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# PART FIVE



## **PART FIVE - PRESCRIPTIVE SPECIFICATIONS**

- **UFGS SECTION 23 08 00.00 23 COMMISSIONING OF HVAC SYSTEMS**



SECTION 23 08 00.00 23N

COMMISSIONING OF HVAC SYSTEMS  
07/06

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only

SHEET METAL AND AIR CONDITIONING CONTRACTORS' NATIONAL ASSOCIATION  
(SMACNA)

SMACNA DCS

(1995, 2nd Ed) HVAC Duct  
Construction Standards - Metal  
and Flexible

1.2 DEFINITIONS

1.2.1 Commissioning

The process of ensuring that systems are designed, installed, functionally tested, and capable of being operated and maintained to perform in conformity with the design intent.

1.2.2 Commissioning Authority (Designation Ca)

The person, persons, or Company responsible, on the Government's behalf, for ensuring the commissioning process is fully carried out according to the contract requirements.

1.2.3 Commissioning Agent (Designation Cx)

The person responsible, on the contractors behalf, for carrying out the detailed planning, and implementation of, the commissioning process.

1.2.4 Design Agent (Designation D)

The Designer of Record. For Design/Build projects, this is the Contractor's Design Agent (AE # 2). For Design/Bid/Build projects, it is the Government's Design Agent (AE # 1).

1.2.5 TAB

Testing, Adjusting and Balancing

1.2.6 BAS

Building Automation System

1.2.7 DDC

Direct Digital Control

1.2.8 Season 1

That season when the HVAC System is up against maximum loading for the first time after completion of construction. Season 1 can be summer or winter depending on when construction is completed.

1.2.9 Season 2

That season when the HVAC System is up against maximum loading for the second time after completion of construction. Season 2 is the opposite of season 1. I.e. if Season 1 was summer, Season 2 will be winter.

1.2.10 Shoulder Season

That time of the season when the HVAC System is up against part load conditions.

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation. Submittals not having a "G" designation are for approval by the Contractor's Quality Control Organization and for information only to the Government or as otherwise designated. The following shall be submitted in accordance with DB Sections 01 33 10.05 20 DESIGN SUBMITTAL PROCEDURES and 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES:

**SD-03 Product Data**

**Commissioning Team; G,**

List of team members with company name and contact information who will represent the Contractor in the pre-commissioning checks and functional performance testing. Provide within 30 days of contract award date. Revisions to the list must be approved by the Contracting Officer prior to the start of the impacted work.

**Executive Commissioning Plan; G,**

Provide the Executive Commissioning Plan within 45 days after DB Final Design Acceptance. This plan shall be written by the Cx Agent and incorporate all plans, procedures, reports and tests required in this and related sections:

Chapter D30 Heating, Ventilating, and Air Conditioning (HVAC) Systems.

**Plan Requirements**

Provide in 3-ring Binder(s) with the following tabbed items, at a minimum:

Table of Contents

First Tier Certification Letter from Contractor

Commissioning Agency Organizational Chart

Commissioning Team Roster

Commissioning Schedule

Deficiencies/Rework Tracking Forms

Commissioning Schedule; G,

Provide commissioning activities schedule within 45 days after DB Final Design Acceptance, incorporating the events outlined in the Executive Commissioning Plan.

Training Schedules; G,

Submit Training Schedules specifically applicable to HVAC and control systems and a complete and concise depiction of the provided training and procedures for maintaining the intent of design. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and Section 01 33 00.05 20 CONSTRUCTION SUBMITTAL PROCEDURES.

SD-06 Test Reports

Test Reports; G,

All test reports, manufacturer's start-up tests, and executed and signed pre-commissioning checklists and functional performance test checklists required by the executive plan. The results of failed tests shall be included along with a description of the corrective action taken.

SD-07 Certificates

Certificates; G,

Provide Contractor's Commissioning Agent qualifications and resume. The Contractor's Commissioning Agent shall be Certified by a recognized Building HVAC Commissioning Program per the National Environmental Balancing Bureau, the Associated Air Balance Council, or the Building Commissioning Association.

Additionally, for the Commissioning Agent proposed for approval, submit information certifying that the Commissioning Agent is part of the General Contractor's (GC's) staff or first tier certified TAB company or is a first tier subcontractor who is not affiliated with any other company participating in work on this contract.

SD-10 - Operation and Maintenance Data

Operation and Maintenance; G,

Submit Operation and Maintenance (O&M) Data specifically applicable to this contract and a complete and concise depiction of the provided equipment, product, or system. Organize and present information in sufficient detail to clearly explain O&M requirements at the system, equipment, component, and subassembly level. Include an index preceding each submittal. Submit in accordance with this section and Section 01 78 24.05 20 FACILITY OPERATION AND MAINTENANCE INFORMATION.

#### 1.4 SEQUENCING AND SCHEDULING

The work described in Checklist A of this Section shall be completed in conjunction with the startup of the HVAC systems and the related sections listed herein. The work described in Checklist B of this section shall begin only after all work required in this and related Sections has been successfully completed, and all tests and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Related Sections include, but are not limited to:

Chapter D30 Heating, Ventilating, and Air Conditioning (HVAC) Systems

#### 1.5 RELATED REQUIREMENTS

Requirements for price breakdown of HVAC TAB work are specified in Section 01 20 00.05 20, "Price and Payment Procedures for Design Build."

Requirements for construction scheduling, including commissioning activities, are specified in Section 01 32 16.00 20N DESIGN AND CONSTRUCTION PROGRESS DOCUMENTATION and Section 01 32 17.05 20 NETWORK ANALYSIS SCHEDULES FOR DESIGN BUILD.

#### 1.6 COMMISSIONING MEETINGS

1.6.1 Conduct monthly commissioning meetings during the duration of the construction contract.

1.6.2 Conduct weekly commissioning meetings during the period when commissioning activities take place.

#### 1.7 PRICE AND PAYMENT PROCEDURES FOR COMMISSIONING RELATED ACTIVITIES

Payment for HVAC Systems shall not exceed 70% for the system labor and material cost until such time as the system commissioning as defined by this section is complete and accepted by the government.

#### 1.8 COMMISSIONING ACTIVITIES COSTS

The Commissioning Activities Costs, required by this section, shall be indicated on the schedule of prices and shall include all Commissioning Activities and TAB line items referred to in Section 01 20 00.05 20 - PRICE AND PAYMENT PROCEDURES FOR DESIGN BUILD.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

#### 3.1 COMMISSIONING TEAM AND CHECKLISTS

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. The Commissioning Agent is responsible for ensuring the completeness and technical accuracy of the commissioning plan. In addition, the Government will be represented by a representative of the Contracting Officer. The team members shall be as follows:

Designation	Function
Cx	Contractor's Commissioning Agent
Q	Contractor's Quality Control Representative
M	Contractor's Mechanical Representative
E	Contractor's Electrical Representative
T	Contractor's Testing, Adjusting, and Balancing Representative
C	Contractor's Controls Representative
Ca	Contracting Officer's Representative

Appendices A and B are provided as a general checklist and have been prepared to best match the various equipment selected during the design of this project. Each checklist shown in Appendices A and B shall be reviewed and modified as necessary to reflect all equipment actually installed during construction of the project. The commissioning team shall review the accuracy and applicability of each item in the checklist and revise as needed. Equipment shown in the checklist but not installed for the project shall be annotated as "NA". Likewise, equipment installed but not listed in the checklist shall be added or revised accordingly. A note as to why it was added or revised shall be inserted with the reviewer's initial. The commissioning team shall also add or modify to any of the equipment checklist items as required and/or specified by the equipment manufacturer. Acceptance by each commissioning team member of each pre-commissioning checklist item shall be indicated by initials and date, unless an "X" is shown indicating that participation by that individual is not required. Acceptance by each commissioning team member of each functional performance test checklist shall be indicated by signature and date.

### 3.2 TESTS

The pre-commissioning checks and functional performance tests shall be performed on all HVAC equipment in a manner which essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, methods shall be established which will provide the information required, including part load testing. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. The Contractor shall provide all materials, services, and labor required to perform the pre-commissioning checks and functional performance tests. A pre-commissioning check or functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members. The Contractor shall submit [Test Reports](#) as specified in the Submittals paragraph.

#### 3.2.1 Pre-Commissioning Checks

Pre-commissioning checks shall be performed for the items indicated on the checklists in Appendix A. All related manufacturer's start up sheets shall be attached to the appropriate checklist. Deficiencies discovered during these checks shall be documented, corrected and retested in accordance with

the applicable contract requirements.

### 3.2.2 Functional Performance Tests

Functional performance tests shall be performed for the items indicated on the checklists in Appendix B. Functional performance tests shall begin only after all pre-commissioning checks and work required in specification sections listed in the SEQUENCING AND SCHEDULING section have been successfully completed. Tests shall prove Heating, Cooling, and Part Load sequences of operation, and shall verify all other relevant contract requirements. Tests shall begin with equipment or components and shall progress through subsystems to complete systems. Upon failure of any functional performance test checklist item, the Contractor shall document and correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

### 3.3 INDEX OF CHECK LISTS

#### A Pre-commissioning Check Lists

- A-1 Structural/Architectural Checklist
- A-2 Piping
- A-3 Ductwork
- A-6 Variable Volume Air Handling Unit
- A-7 VAV Terminal
- A-8 DX Air Cooled Condensing Unit
- A-9 Pumps
- A-13 Hot Water Boiler
- A-17 Unit Heater
- A-18 Exhaust Fan
- A-20 HVAC System Controls
- A-21 Energy Recovery System
- A-22 Minimum Anti-terrorism Requirements

#### B. Functional Performance Tests (FPT) and Check Lists

- B-1 Pumps
- B-4 VAV Terminals
- B-5 Variable Volume Air Handling Unit
- B-9 Air Cooled Condensing Unit
- B-10 Hot Water Boiler
- B-13 Unit Heaters
- B-16 Exhaust Fan
- B-17 Energy Recovery System

3.4 APPENDIX A

PRE-COMMISSIONING CHECKLISTS

A-1 Pre-commissioning Checklist - Structural/Architectural Checklist

For Building or Zone: P-615

Checklist Item	Q	M	E	T	C	D	Ca	Cx
a. Verify all piping, ductwork, EMT, etc. wall/ceiling and floor penetrations in Mesh. rooms or utility chases are sealed with approved fire stopping and/or weatherproof sealants.	___	X	X	X	X	___	___	___
b. Verify the fire rating for the Mech. equipment room(s) is met per the plans and specs.	___	X	X	X	X	___	___	___
c. Verify the Bldg. envelope is sealed per the plans and specs.	___	X	X	X	X	___	___	___
d. Verify the fenestration is rated per the plans and specs and installed correctly. (Fire ratings, force protection, window system shading coefficient / emissivity).	___	X	X	X	X	___	___	___
e. Verify the building is sealed and walls, doors, and dropped ceilings in place prior to the TAB air balance work.	___	X	X	___	X	___	___	___

A-2 Pre-commissioning checklist - Piping

For all HW Piping Systems

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	X	X	X	___	___	___
b. Piping complete.	___	___	X	___	___	___	___	___
c. As-built shop drawings submitted.	___	___	X	___	___	___	___	___
d. Piping flushed and cleaned and initial chemical treatment added.	___	___	X	___	___	___	___	___
e. Strainers cleaned.	___	___	X	___	___	___	___	___
f. Valves installed as required.	___	___	X	___	X	___	___	___
g. Piping insulated as required.	___	___	X	___	___	___	___	___
h. Thermometers and gauges installed as required.	___	___	X	___	X	___	___	___
i. Verify operation of valves.	___	___	X	___	___	___	___	___
j. Air vents installed as specified.	___	___	X	X	X	___	___	___
k. Flexible connectors installed as specified	___	___	X	X	X	___	___	___
l. Verify that piping has been labeled and valves identified as specified.	___	___	X	___	___	___	___	___
m. Hydrostatic test complete.	___	___	X	___	X	___	___	___
n. Verify insulation support blocks installed at piping loading points.	___	___	X	___	X	___	___	___

A-3 Pre-commissioning Checklist - Ductwork

For Air Handler: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Ductwork complete.	___	___	X	___	X	___	___	___
c. As-built shop drawings submitted.	___	___	X	___	X	___	___	___
d. Ductwork leak test complete.	___	___	X	___	X	___	___	___
e. Fire dampers, smoke dampers, and access doors installed as required.	___	___	X	___	X	___	___	___
f. Ductwork insulated as required.	___	___	X	___	X	___	___	___
g. Thermometers and gauges installed as required.	___	___	___	___	___	___	___	___
h. Verify open/closed status of dampers.	___	___	X	___	X	___	___	___
i. Verify smoke and fire damper operation.	___	___	X	___	___	___	___	___
j. Flexible connectors installed as specified	___	___	X	___	X	___	___	___
k. Verify duct systems installed per SMACNA DCS	___	___	X	___	X	___	___	___

A-6 Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Vibration isolation devices installed.	___	___	X	X	X	___	___	___
c. Inspection and access doors are operable and sealed.	___	___	X	___	X	___	___	___
d. Casing undamaged.	___	___	X	X	X	___	___	___
e. Insulation undamaged.	___	___	X	X	X	___	___	___
f. Condensate drainage is unobstructed and sloped correctly. (Visually verify drainage by pouring a cup of water into drain pan.)	___	___	X	X	X	___	___	___
g. Fan belt adjusted.	___	___	X	___	X	___	___	___
h. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
e. Verify proper overload protection for motor starters.	___	___	___	X	___	___	___	___
f. Verify that frequency drive, cables, and motor are compatible.	___	___	___	X	___	___	___	___
g. Verify that the frequency drive programming is application specific.	___	___	___	X	___	___	___	___
Coils								
a. Refrigerant piping properly connected.	___	___	X	X	X	___	___	___
b. Refrigerant piping pressure tested.	___	___	X	X	X	___	___	___
c. Hot water piping properly connected.	___	___	X	X	X	___	___	___

- |  |     |     |   |     |   |     |     |     |
|--|-----|-----|---|-----|---|-----|-----|-----|
| d. Hot water piping pressure tested.                                       | ___ | ___ | X | X   | X | ___ | ___ | ___ |
| e. Air vents installed on water coils with<br>shutoff valves as specified. | ___ | ___ | X | X   | X | ___ | ___ | ___ |
| f. Any damage to coil fins has been<br>repaired.                           | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

Controls

- |   |     |     |   |     |     |     |     |     |
|---|-----|-----|---|-----|-----|-----|-----|-----|
| a. Control valves/actuators properly<br>installed.  | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Control valves/actuators operable.   | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. Dampers/actuators properly installed.  | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| d. Dampers/actuators operable.  | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| e. Verify proper location, installation and<br>calibration of duct static pressure<br>sensor. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| f. Fan air volume controller operable.  | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| g. Air handler controls system operational.   | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| h. Verify smoke detectors installed per<br>NFPA 90A.  | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |

Testing, Adjusting, and Balancing (TAB)

- |  |     |     |   |     |   |     |     |     |
|--|-----|-----|---|-----|---|-----|-----|-----|
| a. Construction filters removed and<br>replaced.                                     | ___ | ___ | X | ___ | X | ___ | ___ | ___ |
| b. Permanent Strainers cleaned or<br>Construction strainers removed and<br>replaced. | ___ | ___ | X | ___ | X | ___ | ___ | ___ |

A-7 Pre-commissioning Checklist - VAV Terminal

For VAV Terminal: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
<b>Installation</b>								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. VAV terminal in place.	___	___	X	X	X	___	___	___
c. VAV terminal ducted.	___	___	X	X	X	___	___	___
d. VAV terminal connected to controls.	___	___	X	X	___	___	___	___
e. Reheat coil connected to hot water pipe.	___	___	X	___	X	___	___	___
f. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
<b>Controls</b>								
a. Cooling only VAV terminal controls set.	___	___	X	X	___	___	___	___
b. Cooling only VAV controls verified.	___	___	X	X	___	___	___	___
c. Reheat VAV terminal controls set.	___	___	X	X	___	___	___	___
d. Reheat terminal/coil controls verified.	___	___	X	X	___	___	___	___
<b>Testing, Adjusting, and Balancing (TAB)</b>								
a. Construction filters removed and replaced.	___	___	X	___	X	___	___	___
b. Verify terminal maximum air flow set.	___	___	X	___	___	___	___	___
c. Verify terminal minimum air flow set.	___	___	X	___	___	___	___	___
d. Verify that flow coefficient is programmed properly.	___	___	X	___	___	___	___	___
e. Permanent Strainers cleaned or Construction strainers removed and replaced.	___	___	X	___	X	___	___	___

A-8 Pre-commissioning Checklist - DX Air Cooled Condensing Unit

For Condensing Unit: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Verify all ductwork is in accordance with manufacturers recommendations	___	___	X	X	X	___	___	___
c. Refrigerant pipe leak tested.	___	___	X	X	X	___	___	___
d. Refrigerant pipe evacuated and charged in accordance with manufacturer's instructions.	___	___	X	X	X	___	___	___
e. Check condenser fans for proper rotation.	___	___	X	___	X	___	___	___
f. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
g. Manufacturer's required maintenance/operational clearance provided.	___	___	X	X	X	___	___	___
h. Verify unit has Hot Gas Bypass, where specified.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	X	___	___	___
b. Power available to unit control panel.	___	___	___	X	___	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls	___	___	___	X	___	___	___	___
d. Verify proper overload protection for motor starters.	___	___	___	X	___	___	___	___
Controls								
a. Unit safety/protection devices tested.	___	___	X	X	___	___	___	___
b. Control system and interlocks installed.	___	___	X	X	___	___	___	___
c. Control system and interlocks operational.	___	___	X	X	___	___	___	___
d. Verify low ambient controls, where specified.	___	___	___	X	___	___	___	___

A-9 Pre-commissioning Checklist - Pumps

For Pump: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Pumps grouted in place.	___	___	X	X	X	___	___	___
c. Pump vibration isolation devices functional.	___	___	X	X	X	___	___	___
d. Pump/motor coupling alignment verified.	___	___	X	X	X	___	___	___
e. Piping system installed.	___	___	X	X	X	___	___	___
f. Piping system pressure tested.	___	___	X	X	X	___	___	___
g. Pump not leaking.	___	___	X	X	X	___	___	___
h. Field assembled couplings aligned to meet manufacturer's prescribed tolerances.	___	___	X	X	X	___	___	___
i. Pressure/temperature gauges installed.	___	___	X	___	X	___	___	___
j. Piping system cleaned.	___	___	X	X	X	___	___	___
k. Chemical water treatment complete.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to pump disconnect.	___	___	___	X	X	___	___	___
b. Pump rotation verified.	___	___	___	X	X	___	___	___
c. Control system interlocks functional.	___	___	___	X	___	___	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
e. Verify proper overload protection for motor starters.	___	___	___	X	___	___	___	___
f. Verify that frequency drive, cables, and motor are compatible.	___	___	___	X	___	___	___	___
g. Verify that the frequency drive programming is application specific.	___	___	___	X	___	___	___	___

Testing, Adjusting, and Balancing (TAB)

a. Permanent Strainers cleaned or \_\_\_\_\_ X \_\_\_\_\_ X \_\_\_\_\_  
Construction strainers removed and  
replaced.

erlock tested. \_\_\_\_\_ X \_\_\_\_\_

A-13 Pre-commissioning Checklist - Hot Water Boiler

For Boiler: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Boiler flue installed.	___	___	X	___	___	___	___	___
c. Boiler hot water piping installed.	___	___	X	___	___	___	___	___
d. Boiler hot water piping tested.	___	___	X	X	___	___	___	___
e. Boiler makeup water piping installed, to include back flow prevention.	___	___	X	___	___	___	___	___
f. Boiler gas piping installed.	___	___	X	X	X	___	___	___
g. Boiler gas piping tested.	___	___	X	X	X	___	___	___
h. Manufacturer's required maintenance clearance provided.	___	___	X	___	___	___	___	___
i. Verify applicable operating permits and certifications completed.	___	___	X	X	X	X	___	___
Startup								
a. Boiler system cleaned and filled with treated water.	___	___	X	___	___	___	___	___
b. Boiler safety/protection devices, including high temperature burner shut-off, low water cutoff, flame failure, pre and post purge, have been tested.	___	___	___	X	___	___	___	___
c. Verify that PRV rating conforms to boiler rating.	___	___	___	X	___	___	___	___
d. Boiler water treatment system functional.	___	___	X	X	___	___	___	___
e. Boiler startup and checkout complete.	___	___	X	X	___	___	___	___
f. Combustion efficiency demonstrated.	___	___	X	___	X	___	___	___

Electrical

- a. Verify that power disconnect is located within sight of the unit served.      \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_
- b. Verify that emergency shutoff switch is located properly.      \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_
- c. Verify proper overload protection for motor starters.      \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_

Controls

- a. Hot water pump interlock installed.      \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_
- b. Hot water pump interlock tested.      \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_
- c. Hot water heating controls operational.      \_\_\_ \_\_\_ X X \_\_\_ \_\_\_ \_\_\_ \_\_\_

A-17 Pre-commissioning Checklist - Unit Heater

For Unit Heater: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Hot water piping properly connected.	___	___	X	___	___	___	___	___
c. Hot water piping pressure tested.	___	___	X	___	___	___	___	___
d. Air vent installed on hot water coil with shutoff valve as specified.	___	___	X	X	X	___	___	___
e. Any damage to coil fins has been repaired.	___	___	X	___	X	___	___	___
f. Manufacturer's required maintenance/operational clearance provided.	___	___	X	X	X	___	___	___
Electrical								
a. Power available to unit disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	X	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
d. Power available to electric heating coil.	___	___	___	X	___	___	___	___
e. Verify proper overload protection for motor starters.	___	___	___	X	___	___	___	___
Controls								
a. Control valves properly installed.	___	___	X	___	___	___	___	___
b. Control valves operable.	___	___	X	X	___	___	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___

Testing, Adjusting, and Balancing (TAB)

- a. Permanent Strainers cleaned or Construction  
strainers removed and replaced.        \_\_\_ \_\_\_ X \_\_\_ X \_\_\_ \_\_\_ \_\_\_

A-18 Pre-commissioning Checklist - Exhaust Fan

For Exhaust Fan: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Fan belt adjusted.	___	___	X	___	X	___	___	___
c. Verify all ductwork is installed per design.	___	___	X	___	X	___	___	___
Electrical								
a. Power available to fan disconnect.	___	___	___	X	___	___	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___	___	___
d. Verify proper overload protection for motor starters.	___	___	___	X	___	___	___	___
Controls								
a. Control interlocks properly installed.	___	___	___	X	___	___	___	___
b. Control interlocks operable.	___	___	___	X	___	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___	___	___

A-20 Pre-commissioning Checklist - HVAC System Controls

For HVAC System: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Layout of control panel matches drawings.	___	___	X	X	___	___	___	___
c. Control components piped and/or wired to each labeled terminal strip.	___	___	X	X	___	___	___	___
d. Verify that control components are installed in the proper location.	___	___	X	X	___	___	___	___
e. Verify that force protection shut down controls installed in proper location.	___	___	X	X	___	___	___	___
f. DDC connection made to each labeled terminal strip as shown.	___	___	X	X	___	___	___	___
g. Control wiring and tubing labeled at all terminations, splices, and junctions.	___	___	X	X	___	___	___	___
h. Shielded wiring used on electronic sensors.	___	___	X	X	___	___	___	___
i. Verify location and coordination of modem/communication line.	___	___	X	X	___	___	___	___
j. Verify damper actuators mounted outside the airstream and attached to proper structural support.	___	___	X	X	___	___	___	___
k. Verify thermostats are located on interior walls with specified options and set to design setpoints.	___	___	X	X	___	___	___	___
l. Verify that workstation is in proper location and includes all specified interfaces.	___	___	X	X	___	___	___	___

Main Power and Control Air

- a. 110 volt AC power available to panel.     \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_
  
- b. Verify proper overload protection for     \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_  
   motor starters.
  
- c. Verify proper sizing and installation     \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_  
   of individual control transformers.
  
- d. Verify proper surge protection of         \_\_\_ \_\_\_ \_\_\_ X \_\_\_ \_\_\_ \_\_\_ \_\_\_  
   incoming power, control wiring, and  
   communication lines.

A-21 Pre-commissioning Checklist - Energy Recovery System

For Energy Recovery System: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that item(s) installed meet approved submittal(s).	___	___	___	X	X	___	___	___
b. Recovery system piping installed.	___	___	X	___	X	___	___	___
c. Recovery system piping tested.	___	___	X	X	X	___	___	___
d. Air vent installed as specified.	___	___	X	X	X	___	___	___
e. Manufacturer's required maintenance clearance provided.	___	___	X	X	X	___	___	___
Startup								
a. Recovery system piping cleaned and filled.	___	___	X	X	X	___	___	___
b. Converter startup and checkout complete.	___	___	X	X	X	___	___	___
Controls								
a. Control valves/actuators properly installed.	___	___	X	___	___	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___	___	___

A-22 Pre-commissioning Checklist - Minimum Anti-terrorism Requirements

For HVAC System: All

Checklist Item	Q	M	E	T	C	D	Ca	Cx
Installation								
a. Verify that seismic protection measures have been installed per para. B-4.5 "Equipment Bracing" of UFC 4-010-01	___	___	X	X	X	___	___	___
b. Verify that all intakes/exhaust are located a minimum 10 ft. above ground elevation	___	___	X	X	X	___	___	___
c. Verify installation of "Emergency HVAC Shutdown Switch"	___	___	X	X	X	___	___	___
d. Verify proper screening (if applicable) of exterior-mounted mechanical equipment per UFC 4-010-01	___	___	X	X	X	___	___	___
e. Check specific project requirements for any additional anti-terrorism requirements that exceed the minimum requirements of UFC 4-010-01	___	___	X	X	X	___	___	___

3.5 APPENDIX B

FUNCTIONAL PERFORMANCE TESTS (FPT) AND CHECKLISTS

All equipment and control systems shall be operated through the entire specified sequence of operations, as directed by the government for witnessing and verifying acceptable operation. Government shall randomly select 10% of specific components or systems to be verified. A functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test. Upon failure of any functional performance test, the Contractor shall correct all deficiencies in accordance with the applicable contract requirements. In the event of a failed FPT, Government shall have the right to require additional testing of at least 1, similar system. The Contractor shall reimburse the Government for all costs associated with effort lost due to tests that are aborted. These costs shall include salary, travel costs and per diem (where applicable) for Government commissioning team members.

B-1 Functional Performance Test Checklist - Pumps

For Pump: All

A. Season 1

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify operation of Hand, Off, Automatic Control.

Hand \_\_\_\_\_, Off \_\_\_\_\_, Automatic \_\_\_\_\_

4. Verify automatic interface with local controller and BAS/ operator work station.
5. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
6. Verify that database is archived upon acceptance of FPT.
7. Verify that the Variable Frequency Drive is not capable of running at any critical vibration frequencies.

B. Shoulder Season

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

C. Season 2

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.

5. Verify that database is archived upon acceptance of FPT.

D. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Agent

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing  
Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

B-4 Functional Performance Test Checklist - VAV Terminals

VAV boxes (Cooling only, Reheat, and Fan Powered): All

A. Season 1

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

B. Shoulder Season

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

C. Season 2

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

D. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Agent

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

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Contracting Officer's Representative

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B-5 Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: All

A. Season 1

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.
6. Verify that the Variable Frequency Drive is not capable of running at any critical vibration frequencies.

B. Shoulder Season

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

C. Season 2

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.

5. Verify that database is archived upon acceptance of FPT.

D. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Agent

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing  
Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

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B-9 Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: All

A. Season 1

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

B. Shoulder Season

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

C. Season 2

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.

5. Verify that database is archived upon acceptance of FPT.

D. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Agent	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's Testing, Adjusting and Balancing Representative	_____
Contractor's Controls Representative	_____
Contracting Officer's Representative	_____

B-10 Functional Performance Test Checklist - Hot Water Boiler

For Boiler: All

A. Season 1

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.
6. Verify that boiler has been inspected by a certified boiler inspector.

B. Shoulder Season

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

C. Season 2

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.

4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.

5. Verify that database is archived upon acceptance of FPT.

D. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Agent

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

B-13 Functional Performance Test Checklist - Unit Heaters

A. Season 1

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

B. Shoulder Season

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

C. Season 2

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

D. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Agent

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Contractor's Mechanical Representative

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Contractor's Electrical Representative

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Contractor's Testing, Adjusting and Balancing Representative

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Contractor's Controls Representative

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Contracting Officer's Representative

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B-16 Functional Performance Test Checklist - Exhaust Fan

For Exhaust Fan: All

A. Season 1

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify operation of Hand, Off, Automatic Control.

Hand \_\_\_\_\_, Off \_\_\_\_\_, Automatic \_\_\_\_\_

4. Verify automatic interface with local controller and BAS/ operator work station.
5. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
6. Verify that database is archived upon acceptance of FPT.

D. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Agent

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

B-17 Functional Performance Test Checklist - Energy Recovery System

For Energy Recovery System: All

A. Season 1

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

B. Shoulder Season

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

C. Season 2

1. (Insert specific sequence of operation)
2. (Insert specific FPT requirement and expected result to demonstrate the sequence of operation occurs within design parameters)
3. Verify automatic interface with local controller and BAS/ operator work station.
4. Generate graphed and text version of trend reports that demonstrate this specific sequence of operation. Data capture shall occur every 15 minutes and trend duration shall not exceed two weeks.
5. Verify that database is archived upon acceptance of FPT.

D. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning  
Agent

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing  
Representative

\_\_\_\_\_

Contractor's Controls Representative

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Contracting Officer's Representative

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# PART SIX

