lynn.myers@jacobs.com

2. Architect

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Contact Person: William Stevens
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Email Address: william.stevens@jacobs.com

3. Electrical Design Engineer (EDE):

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4. Mechanical Design Engineer (MDE):

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Contact Person: Michael Hathorne

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Fax:
Other:
Email Address: michael.hathorne@jacobs.com

5. Fire Alarm Design Engineer (FADE)

Company:	Jacobs
Address:	1100 North Glebe Road, Suite 500 Arlington, VA. 22201
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Phone:	571-218-1236
Fax:	
Other:	
Email Address:	mina.roncevic@jacobs.com

6. Commissioning Authority (CxA):

Company Name:	TBD
Address:	
Contact Person:	TBD
Phone:	
Fax:	
Other:	
Email Address:	

7. Federal Aviation Administration (FAA)

FAA	Headquarters:
Address:	600 Independence Avenue, SW Washington, DC 20591
Contact Person:	TBD
Phone:	
Fax:	
Other:	
Email Address:	

8. Federal Aviation Administration (FAA)

FAA	PIM / Regional Contact
Address:	TBD
Contact Person:	TBD
Phone:	
Fax:	
Other:	
Email Address:	

9. Federal Aviation Administration (FAA):

FAA Regional Contact
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Contact Person: TBD
Phone:
Fax:
Other:
Email Address:

10. Federal Aviation Administration (FAA):

FAA Resident Engineer (RE)
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Contact Person: TBD
Phone:
Fax:
Other:
Email Address:

11. General Contractor

Company Name: TBD
Address: TBD

Contact Person: TBD
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Fax:
Other:
Email Address

12. Electrical Contractor (EC):

Company Name: TBD
Address: TBD

Contact Person: TBD
Phone:
Fax:
Other:
Email Address:

13. Controls Contractor (CC):

Company Name: TBD
Address: TBD

Contact Person: TBD
Phone:
Fax:
Other:
Email Address:

14. Fire Alarm Contractor (FAC):

Company Name: TBD
Address: TBD

Contact Person: TBD
Phone
Fax:
Other:
Email Address:

15. Fire Protection Contractor (FPC):

Company Name: TBD
Address: TBD

Contact Person: TBD
Phone:
Fax:
Other:
Email Address:

16. Mechanical Contractor (MC):

Company Name: TBD
Address: TBD

Contact Person: TBD
Phone:
Fax:
Other:
Email Address:

17. TAB Contractor (TAB):

Company Name: TBD
Address: TBD

Contact Person: TBD
Phone:

APPENDIX B

Systems and Equipment to be Commissioned:

Chilled Water System:

1. Chillers
2. Chilled Water Pumps
3. HVAC Controls

Condenser Water System:

1. Cooling Towers
2. Condenser Water Pumps
3. HVAC Controls

Mechanical Systems:

1. Air Handling Units
2. Exhaust Fans
3. Refrigerant Leak Monitor
4. Water Leak Detection Systems
5. HVAC Controls

Fire Alarm System

APPENDIX C

Pre-Functional Verification Checklists - Samples

This appendix contains samples of system/equipment PFVCs similar to the equipment anticipated to be installed.

The sample PFVCs indicate the level of detail that is required to commission this project. **As specific equipment is approved and installation and start up information obtained, checklists shall be developed that include actual manufacturer's requirements.** The checklists include steps that are typically required, and verification inspection checks that must be carried out and documented prior to and during start-up and performance testing.

Sample PFVCs:

Air Handling Unit

Air Handling Unit, AHU-_____

VAV AHU with Economizer

Pre-Functional Verification Checklist

FAA -

JACOBS™

1100 North Glebe Road, Suite 500
Arlington, VA 22201
Tel: (571) 218-1000
Fax: (571) 218-1600

Task No.	Task Description	Contractor	Contractor Initial and Date
1	**Equipment Delivery and Acceptance Verifications**		
1.1	**Note:** Record actual Name Plate Data and confirm unit is as specified in the contract documents: Manufacturer: _____ Model Number: _____ Serial Number: _____ Volts/Phase/Hz: _____ CFM: _____; Cooling BTUH: _____; Heating BTUH: _____ Motor FLA: _____Amps; Motor HP: _____ Cooling Coil Flow Rate: _____GPM; Heating Coil Flow Rate: _____GPM	MC	
1.2	Verify AHU configuration is as specified in the contract documents.	MC	
1.3	Verify date of manufacture. (Verify by date tag or serial number. If date exceeds 16 weeks notify RE and CxA).	MC	
1.4	Verify unit is free of physical damage (dents, holes, etc.).	MC	
1.5	Verify unit is stored on a flat surface in a safe and dry environment.	MC	
1.6	Verify packing list has been checked and non mounted parts inventoried and confirmed.	MC	
2	**Basic Installation**		
2.1	Verify unit is installed in the proper location per the contract documents.	MC	
2.2	Verify shipping blocks and brackets, etc. have been removed.	MC	
2.3	Verify concrete pad is in good condition and is of sufficient height to allow for proper drainage of condensation.	MC	
2.4	Verify sufficient access and clearance has been provided to and around equipment for servicing. (Access is defined as sufficient space for a middle aged man of average size and health to be able to perform necessary maintenance and repairs.)	MC	
2.5	Verify there is sufficient space on one side of the unit equal to the width of the AHU for removal of the coils and fan assemblies.	MC	
2.6	Verify sufficient space clearance has been provided for the electrical power and control access points and that minimum clearances have been provided per electric code.	MC	
2.7	Verify the unit is level.	MC	
2.8	Verify that vibration and sound isolation equipment is installed per contract documents.	MC	
2.9	Verify all sensor locations are appropriate and away from causes of erratic operation.	MC	
2.10	Verify the following dampers have been installed: -Maximum Outdoor Air Damper_____; Supply Air Isolation Damper_____ -Minimum Outdoor Air Damper_____; Return Air Damper_____	MC	
2.11	Verify Air Flow Measuring Station has been installed in the minimum outdoor air duct in accordance with manufacturer's distance requirements and instructions.	MC	
2.12	Verify duct access doors have been installed at each damper location and any other locations called out in the contract documents.	MC	
2.13	Verify unit to duct flex connectors are installed tight and undamaged	MC	

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Task No.	Task Description	Contractor	Contractor Initial and Date
2.14	Verify damper linkages at each damper are tight.	MC	
2.15	Verify end of damper shaft at each damper has a score mark indicating damper position.	MC	
2.16	Verify all access doors close tightly, are gasketed and are air tight.	MC	
2.17	Verify door latches maintain a good tight seal when secured.	MC	
2.18	Verify the correct filters are installed and fit tight in the filter racks.	MC	
2.19	Verify all penetrations through unit panels and unit enclosure are sealed.	MC	
2.20	Verify caulked seams and air seals are intact.	MC	
2.21	Verify the unit is clean and free of damage, both inside and outside.	MC	
2.22	Verify equipment ID labels for the unit and associated sensors are correct and permanently affixed.	MC	
3	**Coils, Piping and Valves**		
3.1	Verify piping installation is complete and properly supported.	MC	
3.2	Verify piping pressure testing has been completed.	MC	
3.3	Verify piping has been flushed and flushing has been properly documented per specifications.	MC	
3.4	Verify piping connections have been completed and are connected to the appropriate inlet/outlet points on the AHU. Confirm that flexible connections have been used as indicated in the contract documents.	MC	
3.5	Verify isolation valves have been installed in an easily accessible location in both the supply and return water piping of the chilled water coil.	MC	
3.6	Verify pressure gauges and thermometers have been installed in an easily accessible location in both the supply and return water piping of the chilled water coil.	MC	
3.7	Verify a normally closed, 2-way control valve has been installed in an easily accessible location in the chilled water return piping.	MC	
3.8	Verify piping and valves have been installed in the chilled water return piping to allow for manual bypass of the 2-way control valve.	MC	
3.9	Verify a strainer with a drain valve has been installed in the chilled water supply piping.	MC	
3.10	Verify manual air vents have been installed at the high points in the chilled water supply and return piping.	MC	
3.11	Verify a balancing valve has been installed in the chilled water return piping.	MC	
3.12	Verify isolation valves have been installed in an easily accessible location in both the supply and return water piping of the hot water coil.	MC	
3.13	Verify pressure gauges and thermometers have been installed in an easily accessible location in both the supply and return water piping of the hot water coil.	MC	
3.14	Verify a normally open, 2-way control valve has been installed in an easily accessible location in the hot water return piping.	MC	
3.15	Verify piping and valves have been installed in the hot water return piping to allow for manual bypass of the 2-way control valve.	MC	
3.16	Verify a strainer with a drain valve has been installed in the hot water supply piping.	MC	

Air Handling Unit, AHU-_____

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Task No.	Task Description	Contractor	Contractor Initial and Date
3.17	Verify manual air vents have been installed at the high points in the hot water supply and return piping.	MC	
3.18	Verify a balancing valve has been installed in the hot water return piping.	MC	
3.19	Verify the coils are clean, the fins are not damaged and there are no leaks.	MC	
3.20	Verify coil piping connections are tight and are not leaking.	MC	
3.21	Verify valves have been installed facing in the correct direction, based on the direction of water flow.	MC	
3.22	Verify strainers are clean.	MC	
3.23	Verify valves and pipes are properly insulated.	MC	
3.24	Verify valves are labeled.	MC	
3.25	Verify piping has been properly labeled.	MC	
3.26	Verify a condensate pan has been installed under the chilled water coil.	MC	
3.27	Verify the condensate pan is clean.	MC	
3.28	Verify water in the condensate pan flows towards the associated drain connection.	MC	
3.29	Verify AHU condensate drain has been installed per mechanical detail in the contract documents.	MC	
4	**Electrical**		
4.1	Verify safety disconnect switch is installed, within line of sight of unit and labeled.	EC	
4.2	Verify motor is labeled for use with a Variable Frequency Drive (VFD).	EC	
4.3	Verify VFD has been provided with Hand/Off/Auto selection settings through a switch or the VFD keypad.	EC	
4.4	Verify VFD has been provided with Local/Remote speed selection settings through a switch or the VFD keypad.	EC	
4.5	Verify VFD has been provided with a three contactor, Line Bypass selection switch to bypass the VFD and operate the fan using line voltage.	EC	
4.6	Verify properly sized and adjusted electrical motor protection with manufacturer's rating plate and record. Motor FLA Amperage _____. Protection Device (FLA X 125%) Amperage .	EC	
4.7	Verify all electrical connections are tight and enclosed.	EC	
4.8	Verify adequate breaker or fuse size and note. _____ Amps.	EC	
4.9	Verify proper grounding installed for each component.	EC	
4.10	Verify grounding has been tested.	EC	
4.11	Verify supplied voltage and phase are the same as printed on rating label.	EC	
4.12	Switch off local disconnect switch and verify no power to fan is present.	EC	
4.13	Verify control devices are labeled.	EC	
5	**Pre Start-Up Verification**		
5.1	Verify ductwork, dampers and any other equipment that could obstruct airflow are complete.	MC	

Air Handling Unit, AHU-_____

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Task No.	Task Description	Contractor	Contractor Initial and Date
5.2	Verify Fire Alarm System components (Addressable Control Devices, Duct Smoke Detectors, Safety Interlocks) associated with the unit are installed, functional and have been tested.	FAC	
5.3	Verify Direct Digital Control System (DDCS) controls associated with the unit are installed, functional and have been tested.	TCC	
5.4	Verify DDCS control devices and Direct Digital Control Panels (DDCP) are labeled.	TCC	
5.5	Confirm that Air Flow Measuring Station has been started up by manufacturer's certified representative and associated controls have been tested. (Start-up documentation must be pre-approved by CxA)	TCC	
5.6	Verify clean air filters are in place.	MC	
5.7	Verify fan assembly bearings and locking collars are properly tightened.	MC	
5.8	Verify fan wheel is properly aligned, tight on the shaft and freely moving.	MC	
5.9	Verify fan bearings are properly lubricated.	MC	
5.10	Verify fan sheaves are properly aligned and tight on the shaft.	MC	
5.11	Verify belt tensions are correctly adjusted and record. Initial Tension Reading ft-lbs _____ (After 8 hrs run time reading ft-lbs _____), (After 16 hrs run time, Reading ft-lbs _____), (After 24 hrs run time, Reading ft-lbs _____). Note: Correct belt tension information is located on the blower housing. Belt should not squeal on start-up.	MC	
5.12	Verify motor mounting bolts and adjustable motor base bolts are tight.	MC	
5.13	Confirm that VFD has been started up by VFD manufacturer's certified representative and associated controls have been tested. (Start-up documentation must be pre-approved by CxA)	EC	
5.14	Verify and record actual line voltage to VFD and fan motor with VFD set at 100% fan speed. VFD Ph A-B _____ Ph A-C _____ Ph B-C _____ Motor Ph A-B _____ Ph A-C _____ Ph B-C _____	EC	
5.15	Verify and record actual motor amperage with VFD set at 100% fan speed. Motor Ph A Ph B Ph C	EC	
5.16	Verify isolation damper is hard wire interlocked with the fan VFD utilizing VFD Run Permissive circuitry. (Damper shall open when fan is activated in Hand, Auto or Bypass. Fan shall remain off until damper is proven open through hard wire interlock with damper position switch.)	TCC	
5.17	Verify power for isolation damper hard wire interlocks is provided from the VFD.	TCC	
5.18	Verify proper fan rotation.	MC	
5.19	Verify no unusual vibration or noise at any normal operating frequency.	MC	
5.20	Verify no obvious audible air leaks.	MC	
5.21	Confirm fan is ready for the Test and Balancing (TAB) contractor. (TAB to be complete before FPT occurs.)	MC	
5.22	Certify fan is ready for Functional Performance Testing (FPT).	GC	

Air Handling Unit, AHU-_____

VAV AHU with Economizer

Pre-Functional Verification Checklist

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Task No.	Task Description	Contractor	Contractor Initial and Date
	Stipulate, if any outstanding item(s) preclude safe or reliable Functional Performance Testing.		
Notes			
	Checklist items have been initialed by parties having direct knowledge of the event. Completion of checklist items does not indicate acceptance or responsibility by the FAA.		
	General Contractor's Signature_____ Date _____		
	Mechanical Contractor's Signature_____ Date _____		
	Electrical Contractor's Signature_____ Date _____		
	Resident Engineer's Signature _____ Date _____		

APPENDIX D

Functional Performance Tests - Samples

This appendix contains the sample Functional Performance Tests similar to the equipment anticipated to be installed.

The sample Functional Performance Tests are intended to illustrate a level of detail that is appropriate in commissioning practice and to convey the planned format. The tests include steps that are typically required, and verification inspection checks that must be carried out by the contractors, witnessed by the CxA and documented by the CxA.

The CxA will create FPTs based on final design documents and specific equipment installed according to approved submittals.

Sample FPTs:

Air Handling Unit Tests

AHU-____ - Functional Performance Tests

Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
1	**Basic Installation Functional Verification Checklist**				
1.1	Verify start-up and pre-functional testing of Air Handling Unit AHU-____ and associated components have been completed. Record AHU commissioning date: _____	CC			
1.2	Verify the Direct Digital Control System (DDCS) is operational. This includes confirming that communications with the existing building Direct Digital Controllers (DDC) and Operator Work Station (OWS) is operational; that the DDCS has been programmed, powered up, and all sensor/end device connections have been completed; and the graphic screens have been installed on the OWS.	CC			
1.3	Verify control components (sensors, valves, and dampers etc.) are the correct series, model, type, capacity, configuration and options are as specified in submittal and contract documents.	CC			
1.4	**Confirm Sensor/End Device Functionality - Confirm points included in the control system design have been provided, are connected to the correct sensor or end device, and are reading/operating correctly. Confirm that valves stroke fully open and closed and that dampers open completely and close completely.**				
1.4.1	Supply Fan Start/Stop	CC			
1.4.2	Supply Fan Run Status	CC			
1.4.3	Supply Fan Bypass Status	CC			
1.4.4	Supply Fan VFD Speed Control	CC			
1.4.5	Supply Air Static Pressure	CC			
1.4.6	Supply Air Temperature	CC			
1.4.7	Return Air Temperature	CC			
1.4.8	Mixed Air Temperature	CC			
1.4.9	Pre-Heat Air Temperature	CC			
1.4.10	Supply Air Humidity	CC			
1.4.11	Return Air Humidity	CC			
1.4.12	Freezestat Alarm	CC			
1.4.13	Dirty Filter Alarm (Outdoor Air)	CC			
1.4.14	Dirty Filter Alarm (Pre)	CC			
1.4.15	Dirty Filter Alarm (Final)	CC			
1.4.16	Chilled Water Valve Control	CC			
1.4.17	Pre-Heat Hot Water Valve Control	CC			
1.4.18	Humidifier Control	CC			
1.4.19	Minimum Outdoor Air Flow	CC			
1.4.20	Return Air Damper - Modulating Control	CC			
1.4.21	Maximum Outdoor Air Damper - Modulating Control	CC			
1.4.22	Minimum Outdoor Air Damper - Modulating Control	CC			
2	**Function Performance Testing - Simulate the Sequences of Operation: Confirm the control functionality, described in each statement below, occurs. When a control function does not respond as described in the statement, record the deficiency.**				
2.1	**Adjust the time schedule for the AHU to place the unit in the Unoccupied Mode of operation. (Assumes that AHU is in the Occupied Mode at the beginning of testing.) Do this by changing the start of the Unoccupied time period in the schedule to 3 minutes later than the current controller time.**				
2.1.1	Does the controller transition from the Occupied Mode to the Unoccupied Mode after 3 minutes pass?	CC			

AHU-____ - Functional Performance Tests

Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.1.2	Does the supply fan stop?	CC			
2.1.3	Does the pre-heat hot water valve close?	CC			
2.1.4	Does the chilled water valve close?	CC			
2.1.5	Does the DDCS disable the humidifier?	CC			
2.1.6	Does the return air damper fully open?	CC			
2.1.7	Does the minimum outdoor air damper fully close?	CC			
2.1.8	Does the maximum outdoor air damper fully close?	CC			
2.1.9	Does the DDCS command the supply fan VFD speed to 0%?	CC			
2.1.10	Override the mixed air temperature and simulate a drop in temperature below 40°F. Does the pre-heat hot water modulate open to maintain the mixed air temperature above 40°F?	CC			
2.1.11	Override the mixed air temperature and simulate a rise in temperature above 40°F. Does the pre-heat hot water valve close?	CC			
2.1.12	Place the mixed air temperature sensor back into automatic operation. Does the pre-heat hot water valve return to normal operation?	CC			
2.2	**Unoccupied Heating - A representative sample of three VAV boxes associated with the AHU shall be used to test this functionality. Additional VAV boxes will be used if testing reveals there are problems with meeting the required control functionality.**				
2.2.1.1	Override the VAV-5 space temperature sensor and simulate a drop in the zone's temperature to a value below 60 °F. Does the unit's fan start?	CC			
2.2.1.2	Does the minimum outdoor air damper remain closed?	CC			
2.2.1.3	Does the maximum outdoor air damper remain closed?	CC			
2.2.1.4	Does the return air damper remain open?	CC			
2.2.1.5	Does VFD speed control begin to operate as required in the "Supply Fan VFD Speed Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			
2.2.1.6	Does the supply air temperature set point remain fixed at 70°F? Is the supply air temperature set point reset disabled?	CC			
2.2.1.7	Does the pre-heat hot water valve modulate to maintain the supply air temperature set point?	CC			
2.2.1.8	Does the chilled water valve remain closed?	CC			
2.2.1.9	Override the VAV-5 space temperature sensor and simulate a rise in the zone's temperature to a value above 60 °F but below 65 °F. Does the unit continue to operate?	CC			
2.2.1.10	Override the VAV-4 space temperature sensor and simulate a fall in the zone's temperature to a value above 60 °F but below 65 °F. Override the VAV-5 space temperature sensor and simulate a rise in the zone's temperature to a value above 65 °F. Does the air handling unit continue to operate in the unoccupied heating mode?	CC			
2.2.1.11	Override the VAV-4 space temperature sensor and simulate a rise in the zone's temperature to a value above 65 °F. Does the unit's fan stop?	CC			
2.2.1.12	Does the pre-heat hot water valve close?	CC			
2.2.1.13	Does the DDCS command the supply fan VFD speed to 0%?	CC			
2.2.1.14	Does the chilled water valve remain closed?	CC			

AHU-____ - Functional Performance Tests

Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.2.1.15	Does the minimum outdoor air damper remain closed?	CC			
2.2.1.16	Does the maximum outdoor air damper remain closed?	CC			
2.2.1.17	Does the return air damper remain open?	CC			
2.2.1.18	Place control functions and points back into automatic operation and return set points to design settings.				
2.2.2	**Unoccupied Heating Mode Control - VAV-1**				
2.2.2.1	Override the VAV-1 space temperature sensor and simulate a drop in the zone's temperature to a value below 60 °F. Does the unit's fan start?	CC			
2.2.2.2	Does the minimum outdoor air damper remain closed?	CC			
2.2.2.3	Does the maximum outdoor air damper remain closed?	CC			
2.2.2.4	Does the return air damper remain open?	CC			
2.2.2.5	Does VFD speed control begin to operate as required in the "Supply Fan VFD Speed Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			
2.2.2.6	Does the supply air temperature set point remain fixed at 70°F? Is the supply air temperature set point reset disabled?	CC			
2.2.2.7	Does the pre-heat hot water valve modulate to maintain the supply air temperature set point?	CC			
2.2.2.8	Does the chilled water valve remain closed?	CC			
2.2.2.9	Override the VAV-1 space temperature sensor and simulate a rise in the zone's temperature to a value above 60 °F but below 65 °F. Does the unit continue to operate?	CC			
2.2.2.10	Override the VAV-2 space temperature sensor and simulate a fall in the zone's temperature to a value above 60 °F but below 65 °F. Override the VAV-1 space temperature sensor and simulate a rise in the zone's temperature to a value above 65 °F. Does the air handling unit continue to operate in the unoccupied heating mode?	CC			
2.2.2.11	Override the VAV-2 space temperature sensor and simulate a rise in the zone's temperature to a value above 65 °F. Does the unit's fan stop?	CC			
2.2.2.12	Does the pre-heat hot water valve close?	CC			
2.2.2.13	Does the DDCS command the supply fan VFD speed to 0%?	CC			
2.2.2.14	Does the chilled water valve remain closed?	CC			
2.2.2.15	Does the minimum outdoor air damper remain closed?	CC			
2.2.2.16	Does the maximum outdoor air damper remain closed?	CC			
2.2.2.17	Does the return air damper remain open?	CC			
2.2.2.18	Place control functions and points back into automatic operation and return set points to design settings.				
2.2.3	**Unoccupied Heating Mode Control - VAV-4**				
2.2.3.1	Override the VAV-4 space temperature sensor and simulate a drop in the zone's temperature to a value below 60 °F. Does the unit's fan start?	CC			
2.2.3.2	Does the minimum outdoor air damper remain closed?	CC			
2.2.3.3	Does the maximum outdoor air damper remain closed?	CC			
2.2.3.4	Does the return air damper remain open?	CC			
2.2.3.5	Does VFD speed control begin to operate as required in the "Supply Fan VFD Speed Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			

AHU-____ - Functional Performance Tests

Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.2.3.6	Does the supply air temperature set point remain fixed at 70°F? Is the supply air temperature set point reset disabled?	CC			
2.2.3.7	Does the pre-heat hot water valve modulate to maintain the supply air temperature set point?	CC			
2.2.3.8	Does the chilled water valve remain closed?	CC			
2.2.3.9	Override the VAV-4 space temperature sensor and simulate a rise in the zone's temperature to a value above 60 °F but below 65 °F. Does the unit continue to operate?	CC			
2.2.3.10	Override the VAV-3 space temperature sensor and simulate a fall in the zone's temperature to a value above 60 °F but below 65 °F. Override the VAV-4 space temperature sensor and simulate a rise in the zone's temperature to a value above 65 °F. Does the air handling unit continue to operate in the unoccupied heating mode?	CC			
2.2.3.11	Override the VAV-3 space temperature sensor and simulate a rise in the zone's temperature to a value above 65 °F. Does the unit's fan stop?	CC			
2.2.3.12	Does the pre-heat hot water valve close?	CC			
2.2.3.13	Does the DDCS command the supply fan VFD speed to 0%?	CC			
2.2.3.14	Does the chilled water valve remain closed?	CC			
2.2.3.15	Does the minimum outdoor air damper remain closed?	CC			
2.2.3.16	Does the maximum outdoor air damper remain closed?	CC			
2.2.3.17	Does the return air damper remain open?	CC			
2.2.3.18	Place control functions and points back into automatic operation and return set points to design settings.				
2.3	**Unoccupied Cooling - A representative sample of four VAV boxes associated with the AHU shall be used to test this functionality. Additional VAV boxes will be used if testing reveals there are problems with meeting the required control functionality.**				
2.3.1	**Unoccupied Cooling Mode Control - VAV-5**				
2.3.1.1	Override the VAV-5 space temperature sensor and simulate a rise in the zone's temperature to a value above 85 °F. Does the unit's fan start?	CC			
2.3.1.2	Does the minimum outdoor air damper remain closed?	CC			
2.3.1.3	Does the maximum outdoor air damper remain closed?	CC			
2.3.1.4	Does the return air damper remain open?	CC			
2.3.1.5	Does VFD speed control begin to operate as required in the "Supply Fan VFD Speed Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			
2.3.1.6	Does the supply air temperature set point remain fixed at 53°F? Is the supply air temperature set point reset disabled?	CC			
2.3.1.7	Does the chilled water valve modulate to maintain the supply air temperature set point?	CC			
2.3.1.8	Does the pre-heat hot water valve remain closed?	CC			
2.3.1.9	Override the VAV-5 space temperature sensor and simulate a fall in the zone's temperature to a value below 85 °F but above 80 °F. Does the unit continue to operate?	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.3.1.10	Override the VAV-4 space temperature sensor and simulate a rise in the zone's temperature to a value above 80 °F but below 85 °F. Override the VAV-5 space temperature sensor and simulate a fall in the zone's temperature to a value below 80 °F. Does the air handling unit continue to operate in the unoccupied cooling mode?	CC			
2.3.1.11	Override the VAV-4 space temperature sensor and simulate a fall in the zone's temperature to a value below 80 °F. Does the unit's fan stop?	CC			
2.3.1.12	Does the chilled water valve close?	CC			
2.3.1.13	Does the DDCS command the supply fan VFD speed to 0%?	CC			
2.3.1.14	Does the pre-heat hot water valve remain closed?	CC			
2.3.1.15	Does the minimum outdoor air damper remain closed?	CC			
2.3.1.16	Does the maximum outdoor air damper remain closed?	CC			
2.3.1.17	Does the return air damper remain open?	CC			
2.3.1.18	Place control functions and points back into automatic operation and return set points to design settings.				
2.3.2	**Unoccupied Cooling Mode Control - VAV-1**				
2.3.2.1	Override the VAV-1 space temperature sensor and simulate a rise in the zone's temperature to a value above 85 °F. Does the unit's fan start?	CC			
2.3.2.2	Does the minimum outdoor air damper remain closed?	CC			
2.3.2.3	Does the maximum outdoor air damper remain closed?	CC			
2.3.2.4	Does the return air damper remain open?	CC			
2.3.2.5	Does VFD speed control begin to operate as required in the "Supply Fan VFD Speed Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			
2.3.2.6	Does the supply air temperature set point remain fixed at 53°F? Is the supply air temperature set point reset disabled?	CC			
2.3.2.7	Does the chilled water valve modulate to maintain the supply air temperature set point?	CC			
2.3.2.8	Does the pre-heat hot water valve remain closed?	CC			
2.3.2.9	Override the VAV-1 space temperature sensor and simulate a fall in the zone's temperature to a value below 85 °F but above 80 °F. Does the unit continue to operate?	CC			
2.3.2.10	Override the VAV-2 space temperature sensor and simulate a rise in the zone's temperature to a value above 80 °F but below 85 °F. Override the VAV-1 space temperature sensor and simulate a fall in the zone's temperature to a value below 80 °F. Does the air handling unit continue to operate in the unoccupied cooling mode?	CC			
2.3.2.11	Override the VAV-2 space temperature sensor and simulate a fall in the zone's temperature to a value below 80 °F. Does the unit's fan stop?	CC			
2.3.2.12	Does the chilled water valve close?	CC			
2.3.2.13	Does the DDCS command the supply fan VFD speed to 0%?	CC			
2.3.2.14	Does the pre-heat hot water valve remain closed?	CC			
2.3.2.15	Does the minimum outdoor air damper remain closed?	CC			
2.3.2.16	Does the maximum outdoor air damper remain closed?	CC			
2.3.2.17	Does the return air damper remain open?	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.3.2.18	Place control functions and points back into automatic operation and return set points to design settings.				
2.3.3	**Unoccupied Cooling Mode Control - VAV-4**				
2.3.3.1	Override the VAV-4 space temperature sensor and simulate a rise in the zone's temperature to a value above 85 °F. Does the unit's fan start?	CC			
2.3.3.2	Does the minimum outdoor air damper remain closed?	CC			
2.3.3.3	Does the maximum outdoor air damper remain closed?	CC			
2.3.3.4	Does the return air damper remain open?	CC			
2.3.3.5	Does VFD speed control begin to operate as required in the "Supply Fan VFD Speed Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			
2.3.3.6	Does the supply air temperature set point remain fixed at 53°F? Is the supply air temperature set point reset disabled?	CC			
2.3.3.7	Does the chilled water valve modulate to maintain the supply air temperature set point?	CC			
2.3.3.8	Does the pre-heat hot water valve remain closed?	CC			
2.3.3.9	Override the VAV-4 space temperature sensor and simulate a fall in the zone's temperature to a value below 85 °F but above 80 °F. Does the unit continue to operate?	CC			
2.3.3.10	Override the VAV-3 space temperature sensor and simulate a rise in the zone's temperature to a value above 80 °F but below 85 °F. Override the VAV-4 space temperature sensor and simulate a fall in the zone's temperature to a value below 80 °F. Does the air handling unit continue to operate in the unoccupied cooling mode?	CC			
2.3.3.11	Override the VAV-3 space temperature sensor and simulate a fall in the zone's temperature to a value below 80 °F. Does the unit's fan stop?	CC			
2.3.3.12	Does the chilled water valve close?	CC			
2.3.3.13	Does the DDCS command the supply fan VFD speed to 0%?	CC			
2.3.3.14	Does the pre-heat hot water valve remain closed?	CC			
2.3.3.15	Does the minimum outdoor air damper remain closed?	CC			
2.3.3.16	Does the maximum outdoor air damper remain closed?	CC			
2.3.3.17	Does the return air damper remain open?	CC			
2.3.3.18	Place control functions and points back into automatic operation and return set points to design settings.				
2.4	**Morning Warm Up Control - Simulate a space temperature below the occupied heating set point of 72°F at space temperature sensor. Adjust the time schedule for the AHU so that the occupied start time is 10 minutes later than the current time in the controller.**				
2.4.1	Does the unit's fan start?	CC			
2.4.2	Does the minimum outdoor air damper remain closed?	CC			
2.4.3	Does the maximum outdoor air damper remain closed?	CC			
2.4.4	Does the return air damper remain open?	CC			
2.4.5	Does the humidifier begin to operate as required in the "Humidification Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			
2.4.6	Does VFD speed control begin to operate as required in the "Supply Fan VFD Speed Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.4.7	Does the supply air temperature set point remain fixed at 70°F? Is the supply air temperature set point reset disabled?	CC			
2.4.8	Does the pre-heat hot water valve modulate to maintain the supply air temperature set point?	CC			
2.4.9	Does the chilled water valve remain closed?	CC			
2.4.10	Let 10 minutes pass. When the controller's internal clock reaches the programmed occupancy time, does the air handling unit exit Warm-Up Mode and enter the Occupied Mode of operation?	CC			
2.4.11	Place all control functions and points back into automatic operation and return set points to design settings. Change the time schedule to make the current time fall inside the Unoccupied Mode of Operation.				
2.5	**Morning Cool Down Control - Simulate a space temperature above the occupied cooling set point of 74°F at space temperature sensor. Adjust the time schedule for the AHU so that the occupied start time is 10 minutes later than the current time in the controller.**				
2.5.1	Does the unit's fan start?	CC			
2.5.2	Does the minimum outdoor air damper remain closed?	CC			
2.5.3	Does the maximum outdoor air damper remain closed?	CC			
2.5.4	Does the return air damper remain open?	CC			
2.5.5	Does the humidifier begin to operate as required in the "Humidification Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			
2.5.6	Does VFD speed control begin to operate as required in the "Supply Fan VFD Speed Control" sequences? (Sequence to be tested as part of Occupied Control testing.)	CC			
2.5.7	Does the supply air temperature set point remain fixed at 53°F? Is the supply air temperature set point reset disabled?	CC			
2.5.8	Does the chilled water valve modulate to maintain the supply air temperature set point?	CC			
2.5.9	Does the pre-heat hot water valve remain closed?	CC			
2.5.10	Let 10 minutes pass. When the controller's internal clock reaches the programmed occupancy time, does the air handling unit exit Cool-Down Mode and enter the Occupied Mode of operation?	CC			
2.5.11	Place all control functions and points back into automatic operation and return set points to design settings. Change the time schedule to make the current time fall inside the Unoccupied Mode of Operation.				
2.6	**Adjust the time schedule for the AHU to place the unit in the Occupied mode of operation. Do this by changing the start of the Occupied time period in the schedule to 3 minutes later than the current controller time.**				
2.6.1	Does the controller transition from the Unoccupied Mode to the Occupied Mode after 3 minutes pass?	CC			
2.6.2	Does the supply fan start?	CC			
2.6.3	Does the DDCS begin to operate the unit according to the Occupied Mode control sequences?	CC			
2.7	**Minimum Outdoor Air Control**				
2.7.1	Override the minimum outdoor air flow set point and input a value lower than the current air flow setting. Does the minimum outdoor air damper modulate towards the closed position to meet the minimum outdoor air flow set point?	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.7.2	Does the air flow measured at the minimum outdoor air flow measuring station decrease and stabilize at the minimum outdoor air flow set point?	CC			
2.7.3	Override the minimum outdoor air flow set point and input a value greater than the current air flow setting. Does the minimum outdoor air damper modulate towards the open position to meet the minimum outdoor air flow set point?	CC			
2.7.4	Does the air flow measured at the minimum outdoor air flow measuring station increase and stabilize at the minimum outdoor air flow set point?	CC			
2.7.5	Override the minimum outdoor air flow set point and input a value greater than the current air flow setting. Does the minimum outdoor air damper modulate fully open?	CC			
2.7.6	Once the minimum outdoor air damper is fully open does the return air damper modulate towards the closed position to meet the minimum outdoor air flow set point?	CC			
2.7.7	Does the air flow measured at the minimum outdoor air flow measuring station increase and stabilize at the minimum outdoor air flow set point?	CC			
2.7.8	Override the minimum outdoor air flow set point and input a value lower than the current air flow setting. Does the return air damper modulate towards the open position to meet the minimum outdoor air flow set point?	CC			
2.7.9	Does the air flow measured at the minimum outdoor air flow measuring station decrease and stabilize at the minimum outdoor air flow set point?	CC			
2.7.10	Override the minimum outdoor air flow set point and input a value lower than the current air flow setting. Does the return air damper modulate fully open?	CC			
2.7.11	Once the return air damper is fully open does the outdoor air damper modulate towards the closed position to meet the minimum outdoor air flow set point?	CC			
2.7.12	Does the air flow measured at the minimum outdoor air flow measuring station decrease and stabilize at the minimum outdoor air flow set point?	CC			
2.7.13	Place all control functions and points back into automatic operation. Do the minimum outdoor air damper and return air damper modulate to maintain the minimum air flow set point calculated by the DDCS?	CC			
2.8	**Supply Fan Speed Control**				
2.8.1	When the DDCS starts the unit, does the speed of the VFD slowly ramp up from 0% to a speed which maintains the calculated supply air static pressure set point?	CC			
2.8.2	Override the supply air static pressure set point and input a value less than the current supply air static pressure measured. Does the speed of the supply fan decrease?	CC			
2.8.3	Does the speed of the supply fan stabilize and maintain a constant supply air static pressure at the supply air static pressure set point entered?	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.8.4	Override the supply air static pressure set point and input a value greater than the current supply air static pressure measured. Does the speed of the supply fan increase?	CC			
2.8.5	Does the speed of the supply fan stabilize and maintain a constant supply air static pressure at the supply air static pressure set point entered?	CC			
2.8.6	Return set point to design settings. Does the supply fan return to normal operation?	CC			
2.9	**Supply Air Static Pressure Set Point Control**				
2.9.1	Override the heating and cooling set points for all of the VAV boxes associated with AHU-_____ to drive the VAV box dampers to their minimum air flow settings. Set the cooling set points at 80°F and the heating set points at 75°F. Do the VAV box dampers modulate to maintain minimum air flows?	CC			
2.9.2	Does the DDCS lower the static pressure set point towards 0.25" wg.? Does the set point remain above 0.25" wg.?	CC			
2.9.3	Does the DDCS stop lowering the supply air static pressure set point once one of the VAV box dampers is fully open while the other VAV box dampers are partially closed? Note which VAV box is fully open. VAV-_____	CC			
2.9.4	Are all of the VAV boxes maintaining minimum air flow rates still?	CC			
2.9.5	Pick a VAV box which has a damper that is partially closed and set the cooling set point at 75°F and the heating set point at 70°F. Does the VAV box damper modulate open to maintain the new set points? Note which VAV box was adjusted. VAV-_____	CC			
2.9.6	Does the DDCS increase the static pressure set point towards 1.5" wg.? Does the set point remain below 1.5" wg.?	CC			
2.9.7	Does the DDCS stop increasing the supply air static pressure set point once only the VAV box damper, adjusted in step 2.9.5, is fully open while the other VAV box dampers are partially closed?	CC			
2.9.8	Is the VAV box, adjusted in step 2.9.5, maintaining the increased air flow rate called for by the controller?	CC			
2.9.9	Pick a second VAV box which has a damper that is partially closed and set the cooling set point at 75°F and the heating set point at 70°F. Does the VAV box damper modulate open to maintain the new set points? Note which VAV box was adjusted. VAV-	CC			
2.9.10	Does the DDCS increase the static pressure set point towards 1.5" wg.? Does the set point remain below 1.5" wg.?	CC			
2.9.11	Does the DDCS stop increasing the supply air static pressure set point once only the VAV box damper, adjusted in step 2.9.9, is fully open while the other VAV box dampers are partially closed?	CC			
2.9.12	Is the VAV box, adjusted in step 2.9.9, maintaining the increased air flow rate called for by the controller?	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.9.13	Override the heating and cooling set points for all of the VAV boxes associated with AHU-_____ to drive the VAV box dampers to their maximum air flow settings. Set the cooling set points at 70°F and the heating set points at 65°F. Do the VAV box dampers modulate to maintain maximum air flows?	CC			
2.9.14	Does the DDCS increase the static pressure set point towards 1.5" wg.? Does the set point remain below 1.5" wg.?	CC			
2.9.15	Does the DDCS stop increasing the supply air static pressure set point once one of the VAV box dampers is fully open while the other VAV box dampers are partially closed? Note which VAV box is fully open. VAV-_____	CC			
2.9.16	Pick the VAV box which has its damper fully open and set the cooling set point at 75°F and the heating set point at 70°F. Does the VAV box damper modulate closed to maintain the new set points?	CC			
2.9.17	Does the DDCS lower the static pressure set point towards 0.25" wg.? Does the set point remain above 0.25" wg.?	CC			
2.9.18	Does the DDCS stop lowering the supply air static pressure set point once one of the VAV box dampers is fully open while the other VAV box dampers are partially closed? Note which VAV box is fully open. VAV-_____	CC			
2.9.19	Place all control functions and points back into automatic operation and return set points to design settings. Do the VAV boxes and the unit return to normal operation?	CC			
2.10	**Supply Air Temperature Set Point Reset Control**				
2.10.1	Override all of the VAV box space temperature sensors associated with the air handling unit and input a value of 70°F for each one. Pick one VAV box, override the associated space temperature sensor and input a value of 78°F. Does the supply air temperature set point decrease to 53°F? Note which VAV box was adjusted. VAV-_____	CC			
2.10.2	Override the space temperature sensor, adjusted in step 2.10.1, and input a value of 68°F. Does the supply air temperature set point increase to 65°F?	CC			
2.10.3	Override two additional space temperature sensors and input values of 78°F. Does the supply air temperature set point decrease to 53°F? Note which VAV boxes were adjusted. VAV-_____ & VAV-_____	CC			
2.10.4	Override the first space temperature sensor, adjusted in step 2.10.3, and input a value of 68°F. Does the supply air temperature set point remain at 53°F?	CC			
2.10.5	Override the second space temperature sensor, adjusted in step 2.10.3, and input a value of 68°F. Does the supply air temperature set point increase to 65°F?	CC			
2.10.6	Return the space temperatures to normal operation. Does the supply air temperature set point reset return to automatic operation?	CC			
2.11	**Supply Air Temperature Control**				
2.11.1	**Override the outdoor air temperature sensor and input a value which is greater than 65°F. This disables the Free Cooling Mode.**				

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.11.1.1	Override the supply air temperature set point and input a value of 53°F. Does the chilled water valve modulate open?	CC			
2.11.1.2	Does the pre-heat hot water valve remain closed?	CC			
2.11.1.3	Does the relief air damper remain closed?	CC			
2.11.1.4	Does the maximum outdoor air damper remain closed?	CC			
2.11.1.5	Does the return air damper continue to maintain minimum outdoor air flow (remain mostly open)?	CC			
2.11.1.6	Does the supply air temperature stabilize at the supply air temperature set point?	CC			
2.11.1.7	Override the supply air temperature set point and input a value of 65°F. Does the chilled water valve modulate closed?	CC			
2.11.1.8	Does the pre-heat hot water valve start to modulate open once the chilled water valve is completely closed (not before)?	CC			
2.11.1.9	Does the relief air damper remain closed?	CC			
2.11.1.10	Does the maximum outdoor air damper remain closed?	CC			
2.11.1.11	Does the return air damper continue to maintain minimum outdoor air flow (remain mostly open)?	CC			
2.11.1.12	Does the supply air temperature stabilize at the supply air temperature set point?	CC			
2.11.1.13	Override the supply air temperature set point and input a value of 55°F. Does the pre-heat hot water valve modulate closed?	CC			
2.11.1.14	Does the chilled water valve start to modulate open once the pre-heat hot water valve is completely closed (not before)?	CC			
2.11.1.15	Does the relief air damper remain closed?	CC			
2.11.1.16	Does the maximum outdoor air damper remain closed?	CC			
2.11.1.17	Does the return air damper continue to maintain minimum outdoor air flow (remain mostly open)?	CC			
2.11.1.18	Does the supply air temperature stabilize at the supply air temperature set point?	CC			
2.11.1.19	Return the supply air temperature set point to automatic control. Do the chilled water valve, pre-heat hot water valve, maximum outdoor, return air and relief air dampers modulate in coordination to meet the required set point?	CC			
2.11.2	**Override the outdoor air temperature sensor and input a value which is less than 65°F. This enables the Free Cooling Mode.**				
2.11.2.1	Override the supply air temperature set point and input a value of 60°F. Do the maximum outdoor air damper and relief air damper begin to modulate open while the return air damper modulates closed?	CC			
2.11.2.2	Does the chilled water valve remain closed?	CC			
2.11.2.3	Does the pre-heat hot water valve remain closed?	CC			
2.11.2.4	Does the minimum outdoor air damper fully open?	CC			
2.11.2.5	Does the supply air temperature stabilize at the supply air temperature set point?	CC			
2.11.2.6	Override the supply air temperature set point and input a value of 50°F. Do the maximum outdoor air damper and relief air damper modulate completely open while the return air damper modulates completely closed?	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.11.2.7	Does the chilled water valve start to modulate open once the maximum outdoor air damper is completely open and the return air damper is completely closed (not before)?	CC			
2.11.2.8	Does the pre-heat hot water valve remain closed?	CC			
2.11.2.9	Does the minimum outdoor air damper remain fully open?	CC			
2.11.2.10	Does the supply air temperature stabilize at the supply air temperature set point?	CC			
2.11.2.11	Override the supply air temperature set point and input a value of 60°F. Does the chilled water valve modulate closed?	CC			
2.11.2.12	Do the maximum outdoor air damper and relief air damper begin to modulate closed while the return air damper modulates open, once the chilled water valve is completely closed (not before)?	CC			
2.11.2.13	Does the pre-heat hot water valve remain closed?	CC			
2.11.2.14	Does the minimum outdoor air damper remain fully open?	CC			
2.11.2.15	Does the supply air temperature stabilize at the supply air temperature set point?	CC			
2.11.2.16	Override the supply air temperature set point and input a value of 70°F. Do the maximum outdoor air damper and relief air damper modulate completely closed while the return air damper modulates to maintain the minimum outdoor air flow?	CC			
2.11.2.17	Does the pre-heat hot water valve start to modulate open once the maximum outdoor air damper and relief air damper are completely closed (not before)?	CC			
2.11.2.18	Does the chilled water valve remain closed?	CC			
2.11.2.19	Does the minimum outdoor air damper begin to modulate to maintain minimum outdoor air flow?	CC			
2.11.2.20	Does the supply air temperature stabilize at the supply air temperature set point?	CC			
2.11.2.21	Override the supply air temperature set point and input a value of 55°F. Does the pre-heat hot water valve modulate closed?	CC			
2.11.2.22	Do the maximum outdoor air damper and relief air damper begin to modulate open while the return air damper modulates closed, once the pre-heat hot water valve is completely closed (not before)?	CC			
2.11.2.23	Does the chilled water valve remain closed?	CC			
2.11.2.24	Does the minimum outdoor air damper fully open?	CC			
2.11.2.25	Does the supply air temperature stabilize at the supply air temperature set point?	CC			
2.11.2.26	Return the supply air temperature set point to automatic control. Do the chilled water valve, pre-heat hot water valve, maximum outdoor, return air and relief air dampers in coordination to meet the required set point?	CC			
2.12	**Filter Monitoring**				
2.12.1	Increase the differential pressure across the differential pressure switch associated with the Pre-filter above the set point for the filter. Does the DDCS registers a maintenance alarm?	CC			
2.12.2	Decrease the differential pressure across the differential pressure switch associated with the Pre-filter below the set point for the filter. Does the DDCS filter maintenance alarm return to normal?	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.12.3	Increase the differential pressure across the differential pressure switch associated with the Final-filter above the set point for the filter. Does the DDCS registers a maintenance alarm?	CC			
2.12.4	Decrease the differential pressure across the differential pressure switch associated with the Final-filter below the set point for the filter. Does the DDCS filter maintenance alarm return to normal?	CC			
2.12.5	Increase the differential pressure across the differential pressure switch associated with the Outdoor Air-filter above the set point for the filter. Does the DDCS registers a maintenance alarm?	CC			
2.12.6	Decrease the differential pressure across the differential pressure switch associated with the Outdoor Air-filter below the set point for the filter. Does the DDCS filter maintenance alarm return to normal?	CC			
2.13	**Freezestat Shutdown**				
2.13.1	Manually trip the freezestat. Does the supply fan stop?	CC			
2.13.2	Does the minimum outdoor air damper fully close?	CC			
2.13.3	Does the maximum outdoor air damper fully close?	CC			
2.13.4	Does the return air damper fully opn?	CC			
2.13.5	Does the DDCS disable the humidifier?	CC			
2.13.6	Does the chilled water valve fully open?	CC			
2.13.7	Does the pre-heat hot water valve fully open?	CC			
2.13.8	Does the pre-heat hot water circulating pump start?	CC			
2.13.9	Place the Supply Fan VFD Hand-Off-Auto selector in the "Hand" position. Does the fan remain off?	CC			
2.13.10	Place the Supply Fan VFD Normal/Bypass selector switch in the "Bypass" position. Does the fan remain off?	CC			
2.13.11	Place the Supply Fan VFD Hand-Off-Auto selector back in the "Auto" position. Does the fan remain off?	CC			
2.13.12	Place the Supply Fan VFD Normal/Bypass selector switch back in the "Normal" position. Does the fan remain off?	CC			
2.13.13	Reset the freezestat. Does the unit restart and return to normal operation?	CC			
2.14	**Fire Alarm System/Duct Smoke Shutdown**				
2.14.1	With the unit on, smoke test the supply air duct smoke detector. Does the supply fan stop?	CC			
2.14.2	Place the Supply Fan VFD Hand-Off-Auto selector in the "Hand" position. Does the fan remain off?	CC			
2.14.3	Place the Supply Fan VFD Normal/Bypass selector switch in the "Bypass" position. Does the fan remain off?	CC			
2.14.4	Place the Supply Fan VFD Hand-Off-Auto selector back in the "Auto" position. Does the fan remain off?	CC			
2.14.5	Place the Supply Fan VFD Normal/Bypass selector switch back in the "Normal" position. Does the fan remain off?	CC			
2.14.6	Reset the supply air duct smoke detector/fire alarm system and restart the air handling unit.				
2.15	**Power Failure Fan Restart**				
2.15.1	While operating in the "Auto" mode of operation, manually turn off power to the air handling unit using the disconnect switch at the supply fan VFD. Does the unit stop?	CC			
2.15.2	Does the pre-heat hot water valve close?	CC			

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Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
2.15.3	Does the chilled water valve close?	CC			
2.15.4	Does the return air damper fully open?	CC			
2.15.5	Does the minimum outdoor air damper fully close?	CC			
2.15.6	Does the maximum outdoor air damper fully close?	CC			
2.15.7	Does the humidifier shut down?	CC			
2.15.8	After 60 seconds pass, does the control system register that the supply fan status does not match the command and generate an alarm? Does the DDCS cancel the start command?	CC			
2.15.9	Reset the start command in the DDCS and use the disconnect switch at the supply fan VFD to turn power back on for the air handling unit. Does the unit restart after a time delay has elapsed?	CC			
2.15.10	Do automatic control functions return to normal.	CC			
3	**<u>Failure Condition Testing</u> - Simulates loss of control signal from the unit's controller and loss of power to the controller.**				
3.1	**With the AHU operating in the occupied mode, turn off power to the unit's controller from the associated electrical panel.**				
3.1.1	Did the supply fan stop?	CC			
3.1.2	Did the pre-heat hot water valve fail to the open position?	CC			
3.1.3	Did the chilled water valve fail to the closed position?	CC			
3.1.4	Did the return air damper fail to the open position?	CC			
3.1.5	Did the minimum outdoor air damper fail to the closed position?	CC			
3.1.6	Did the maximum outdoor air damper fail to the closed position?	CC			
3.1.7	Did the humidifier fail off?	CC			
3.2	**At the supply fan VFD, switch the fan HOA to "Hand".**				
3.2.1	Did the supply fan start?	CC			
3.2.2	Did the unit's dampers and valves remain in their failure positions?	CC			
3.2.3	Did the speed of the supply fan ramp up to it's programmed default minimum speed setting?	CC			
3.2.4	At the supply fan VFD, switch speed control from "remote" to "local" and manually increase the fan speed. Did the speed of the supply fan increase?	CC			
3.2.5	At the supply fan VFD, manually decrease the fan speed. Did the speed of the supply fan decrease?	CC			
3.2.6	At the supply fan VFD, switch speed control from "local" to "remote". Did the speed of the supply fan return to it's programmed default minimum speed setting?	CC			
3.3	**At the supply fan VFD, switch the fan HOA to "Off".**				
3.3.1	Did the supply fan stop?	CC			
3.3.2	Did the unit's dampers and valves remain in their failure positions?	CC			
3.4	**At the supply fan VFD place the bypass switch in the "Bypass" position.**				
3.4.1	Did the supply fan start?	CC			
3.4.2	Does the fan run at full speed?	CC			
3.4.3	Did the unit's dampers and valves remain in their failure positions?	CC			
3.5	**At the supply fan VFD place the bypass switch in the "Normal" position.**				
3.5.1	Did the supply fan stop?	CC			
3.5.2	Did the unit's dampers and valves remain in their failure positions?	CC			

AHU-____ - Functional Performance Tests

Task No.	Task Description	Contractor	Checked	Ok	Deficiency Comment #
3.6	**With the supply fan off, restore power to the unit's controller.**				
3.6.1	At the supply fan VFD, switch the fan HOA to "Auto".				
3.6.2	Confirm that the controller restarts AHU and that automatic control functions return to normal.	CC			
	Deficiency Record				
1					
2					
3					
4					
5					
6					
7					
8					
9					
	Other Deficiencies Noted but not Directly Associated with the FPT				
M1					
M2					
	Testing plan has been signed by parties having direct knowledge of the event. Completion of functional performance testing does not indicate acceptance or responsibility by the FAA.				
	Temperature Controls Contractor - Signature and Date:				
	Mechanical Contractor - Signature and Date:				
	Commissioning Agent - Signature and Date:				
	Resident Engineer - Signature and Date:				