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USACE / NAVFAC / AFCEA UFGS-15995A (July 2003)  
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Preparing Activity: USACE Superseding  
UFGS-15995A (December 2001)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags

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07/03

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## UNIFIED FACILITIES GUIDE SPECIFICATIONS

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Latest change indicated by CHG tags

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### SECTION 15995A

#### COMMISSIONING OF HVAC SYSTEMS 07/03

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NOTE: This guide specification covers the requirements for commissioning of HVAC systems.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

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## PART 1 GENERAL

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NOTE: Use of this specification is mandatory for all projects. A properly functioning HVAC system assures a comfortable, healthy and productive environment for the user. The "Design Agent's Representative" will be a member of the HVAC design team, i.e. from the AE or Engineering Division. The "Design Agent's Representative" will actively participate in the process, including review of all submittals contained herein.

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### 1.1 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an

item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

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Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.] [for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

#### SD-03 Product Data

##### Commissioning Team

List of team members who will represent the Contractor in the pre-commissioning checks and functional performance testing, at least 2 weeks prior to the start of pre-commissioning checks. Proposed revision to the list, prior to the start of the impacted work.

##### Tests

Detailed procedures for pre-commissioning checks and functional performance tests, at least 4 weeks prior to the start of pre-commissioning checks.

Pre-Commissioning Checks[; G][; G, [\_\_\_\_]]

Schedule for pre-commissioning checks and functional performance tests, at least 2 weeks prior to the start of pre-commissioning

checks.

## SD-06 Test Reports

Test Reports[; G][; G, [\_\_\_\_]]

Completed pre-commissioning checklists and functional performance test checklists organized by system and by subsystem and submitted as one package. The results of failed tests shall be included along with a description of the corrective action taken.

## 1.2 SEQUENCING AND SCHEDULING

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NOTE: Provide seismic requirements, if a Government designer (either Corps office of A/E) is the Engineer of Record, and show on the drawings. Delete the bracketed phrase if seismic details are not included. Sections 13080 and 15070, properly edited, must be included in the contract documents.  
\*\*\*\*\*

The work described in this Section shall begin only after all work required in related Sections, including Section 15950A HEATING, VENTILATING AND AIR CONDITIONING (HVAC) CONTROL SYSTEMS and Section 15990A TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS, has been successfully completed, and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Seismic details shall be in accordance with Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 15070A SEISMIC PROTECTION FOR MECHANICAL EQUIPMENT [as indicated]

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

## 3.1 COMMISSIONING TEAM AND CHECKLISTS

\*\*\*\*\*  
NOTE: The "Design Agent's Representative" will be included as a member of the commissioning team for the pre-commissioning checklists and will participate in the functional performance tests.  
\*\*\*\*\*

The checklists provided are to be used as guides for the preparation of project checklists. The appropriate checklist should be included in the project specification for each HVAC equipment component. The designer will add additional checklists for equipment or systems not included in this guide specification or modify the checklists where necessary for specific project requirements. If, for example, a system needs to be tested with certain internal load, each appropriate checklist should be modified to include this requirement along with specifics on how load should be generated.  
\*\*\*\*\*

The Contractor shall designate team members to participate in the pre-commissioning checks and the functional performance testing specified herein. In addition, the Government will be represented by a representative of the Contracting Officer, the Design Agent's Representative, and the Using Agency. The team members shall be as follows:

| Designation    | Function                                          |
|----------------|---------------------------------------------------|
| Q              | Contractor's Chief 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              |
| D              | Design Agent's Representative                     |
| O              | Contracting Officer's Representative              |
| U              | Using Agency'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 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 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. Testing and verification required by this section shall be performed during the Commissioning phase. 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. Deficiencies discovered during these checks shall be 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 have been successfully completed. Tests shall prove all modes of the 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 correct all deficiencies in accordance with the applicable contract requirements. The checklist shall then be repeated until it has been completed with no errors.

APPENDIX A  
PRE-COMMISSIONING CHECKLISTS

Pre-commissioning checklist - Piping

For [\_\_\_\_\_] Piping System

| Checklist Item                                                             | Q   | M   | E | T   | C   | D   | O   | U   |
|----------------------------------------------------------------------------|-----|-----|---|-----|-----|-----|-----|-----|
| Installation                                                               |     |     |   |     |     |     |     |     |
| a. Piping complete.                                                        | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| b. As-built shop drawings submitted.                                       | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| c. Piping flushed and cleaned.                                             | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| d. Strainers cleaned.                                                      | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| e. Valves installed as required.                                           | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| f. Piping insulated as required.                                           | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| g. Thermometers and gauges installed as required.                          | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| h. Verify operation of valves.                                             | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| i. Air vents installed as specified.                                       | ___ | ___ | X | X   | X   | ___ | ___ | ___ |
| j. Flexible connectors installed as specified                              | ___ | ___ | X | X   | X   | ___ | ___ | ___ |
| k. Verify that piping has been labeled and valves identified as specified. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB)                                    |     |     |   |     |     |     |     |     |
| a. Hydrostatic test complete.                                              | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| b. TAB operation complete.                                                 | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |

# Pre-commissioning Checklist - Ductwork

For Air Handler: [\_\_\_\_\_]

| Checklist Item                                                                                                                                                                                        | Q   | M   | E   | T   | C   | D   | O   | U    |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|
| Installation                                                                                                                                                                                          |     |     |     |     |     |     |     |      |
| a. Ductwork complete.                                                                                                                                                                                 | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| b. As-built shop drawings submitted.                                                                                                                                                                  | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| c. Ductwork leak test complete.                                                                                                                                                                       | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| NOTE: The first bracketed item d will be used for Army projects, the second for Air Force projects.                                                                                                   |     |     |     |     |     |     |     |      |
| [d. Fire dampers, smoke dampers, and access doors installed as required.                                                                                                                              | ___ | ___ | X   | ___ | X   | ___ | ___ | ___] |
| [d. Fire dampers, smoke dampers, and access doors installed as required with installation of each verified by the specified team members initialing each location on a copy of the as-built drawings. | ___ | ___ | X   | ___ | X   | ___ | ___ | ___] |
| e. Ductwork insulated as required.                                                                                                                                                                    | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| f. Thermometers and gauges installed as required.                                                                                                                                                     | ___ | ___ | ___ | ___ | ___ | ___ | ___ | ___  |
| g. Verify open/closed status of dampers.                                                                                                                                                              | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| h. Verify smoke and fire damper operation.                                                                                                                                                            | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___  |
| i. Flexible connectors installed as specified                                                                                                                                                         | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| Testing, Adjusting, and Balancing (TAB)                                                                                                                                                               |     |     |     |     |     |     |     |      |
| a. TAB operation complete.                                                                                                                                                                            | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |



# Pre-commissioning Checklist - Multizone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

| Checklist Item                                                                                                               | Q   | M   | E   | T   | C   | D   | O   | U    |
|------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|
| Installation                                                                                                                 |     |     |     |     |     |     |     |      |
| a. Vibration isolation devices installed [and freed to float with adequate movement and seismic restraint] as specified.     | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| b. Inspection and access doors are operable and sealed.                                                                      | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| c. Casing undamaged.                                                                                                         | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| d. Insulation undamaged.                                                                                                     | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| e. Condensate drainage is unobstructed.<br>(Visually verify pan drains completely by pouring a cup of water into drain pan.) | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| f. Fan belt adjusted.                                                                                                        | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| g. Manufacturer's required maintenance clearance provided.                                                                   | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| Electrical                                                                                                                   |     |     |     |     |     |     |     |      |
| a. Power available to unit disconnect.                                                                                       | ___ | ___ | ___ | 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. Power available to electric heating coil.                                                                                | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___] |
| Coils                                                                                                                        |     |     |     |     |     |     |     |      |
| [a. Chilled water piping properly connected.                                                                                 | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [a. Refrigerant piping properly connected.                                                                                   | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [b. Chilled water piping pressure tested.                                                                                    | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [b. Refrigerant piping pressure tested.                                                                                      | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [c. Hot water piping properly connected.                                                                                     | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [c. Steam and condensate piping properly connected.                                                                          | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [d. Hot water piping pressure tested.                                                                                        | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |

Pre-commissioning Checklist - Multizone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

| Checklist Item                                                            | Q   | M   | E | T   | C | D   | O   | U    |
|---------------------------------------------------------------------------|-----|-----|---|-----|---|-----|-----|------|
| [d. Steam and condensate piping pressure tested.                          | ___ | ___ | X | X   | X | ___ | ___ | ___] |
| e. Air vents installed on water coils [with shutoff valves] as specified. | ___ | ___ | X | X   | X | ___ | ___ | ___  |
| f. Any damage to coil fins has been repaired                              | ___ | ___ | X | ___ | X | ___ | ___ | ___  |

Controls

|                                                 |     |     |   |     |     |     |     |     |
|-------------------------------------------------|-----|-----|---|-----|-----|-----|-----|-----|
| a. Control valves/actuators properly installed. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Control valves/actuators operable.           | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. O.A. dampers/actuators properly installed.   | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| d. O.A. dampers/actuators operable.             | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| e. Zone dampers/actuators properly installed.   | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| f. Zone dampers/actuators operable.             | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |

Testing, Adjusting, and Balancing (TAB)

|                                                                                 |     |     |     |     |     |     |     |     |
|---------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| a. Construction filters removed and replaced.                                   | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| b. TAB report submitted.                                                        | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| c. TAB results within limits specified in Section 15990A                        | ___ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| d. TAB results for outside air intake within limits specified in Section 15990A | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |

# Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

| Checklist Item                                                                                                  | Q   | M   | E   | T   | C   | D   | O   | U    |
|-----------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|
| Installation                                                                                                    |     |     |     |     |     |     |     |      |
| a. Vibration isolation devices installed.                                                                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| b. Inspection and access doors are operable and sealed.                                                         | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| c. Casing undamaged.                                                                                            | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| d. Insulation undamaged.                                                                                        | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| e. Condensate drainage is unobstructed.<br>(Visually verify drainage by pouring a cup of water into drain pan.) | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| f. Fan belt adjusted.                                                                                           | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| g. 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. Power available to electric heating coil.                                                                   | ___ | ___ | ___ | X   | X   | ___ | ___ | ___] |
| Coils                                                                                                           |     |     |     |     |     |     |     |      |
| [a. Chilled water piping properly connected.                                                                    | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [a. Refrigerant piping properly connected.                                                                      | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [b. Chilled water piping pressure tested.                                                                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [b. Refrigerant piping pressure tested.                                                                         | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [c. Hot water piping properly connected.                                                                        | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [c. Steam and condensate piping properly connected.                                                             | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [d. Hot water piping pressure tested.                                                                           | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [d. Steam and condensate piping pressure tested.                                                                | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |

Pre-commissioning Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

| Checklist Item                                                             | Q   | M   | E | T   | C | D   | O   | U    |
|----------------------------------------------------------------------------|-----|-----|---|-----|---|-----|-----|------|
| [e. Air vents installed on water coils [with shutoff valves] as specified. | ___ | ___ | X | X   | X | ___ | ___ | ___] |
| f. Any damage to coil fins has been repaired.                              | ___ | ___ | X | ___ | X | ___ | ___ | ___  |

Controls

|                                                                                         |     |     |   |     |     |     |     |     |
|-----------------------------------------------------------------------------------------|-----|-----|---|-----|-----|-----|-----|-----|
| a. Control valves/actuators properly 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 calibration of duct static pressure sensor. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| f. Fan air volume controller operable.                                                  | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| g. Air handler controls system operational.                                             | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |

Testing, Adjusting, and Balancing (TAB)

|                                                                                 |     |     |     |     |     |     |     |     |
|---------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| a. Construction filters removed and replaced.                                   | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| b. TAB report submitted.                                                        | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| c. TAB results within limits specified in Section 15990A                        | ___ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| d. TAB results for outside air intake within limits specified in Section 15990A | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |

# Pre-commissioning Checklist - VAV Terminal

For VAV Terminal: [\_\_\_\_\_]

| Checklist Item                                             | Q   | M   | E   | T   | C   | D   | O   | U    |
|------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|
| Installation                                               |     |     |     |     |     |     |     |      |
| a. VAV terminal in place.                                  | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| b. VAV terminal ducted.                                    | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| c. VAV terminal connected to controls.                     | ___ | ___ | X   | X   | ___ | ___ | ___ | ___  |
| [d. Reheat coil connected to hot water pipe.               | ___ | ___ | X   | ___ | X   | ___ | ___ | ___] |
| [e. Electric reheat coil connected to local disconnect.    | ___ | ___ | ___ | ___ | X   | ___ | ___ | ___] |
| f. Manufacturer's required maintenance clearance provided. | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| Controls                                                   |     |     |     |     |     |     |     |      |
| 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   | ___ | ___ | ___ | ___  |
| Testing, Adjusting, and Balancing (TAB)                    |     |     |     |     |     |     |     |      |
| a. Verify terminal maximum air flow set.                   | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___  |
| b. Verify terminal minimum air flow set.                   | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___  |
| c. TAB operation complete.                                 | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |

# Pre-commissioning Checklist - DX Air Cooled Condensing Unit

For Condensing Unit: [\_\_\_\_\_]

| Checklist Item                                                                            | Q   | M   | E   | T   | C   | D   | O   | U   |
|-------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                                              | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| b. Refrigerant pipe leak tested.                                                          | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| c. Refrigerant pipe evacuated and charged in accordance with manufacturer's instructions. | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| d. Check condenser fans for proper rotation.                                              | ___ | ___ | 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   | X   | ___ | ___ | ___ |
| b. Power available to unit control panel.                                                 | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| c. Verify that power disconnect is located within sight of the unit it controls           | ___ | ___ | ___ | 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   | ___ | ___ | ___ | ___ |

# Pre-commissioning Checklist - Pumps

For Pump: [\_\_\_\_\_]

| Checklist Item                                                                           | Q   | M   | E | T | C | D   | O   | U   |
|------------------------------------------------------------------------------------------|-----|-----|---|---|---|-----|-----|-----|
| Installation                                                                             |     |     |   |   |   |     |     |     |
| a. Pumps grouted in place.                                                               | ___ | ___ | X | X | X | ___ | ___ | ___ |
| b. Pump vibration isolation devices functional.                                          | ___ | ___ | X | X | X | ___ | ___ | ___ |
| c. Pump/motor coupling alignment verified.                                               | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Piping system installed.                                                              | ___ | ___ | X | X | X | ___ | ___ | ___ |
| e. Piping system pressure tested.                                                        | ___ | ___ | X | X | X | ___ | ___ | ___ |
| f. Pump not leaking.                                                                     | ___ | ___ | X | X | X | ___ | ___ | ___ |
| g. Field assembled couplings aligned to meet manufacturer's prescribed tolerances. _____ |     |     | 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 |   | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB)                                                  |     |     |   |   |   |     |     |     |
| a. Pressure/temperature gauges installed.                                                | ___ | ___ | X |   | X | ___ | ___ | ___ |
| b. Piping system cleaned.                                                                | ___ | ___ | X | X | X | ___ | ___ | ___ |
| c. Chemical water treatment complete.                                                    | ___ | ___ | X | X | X | ___ | ___ | ___ |
| d. Water balance complete.                                                               | ___ | ___ | X |   | X | ___ | ___ | ___ |
| e. Water balance with design maximum flow.                                               | ___ | ___ | X |   | X | ___ | ___ | ___ |
| f. TAB Report submitted.                                                                 | ___ | ___ | X |   | X | ___ | ___ | ___ |

# Pre-commissioning Checklist - Packaged Air Cooled Chiller

For Chiller: [\_\_\_\_\_]

| Checklist Item                                                                   | Q   | M   | E   | T   | C   | D   | O   | U   |
|----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                                     |     |     |     |     |     |     |     |     |
| a. Chiller properly piped.                                                       | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| b. Chilled water pipe leak tested.                                               | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| c. Verify that refrigerant used complies with specified requirements.            | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| d. Any damage to coil fins has been repaired.                                    | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| e. Manufacturer's required maintenance clearance provided.                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| Electrical                                                                       |     |     |     |     |     |     |     |     |
| a. Power available to unit disconnect.                                           | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| b. Power available to unit control panel.                                        | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| c. Separate power is supplied to electric heating tape.                          | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| d. Verify that power disconnect is located within sight of the unit it controls. | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| Controls                                                                         |     |     |     |     |     |     |     |     |
| a. Factory startup and checkout complete.                                        | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| b. Chiller safety/protection devices tested.                                     | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| c. Chilled water flow switch installed.                                          | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| d. Chilled water flow switch tested.                                             | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| e. Chilled water pump interlock installed.                                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| f. Chilled water pump interlock tested.                                          | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |



# Pre-commissioning Checklist - Centrifugal Chiller

For Chiller: [\_\_\_\_\_]

| Checklist Item                                                                     | Q   | M   | E   | T   | C   | D   | O   | U   |
|------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                                       |     |     |     |     |     |     |     |     |
| a. Chilled water connections properly piped.                                       | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| b. Condenser water connections properly piped                                      | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| c. Chilled water pipe leak tested.                                                 | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| d. Condenser water pipe leak tested.                                               | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| e. High efficiency purge unit installed and operating as specified.                | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| f. Refrigerant leak detector installed.                                            | ___ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| g. Oxygen sensor installed and tested.                                             | ___ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| h. Mechanical room ventilation installed as specified.                             | ___ | ___ | ___ | ___ | ___ | ___ | ___ | ___ |
| i. Manufacturer's required maintenance clearance provided.                         | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| j. Field assembled couplings aligned to meet manufacturer's prescribed tolerances. | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| Electrical                                                                         |     |     |     |     |     |     |     |     |
| a. Power available to unit starter.                                                | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| b. Power available to unit control panel.                                          | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| c. Verify that power disconnect is located within sight of the unit it controls.   | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| Controls                                                                           |     |     |     |     |     |     |     |     |
| a. Factory startup and checkout complete.                                          | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| b. Chiller safety/protection devices tested.                                       | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| c. Chilled water flow switch installed.                                            | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| d. Chilled water flow switch tested.                                               | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| e. Chilled water pump interlock installed.                                         | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| f. Chilled water pump interlock tested.                                            | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| g. Condenser water flow switch installed.                                          | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| h. Condenser water flow switch tested.                                             | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |

Pre-commissioning Checklist - Centrifugal Chiller

For Chiller: [\_\_\_\_\_]

| Checklist Item                               | Q   | M   | E   | T | C   | D   | O   | U   |
|----------------------------------------------|-----|-----|-----|---|-----|-----|-----|-----|
| i. Condenser water pump interlock installed. | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |
| j. Condenser water pump interlock tested.    | ___ | ___ | ___ | X | ___ | ___ | ___ | ___ |

# Pre-commissioning Checklist - Cooling Tower

For Cooling Tower: [\_\_\_\_\_]

| Checklist Item                                                                     | Q   | M   | E   | T   | C   | D   | O   | U   |
|------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                                       |     |     |     |     |     |     |     |     |
| a. Cooling tower in place.                                                         | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| b. Cooling tower piped.                                                            | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| c. Cooling tower fan drive adjusted.                                               | ___ | ___ | ___ | ___ | X   | ___ | ___ | ___ |
| d. Cooling tower makeup water supply piped.                                        | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| e. Verify makeup control valve shutoff.                                            | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| f. Fan lubricated and blade pitch adjusted.                                        | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| g. Manufacturer's required maintenance/<br>operational clearance provided.         | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| Electrical                                                                         |     |     |     |     |     |     |     |     |
| a. Power available to tower disconnect.                                            | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| b. Power available to electric sump heater<br>and heater functional.               | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| c. Control system interlocks functional.                                           | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| d. Motor and fan rotation checked.                                                 | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| e. Verify that power disconnect is located<br>within sight of the unit's controls. | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| Piping                                                                             |     |     |     |     |     |     |     |     |
| a. Tower basin is clean and filled.                                                | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| b. Condenser water treatment functional.                                           | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| c. Water balance with design flow verified.                                        | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| d. Water distribution headers balanced.                                            | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |

# Pre-commissioning Checklist - Hot Water Boiler

For Boiler: [\_\_\_\_\_]

| Checklist Item                                                                                                                                          | Q   | M   | E   | T   | C   | D   | O   | U   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                                                                                                            |     |     |     |     |     |     |     |     |
| a. Boiler flue installed.                                                                                                                               | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| b. Boiler hot water piping installed.                                                                                                                   | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| c. Boiler hot water piping tested.                                                                                                                      | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| d. Boiler makeup water piping installed.                                                                                                                | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| e. Boiler fuel oil piping installed.                                                                                                                    | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| f. Boiler fuel oil piping tested.                                                                                                                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| g. Boiler gas piping installed.                                                                                                                         | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| h. Boiler gas piping tested.                                                                                                                            | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| i. Manufacturer's required maintenance clearance provided.                                                                                              | ___ | ___ | 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   | ___ | ___ | ___ | ___ |
| Controls                                                                                                                                                |     |     |     |     |     |     |     |     |
| a. Hot water pump interlock installed.                                                                                                                  | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| b. Hot water pump interlock tested.                                                                                                                     | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| c. Hot water heating system balanced.                                                                                                                   | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |

Pre-commissioning Checklist - Hot Water Boiler

For Boiler: [\_\_\_\_\_]

| Checklist Item                             | Q   | M   | E | T | C   | D   | O   | U   |
|--------------------------------------------|-----|-----|---|---|-----|-----|-----|-----|
| d. Hot water heating controls operational. | ___ | ___ | X | X | ___ | ___ | ___ | ___ |

# Pre-commissioning Checklist - Steam Boiler

For Boiler: [\_\_\_\_\_]

| Checklist Item                                                                                                                                          | Q   | M   | E   | T   | C   | D   | O   | U   |
|---------------------------------------------------------------------------------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                                                                                                            |     |     |     |     |     |     |     |     |
| a. Boiler flue installed.                                                                                                                               | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| b. Boiler steam piping installed.                                                                                                                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| c. Boiler steam piping tested.                                                                                                                          | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| d. Boiler makeup water piping installed.                                                                                                                | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| e. Boiler makeup water piping tested.                                                                                                                   | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| f. Boiler fuel oil piping installed.                                                                                                                    | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| g. Boiler fuel oil piping tested.                                                                                                                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| h. Boiler gas piping installed.                                                                                                                         | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| i. Boiler gas piping tested.                                                                                                                            | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| j. Manufacturer's required maintenance clearance provided.                                                                                              | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| Startup                                                                                                                                                 |     |     |     |     |     |     |     |     |
| a. Boiler system cleaned and filled with treated water.                                                                                                 | ___ | ___ | X   | X   | 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 feed water system operational.                                                                                                                | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| e. Boiler water treatment system functional.                                                                                                            | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| f. Boiler startup and checkout complete.                                                                                                                | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| g. All steam traps operational.                                                                                                                         | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| h. All condensate return pumps operational.                                                                                                             | ___ | ___ | ___ | ___ | X   | ___ | ___ | ___ |
| i. Combustion efficiency demonstrated.                                                                                                                  | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| Electrical                                                                                                                                              |     |     |     |     |     |     |     |     |
| a. Verify that power disconnect is located within sight of the unit served.                                                                             | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |

# Pre-commissioning Checklist - Steam/Hot Water Converter

For Converter: [\_\_\_\_\_]

| Checklist Item                                               | Q   | M   | E   | T   | C   | D   | O   | U   |
|--------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                 |     |     |     |     |     |     |     |     |
| a. Converter steam piping installed.                         | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| b. Converter steam piping tested.                            | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| c. Hot water piping installed.                               | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| d. Hot water piping tested.                                  | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| e. Makeup water piping installed.                            | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| f. Vacuum breaker installed on shell of shell and tube unit. | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| g. Air vent installed as specified.                          | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| h. Manufacturer's required maintenance clearance provided.   | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| Startup                                                      |     |     |     |     |     |     |     |     |
| a. Hot water system cleaned and filled.                      | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| b. All steam traps operational.                              | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| c. All condensate return pumps operational.                  | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| d. Converter safety/protection devices tested.               | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| e. Converter startup and checkout complete.                  | ___ | ___ | X   | X   | X   | ___ | ___ | ___ |
| Controls                                                     |     |     |     |     |     |     |     |     |
| a. Control valves/actuators properly installed.              | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| b. Control valves/actuators operable.                        | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |

# Pre-commissioning Checklist - Fan Coil Unit

For Fan Coil Unit: [\_\_\_\_\_]

| Checklist Item                                                                   | Q   | M   | E   | T   | C   | D   | O   | U    |
|----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|
| Installation                                                                     |     |     |     |     |     |     |     |      |
| a. Vibration isolation devices installed.                                        | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| b. Access doors/removable panels are operable and sealed.                        | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| c. Casing undamaged.                                                             | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| d. Insulation undamaged.                                                         | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| e. Condensate drainage is unobstructed.                                          | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| f. Fan belt adjusted.                                                            | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| g. Any damage to coil fins has been repaired.                                    | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| h. Manufacturer's required maintenance clearance provided.                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| Electrical                                                                       |     |     |     |     |     |     |     |      |
| a. Power available to unit disconnect.                                           | ___ | ___ | ___ | 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. Power available to electric heating coil.                                    | ___ | ___ | ___ | X   | X   | ___ | ___ | ___] |
| Coils                                                                            |     |     |     |     |     |     |     |      |
| [a. Dual temperature piping properly connected.                                  | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___] |
| [a. Chilled water piping properly connected.                                     | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [b. Dual temperature piping pressure tested.                                     | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___] |
| [b. Chilled water piping pressure tested.                                        | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [c. Hot water piping properly connected.                                         | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___] |
| [d. Hot water piping pressure tested.                                            | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___] |
| Controls                                                                         |     |     |     |     |     |     |     |      |
| a. Control valves/actuators properly installed.                                  | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___  |



Pre-commissioning Checklist - Fan Coil Unit

For Fan Coil Unit: [\_\_\_\_\_]

| Checklist Item                                            | Q   | M   | E | T   | C   | D   | O   | U   |
|-----------------------------------------------------------|-----|-----|---|-----|-----|-----|-----|-----|
| b. Control valves/actuators operable.                     | ___ | ___ | X | X   | ___ | ___ | ___ | ___ |
| c. Verify proper location and installation of thermostat. | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB)                   |     |     |   |     |     |     |     |     |
| a. Construction filters removed and replaced.             | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. TAB results within limits specified in Section 15990A  |     |     |   |     |     |     |     |     |
| c. TAB Report submitted.                                  | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |

# Pre-commissioning Checklist - Unit Heater

For Unit Heater: [\_\_\_\_\_]

| Checklist Item                                                                   | Q   | M   | E   | T   | C   | D   | O   | U    |
|----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|
| Installation                                                                     |     |     |     |     |     |     |     |      |
| [a. Hot water piping properly connected.                                         | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___] |
| [a. Steam and condensate piping properly connected.                              | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [b. Hot water piping pressure tested.                                            | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___] |
| [b. Steam and condensate piping pressure tested.                                 | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| c. Air vent installed on hot water coil with shutoff valve as specified.         | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| d. Any damage to coil fins has been repaired.                                    | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| e. 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   | ___ | ___ | ___ | ___  |
| 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. TAB Report submitted.                                                         | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |

Pre-commissioning Checklist - Exhaust Fan

For Exhaust Fan: [\_\_\_\_\_]

| Checklist Item                                                                   | Q   | M   | E   | T   | C   | D   | O   | U   |
|----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                                     |     |     |     |     |     |     |     |     |
| a. Fan belt adjusted.                                                            | ___ | ___ | 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   | ___ | ___ | ___ | ___ |
| 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   | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB)                                          |     |     |     |     |     |     |     |     |
| a. TAB results within limits specified in Section 15990A                         | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| b. TAB Report submitted.                                                         | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |

# Pre-commissioning Checklist - Computer Room Unit

For Computer Room Unit: [\_\_\_\_\_]

| Checklist Item                                                                   | Q   | M   | E   | T   | C   | D   | O   | U    |
|----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|------|
| Installation                                                                     |     |     |     |     |     |     |     |      |
| a. Unit properly supported.                                                      | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| b. Access doors are operable and sealed.                                         | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| c. Casing undamaged.                                                             | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| d. Insulation undamaged.                                                         | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| e. Condensate drainage is unobstructed and routed to floor drain.                | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| f. Fan belt adjusted.                                                            | ___ | ___ | X   | ___ | X   | ___ | ___ | ___  |
| g. Manufacturer's required maintenance operational clearance provided.           | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| Electrical                                                                       |     |     |     |     |     |     |     |      |
| a. Power available to unit disconnect.                                           | ___ | ___ | ___ | X   | X   | ___ | ___ | ___  |
| b. Proper motor rotation verified.                                               | ___ | ___ | ___ | ___ | X   | ___ | ___ | ___  |
| c. Proper motor rotation verified.                                               | ___ | ___ | ___ | ___ | X   | ___ | ___ | ___  |
| d. Verify that power disconnect is located within sight of the unit it controls. | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___  |
| [e. Power available to reheat coils.                                             | ___ | ___ | ___ | ___ | X   | ___ | ___ | ___] |
| Coils/Humidifier                                                                 |     |     |     |     |     |     |     |      |
| [a. Chilled water piping properly connected.                                     | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___] |
| [a. Refrigerant piping properly connected.                                       | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [b. Chilled water piping pressure tested.                                        | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [b. Refrigerant piping pressure tested.                                          | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [c. Hot water piping properly connected.                                         | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___] |
| [c. Steam piping properly connected.                                             | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| [d. Hot water piping pressure tested.                                            | ___ | ___ | X   | X   | ___ | ___ | ___ | ___] |
| [d. Steam piping pressure tested.                                                | ___ | ___ | X   | X   | X   | ___ | ___ | ___] |
| e. Humidifier makeup water connected.                                            | ___ | ___ | X   | X   | X   | ___ | ___ | ___  |
| Controls                                                                         |     |     |     |     |     |     |     |      |

Pre-commissioning Checklist - Computer Room Unit

For Computer Room Unit: [\_\_\_\_\_]

| Checklist Item                                                           | Q   | M   | E   | T   | C   | D   | O   | U   |
|--------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| a. Control valves operable.                                              | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| b. Unit control system operable and verified.                            | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| c. Verify proper location and installation of thermostat and humidistat. | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB)                                  |     |     |     |     |     |     |     |     |
| a. Construction filters removed and replaced.                            | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| b. TAB results within limits specified in Section 15990A                 | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |
| c. TAB Report submitted.                                                 | ___ | ___ | X   | ___ | X   | ___ | ___ | ___ |

# Pre-commissioning Checklist - HVAC System Controls

For HVAC System: [\_\_\_\_\_]

| Checklist Item                                                                    | Q   | M   | E   | T   | C   | D   | O   | U   |
|-----------------------------------------------------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|
| Installation                                                                      |     |     |     |     |     |     |     |     |
| a. As-built shop drawings submitted.                                              | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| b. Layout of control panel matches drawings.                                      | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| c. Framed instructions mounted in or near control panel.                          | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| d. Components properly labeled (on inside and outside of panel).                  | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| e. Control components piped and/or wired to each labeled terminal strip.          | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| f. EMCS 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. Air dryer installed as specified.                                              | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| j. Water drain installed as specified.                                            | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| Main Power and Control Air                                                        |     |     |     |     |     |     |     |     |
| a. 110 volt AC power available to panel.                                          | ___ | ___ | ___ | X   | ___ | ___ | ___ | ___ |
| b. 138 kPa gauge (20 psig) 20 psig compressed air available to panel.             | ___ | ___ | X   | X   | ___ | ___ | ___ | ___ |
| Testing, Commissioning, and Balancing                                             |     |     |     |     |     |     |     |     |
| a. Testing, Commissioning, and Balancing Report submitted.                        | ___ | ___ | X   | ___ | ___ | ___ | ___ | ___ |

# Pre-commissioning Checklist - Single Zone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

| Checklist Item                                                                   | Q  | M  | E  | T  | C  | D  | O  | U   |
|----------------------------------------------------------------------------------|----|----|----|----|----|----|----|-----|
| <b>Installation</b>                                                              |    |    |    |    |    |    |    |     |
| a. Vibration isolation devices installed.                                        | __ | __ | X  | X  | X  | __ | __ | __  |
| b. Inspection and access doors are operable and sealed.                          | __ | __ | X  | __ | X  | __ | __ | __  |
| c. Casing undamaged.                                                             | __ | __ | X  | X  | X  | __ | __ | __  |
| d. Insulation undamaged.                                                         | __ | __ | X  | X  | X  | __ | __ | __  |
| e. Condensate drainage is unobstructed.                                          | __ | __ | X  | X  | X  | __ | __ | __  |
| f. Fan belt adjusted.                                                            | __ | __ | X  | __ | X  | __ | __ | __  |
| g. Any damage to coil fins has been repaired.                                    | __ | __ | X  | __ | X  | __ | __ | __  |
| h. Manufacturer's required maintenance clearance provided.                       | __ | __ | X  | X  | X  | __ | __ | __  |
| <b>Electrical</b>                                                                |    |    |    |    |    |    |    |     |
| 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. Power available to electric heating coil.                                     | __ | __ | __ | X  | __ | __ | __ | __  |
| <b>Coils</b>                                                                     |    |    |    |    |    |    |    |     |
| [a. Chilled water piping properly connected.                                     | __ | __ | X  | __ | __ | __ | __ | __] |
| [a. Refrigerant piping properly connected.                                       | __ | __ | X  | X  | X  | __ | __ | __] |
| [b. Chilled water piping pressure tested.                                        | __ | __ | X  | X  | X  | __ | __ | __] |
| [b. Refrigerant piping pressure tested.                                          | __ | __ | X  | X  | X  | __ | __ | __] |
| [c. Hot water piping properly connected.                                         | __ | __ | X  | __ | __ | __ | __ | __] |
| [c. Steam and condensate piping properly connected.                              | __ | __ | X  | X  | X  | __ | __ | __] |
| [d. Hot water piping pressure tested.                                            | __ | __ | X  | X  | __ | __ | __ | __] |
| [d. Steam and condensate piping pressure tested.                                 | __ | __ | X  | X  | X  | __ | __ | __] |

# Pre-commissioning Checklist - Single Zone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

| Checklist Item                                                             | Q   | M   | E | T   | C   | D   | O   | U   |
|----------------------------------------------------------------------------|-----|-----|---|-----|-----|-----|-----|-----|
| [e. Air vents installed on water coils [with shutoff valves] as specified. | ___ | ___ | X | X   | X   | ___ | ___ | ___ |
| f. Any damage to coil fins has been repaired.                              | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| Controls                                                                   |     |     |   |     |     |     |     |     |
| a. Control valves/actuators properly installed.                            | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| b. Control valves/actuators operable.                                      | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| c. Dampers/actuators properly installed.                                   | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| d. Dampers/actuators operable.                                             | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| e. Verify proper location and installation of thermostat.                  | ___ | ___ | X | ___ | ___ | ___ | ___ | ___ |
| Testing, Adjusting, and Balancing (TAB)                                    |     |     |   |     |     |     |     |     |
| a. Construction filters removed and replaced.                              | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| b. TAB results within limits specified in Section 15990A                   | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| c. TAB Report submitted.                                                   | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |



# Pre-commissioning Checklist - Energy Recovery System

For Energy Recovery System: [\_\_\_\_\_]

| Checklist Item                                             | Q   | M   | E | T   | C   | D   | O   | U   |
|------------------------------------------------------------|-----|-----|---|-----|-----|-----|-----|-----|
| Installation                                               |     |     |   |     |     |     |     |     |
| a. Recovery system piping installed.                       | ___ | ___ | X | ___ | X   | ___ | ___ | ___ |
| b. Recovery system piping tested.                          | ___ | ___ | X | X   | X   | ___ | ___ | ___ |
| c. Air vent installed as specified.                        | ___ | ___ | X | X   | X   | ___ | ___ | ___ |
| d. 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 | ___ | ___ | ___ | ___ | ___ |

APPENDIX B  
FUNCTIONAL PERFORMANCE TESTS CHECKLISTS

## Functional Performance Test Checklist - Pumps

For Pump: [\_\_\_\_\_]

Prior to performing this checklist, ensure that for closed loop systems, system is pressurized and the make-up water system is operational or, for open loop systems, that the sumps are filled to the proper level.

1. Activate pump start using control system commands (all possible combination, on/auto, etc.). ON \_\_\_\_\_ AUTO \_\_\_\_\_ OFF \_\_\_\_\_

a. Verify pressure drop across strainer:

|                                |                  |
|--------------------------------|------------------|
| Strainer inlet pressure _____  | kPa (_____ psig) |
| Strainer outlet pressure _____ | kPa (_____ psig) |
| Strainer inlet pressure _____  | psig             |
| Strainer outlet pressure _____ | psig             |

b. Verify pump inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, pump design conditions, and pump manufacturer's performance.

|                                  | DESIGN | SYSTEM TEST | ACTUAL |
|----------------------------------|--------|-------------|--------|
| Pump inlet pressure (kPa gauge)  | _____  | _____       | _____  |
| Pump outlet pressure (kPa gauge) | _____  | _____       | _____  |

  

|                             | DESIGN | SYSTEM TEST | ACTUAL |
|-----------------------------|--------|-------------|--------|
| Pump inlet pressure (psig)  | _____  | _____       | _____  |
| Pump outlet pressure (psig) | _____  | _____       | _____  |

c. Operate pump at shutoff and at 100 percent of designed flow when all components are in full flow. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

|                                 | SHUTOFF | 100 percent |
|---------------------------------|---------|-------------|
| Pump inlet pressure (kPa gauge) | _____   | _____       |
| Pump outlet pressure            | _____   | _____       |
| Pump flow rate (L/s)            | _____   | _____       |

  

|                            | SHUTOFF | 100 percent |
|----------------------------|---------|-------------|
| Pump inlet pressure (psig) | _____   | _____       |
| Pump outlet pressure       | _____   | _____       |
| Pump flow rate (gpm)       | _____   | _____       |

d. Operate pump at shutoff and at minimum flow or when all components are in full by-pass. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

|                                 | SHUTOFF | 100 percent |
|---------------------------------|---------|-------------|
| Pump inlet pressure (kPa gauge) | _____   | _____       |
| Pump outlet pressure            | _____   | _____       |
| Pump flow rate (L/s)            | _____   | _____       |

  

|                                 | SHUTOFF | 100 percent |
|---------------------------------|---------|-------------|
| Pump inlet pressure (kPa gauge) | _____   | _____       |
| Pump outlet pressure            | _____   | _____       |
| Pump flow rate (L/s)            | _____   | _____       |

Functional Performance Test Checklist - Pumps

For Pump: [\_\_\_\_\_]

|                            |       |       |
|----------------------------|-------|-------|
| Pump inlet pressure (psig) | _____ | _____ |
| Pump outlet pressure       | _____ | _____ |
| Pump flow rate (gpm)       | _____ | _____ |

2. Verify motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions.

a. Full flow:

|                   | PHASE 1 | PHASE 2 | PHASE 3 |
|-------------------|---------|---------|---------|
| Amperage          | _____   | _____   | _____   |
| Voltage           | _____   | _____   | _____   |
| Voltage           | _____   | _____   | _____   |
| Voltage to ground | _____   | _____   | _____   |

b. Minimum flow:

|                   | PHASE 1 | PHASE 2 | PHASE 3 |
|-------------------|---------|---------|---------|
| Amperage          | _____   | _____   | _____   |
| Voltage           | _____   | _____   | _____   |
| Voltage           | _____   | _____   | _____   |
| Voltage to ground | _____   | _____   | _____   |

3. Unusual vibration, noise, etc.

\_\_\_\_\_

\_\_\_\_\_

4. 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 Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

Functional Performance Test Checklist - Centrifugal Chiller

For Chiller: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows:

- a. Time of day startup program initiates chiller start: \_\_\_\_\_
- b. Start condenser water pump and establish condenser water flow. Verify chiller condenser water proof-of-flow switch operation. \_\_\_\_\_
- c. Start chilled water pump and establish chilled water flow. Verify chiller chilled water proof-of-flow switch operation. \_\_\_\_\_
- d. Verify control system energizes chiller start sequence. \_\_\_\_\_
- e. Verify chiller senses chilled water temperature above set point and control system activates chiller start. \_\_\_\_\_
- f. Verify functioning of "soft start" sequence. \_\_\_\_\_
- g. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_
- h. Restart air handling equipment one minute after chiller shut down. Verify condenser water pump, cooling tower, and chiller restart sequence. \_\_\_\_\_

2. 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 Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

## Functional Performance Test Checklist - Cooling Tower

For Cooling Tower: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall demonstrate operation of the cooling tower as per specification and the following:

a. Activate cooling tower fan start using control system command. This should first start condenser water pump, establish flow, delay fan start, as specified, to equalize flow in distribution basin and sump. Verify fan start after timed delay. \_\_\_\_\_

b. After chiller startup, control system should modulate bypass valve and two-speed fan motor to maintain condenser water set point. Verify function of bypass valve under varying loads. \_\_\_\_\_

c. Verify cooling tower interlock with chiller. \_\_\_\_\_

d. Verify makeup water float valve is functioning: \_\_\_\_\_  
Activate chemical treatment feed valve, verify makeup of chemical treatment system, pump, and controls: \_\_\_\_\_

e. Entering water temperature [\_\_\_\_\_] degrees C  
Leaving water temperature: [\_\_\_\_\_] degrees C  
Air volume measured: [\_\_\_\_\_] L/s  
Air volume calculated: [\_\_\_\_\_] L/s  
Entering wet bulb temperature: [\_\_\_\_\_] degrees C  
Measured water flow: [\_\_\_\_\_] L/s

e. Entering water temperature [\_\_\_\_\_] degrees F  
Leaving water temperature: [\_\_\_\_\_] degrees F  
Air volume measured: [\_\_\_\_\_] cfm  
Air volume calculated: [\_\_\_\_\_] cfm  
Entering wet bulb temperature: [\_\_\_\_\_] degrees F  
Measured water flow: [\_\_\_\_\_] gpm

2. 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 Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

Functional Performance Test Checklist - Cooling Tower

For Cooling Tower: [\_\_\_\_\_]

## Functional Performance Test Checklist - VAV Terminals

The Contracting officer will select VAV terminals to be spot-checked during the functional performance test. The number of terminals shall not exceed [2] [10] [10 percent].

1. Functional Performance Test: Contractor shall demonstrate operation of selected VAV boxes as per specifications including the following:

a. Cooling only VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambient and measure maximum air flow. Turn thermostat to 5 degrees F below ambient and measure minimum air flow.

Maximum flow [\_\_\_\_\_] L/s  
Minimum flow [\_\_\_\_\_] L/s

Maximum flow [\_\_\_\_\_] cfm  
Minimum flow [\_\_\_\_\_] cfm

(2) Check damper maximum/minimum flow settings.

Maximum flow setting [\_\_\_\_\_] L/s  
Minimum flow setting [\_\_\_\_\_] L/s

Maximum flow setting [\_\_\_\_\_] cfm  
Minimum flow setting [\_\_\_\_\_] cfm

b. Cooling with reheat VAV boxes:

(1) Verify VAV box response to room temperature set point adjustment. Turn thermostat to 3 degrees C 5 degrees F above ambient and measure maximum air flow. Turn thermostat to 3 degrees C 5 degrees F below ambient and measure minimum air flow.

Maximum flow [\_\_\_\_\_] L/s  
Minimum flow [\_\_\_\_\_] L/s

Maximum flow [\_\_\_\_\_] cfm  
Minimum flow [\_\_\_\_\_] cfm

(2) Check damper maximum/minimum flow settings.

Maximum flow setting [\_\_\_\_\_] L/s  
Minimum flow setting [\_\_\_\_\_] L/s

Maximum flow setting [\_\_\_\_\_] cfm  
Minimum flow setting [\_\_\_\_\_] cfm

Reheat coil operation range (full open to full closed) \_\_\_\_\_

c. Fan powered VAV boxes:

(1) Verify VAV box response to sensor call for heating via set



Functional Performance Test Checklist - VAV Terminals

point adjustment. Changes to be cooling setpoint to heating set point and return to cooling set point. \_\_\_\_\_ Verify cooling damper closes to minimum position, blower fan energizes according to sequence of operation, and upon further drop in space temperature, heating coil activation and deactivation. \_\_\_\_\_

(2) Check primary air damper maximum/minimum flow settings.

Maximum flow setting [\_\_\_\_\_] L/s

Minimum flow setting [\_\_\_\_\_] L/s

(3) Check blower fan flow. [\_\_\_\_\_] L/s

Maximum flow setting [\_\_\_\_\_] cfm

Minimum flow setting [\_\_\_\_\_] cfm

(3) Check blower fan flow. [\_\_\_\_\_] cfm

(4) Verify free operation of fan backdraft damper (insure no primary air is being discharged through the recirculated air register).

---

(5) Verify that no recirculated air is being induced when box is in full cooling. \_\_\_\_\_

2. 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 Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

## Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the [supply fan operating] [supply and return fans operating] mode is initiated:

(1) All dampers in normal position [and fan inlet vanes modulate to maintain the required static pressure]. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) System safeties allow start if safety conditions are met. \_\_\_\_\_

(4) VAV fan controller shall "soft-start" fan. \_\_\_\_\_

(5) Modulate all VAV boxes to minimum air flow and verify that the static pressure does not exceed the design static pressure Class shown.

---

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. \_\_\_\_\_

(2) Return air damper open. \_\_\_\_\_

(3) Relief air damper [at minimum position] [closed]. \_\_\_\_\_

(4) Chilled water control valve modulating to maintain leaving air temperature set point. \_\_\_\_\_

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point.

---

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. \_\_\_\_\_

(2) Relief air damper modulates with outside air damper according to sequence of operation. \_\_\_\_\_

(3) Chilled water control valve modulating to maintain leaving air temperature set point. \_\_\_\_\_

(4) Hot water control valve modulating to maintain leaving air temperature set point. \_\_\_\_\_

(5) Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point.

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

d. Unoccupied mode of operation

(1) All dampers in normal position. \_\_\_\_\_

(2) Verify low limit space temperature is maintained as specified in sequence of operation. \_\_\_\_\_

e. The following shall be verified when the [supply fan off] [supply and return fans off] mode is initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) Fan de-energizes. \_\_\_\_\_

f. Verify the chilled water coil control valve operation by setting all VAV's to maximum and minimum cooling.

|                               | Max cooling | Min cooling |
|-------------------------------|-------------|-------------|
| Supply air volume (_____ L/s) | _____       | _____       |

|                                    |       |       |
|------------------------------------|-------|-------|
| Supply air temp. (_____ degrees C) | _____ | _____ |
|------------------------------------|-------|-------|

|                              | Max cooling | Min cooling |
|------------------------------|-------------|-------------|
| Supply air volume _____ cfm) | _____       | _____       |

|                                    |       |       |
|------------------------------------|-------|-------|
| Supply air temp. (_____ degrees F) | _____ | _____ |
|------------------------------------|-------|-------|

g. Verify safety shut down initiated by smoke detectors. \_\_\_\_\_

h. Verify safety shut down initiated by low temperature protection thermostat. \_\_\_\_\_

2. 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 Chief Quality Control Representative

Contractor's Mechanical Representative

Contractor's Electrical Representative

Contractor's Testing, Adjusting and Balancing Representative

Contractor's Controls Representative

Functional Performance Test Checklist - Variable Volume Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]   
Contracting Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_] \_\_\_\_\_

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the [supply fan operating] [supply and return fans operating] mode is initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) System safeties allow start if safety conditions are met. \_\_\_\_\_

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. \_\_\_\_\_

(2) Return air damper open. \_\_\_\_\_

(3) Relief air damper [at minimum position] [closed]. \_\_\_\_\_

(4) Chilled water control valve modulating to maintain space cooling temperature set point. \_\_\_\_\_

(5) Hot water control valve modulating to maintain space heating temperature set point input from outside air temperature controller. \_\_\_\_\_

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulated to maintain mixed air temperature set point. \_\_\_\_\_

(2) Relief air damper modulates with outside air damper according to sequence of operation. \_\_\_\_\_

(3) Chilled water control valve modulating to maintain space cooling temperature set point. \_\_\_\_\_

d. Unoccupied mode of operation

(1) All dampers in normal position. \_\_\_\_\_

(2) Verify low limit space temperature is maintained as specified in sequence of operation. \_\_\_\_\_

e. The following shall be verified when the [supply fan off] [supply and return fans off] mode is initiated:

Functional Performance Test Checklist - Single Zone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) Fan de-energizes. \_\_\_\_\_

f. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point. \_\_\_\_\_

g. Verify safety shut down initiated by smoke detectors. \_\_\_\_\_

h. Verify safety shut down initiated by low temperature protection thermostat. \_\_\_\_\_

2. 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 Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

## Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:

a. The following shall be verified when the supply and return fans operating mode is initiated:

(1) All dampers in normal position. \_\_\_\_\_

(2) All valves in normal position. \_\_\_\_\_

(3) System safeties allow start if safety conditions are met. \_\_\_\_\_

b. Occupied mode of operation - economizer de-energized.

(1) Outside air damper at minimum position. \_\_\_\_\_

(2) Return air damper open. \_\_\_\_\_

(3) Relief air damper [at minimum position] [closed]. \_\_\_\_\_

(4) Chilled water control valve modulating to maintain cold deck supply air temperature set point. \_\_\_\_\_

(5) Hot water control valve modulating to maintain hot deck supply air temperature set point input from outside air temperature controller.

---

c. Occupied mode of operation - economizer energized.

(1) Outside air damper modulates to maintain mixed air temperature set point. \_\_\_\_\_

(2) Relief air damper modulates with outside air damper according to sequence of operation. \_\_\_\_\_

(3) Chilled water control valve modulating to maintain cold deck supply air temperature set point. \_\_\_\_\_

(4) Hot water control valve modulating to maintain hot deck supply air temperature set point input from outside air temperature controller.

---

d. Unoccupied mode of operation

(1) All dampers in normal position. \_\_\_\_\_

(2) Verify low limit space temperature is maintained as specified in sequence of operation. \_\_\_\_\_

e. The following shall be verified when the supply and return fans off

## Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_] mode is initiated:

- (1) All dampers in normal position. \_\_\_\_\_
- (2) All valves in normal position. \_\_\_\_\_
- (3) Fan de-energizes. \_\_\_\_\_

f. Verify zone damper operation by varying zone thermostat set points from cooling set point to heating set point and returning to cooling set point. \_\_\_\_\_

g. Verify safety shut down initiated by smoke detectors. \_\_\_\_\_

h. Verify safety shut down initiated by low temperature protection thermostat. \_\_\_\_\_

i. Index room thermostats to full cooling then to full heating. Measure and record cold deck, hot deck, and supply air temperatures and determine damper leakage for a minimum of 2 zones.

Cold deck temperature \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)  
Hot deck temperature \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)

Cold deck temperature \_\_\_\_\_ degrees F  
Hot deck temperature \_\_\_\_\_ degrees F

Zone \_\_\_\_\_  
Cooling temperature \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)  
Heating temperature \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)  
Damper leakage cooling \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)  
Damper leakage heating \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)

Zone \_\_\_\_\_  
Cooling temperature \_\_\_\_\_ degrees F  
Heating temperature \_\_\_\_\_ degrees F  
Damper leakage cooling \_\_\_\_\_ degrees F  
Damper leakage heating \_\_\_\_\_ degrees

Zone \_\_\_\_\_  
Cooling temperature \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)  
Heating temperature \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)  
Damper leakage cooling \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)  
Damper leakage heating \_\_\_\_\_ degrees C ( \_\_\_\_\_ degrees F)

Zone \_\_\_\_\_  
Cooling temperature \_\_\_\_\_ degrees F  
Heating temperature \_\_\_\_\_ degrees F  
Damper leakage cooling \_\_\_\_\_ degrees F  
Damper leakage heating \_\_\_\_\_ degrees F

Functional Performance Test Checklist - Multizone Air Handling Unit

For Air Handling Unit: [\_\_\_\_\_]

2. 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 Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_



# Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows.

a. Start chilled water pump and establish chilled water flow. Verify chiller-chilled water proof-of-flow switch operation. \_\_\_\_\_

b. Verify control system energizes chiller start sequence. \_\_\_\_\_

c. Verify chiller senses chilled water temperature above set point and control system activates chiller start. \_\_\_\_\_

d. Verify functioning of "soft start" sequence. \_\_\_\_\_

e. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_

f. Restart air handling equipment one minute after chiller shut down. Verify chiller restart sequence. \_\_\_\_\_

2. Verify chiller inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, chiller design conditions, and chiller manufacturer's performance data.

|                         |             | DESIGN | SYSTEM TEST | ACTUAL |
|-------------------------|-------------|--------|-------------|--------|
| Chiller inlet pressure  | (kPa gauge) | _____  | _____       | _____  |
| Chiller inlet pressure  | (psig)      | _____  | _____       | _____  |
| Chiller outlet pressure | (kPa gauge) | _____  | _____       | _____  |
| Chiller outlet pressure | (psig)      | _____  | _____       | _____  |

3. Verify chiller amperage each phase and voltage phase-to-phase and phase-to-ground.

|                   | PHASE 1 | PHASE 2 | PHASE 3 |
|-------------------|---------|---------|---------|
| Amperage          | _____   | _____   | _____   |
| Voltage           | _____   | _____   | _____   |
| Voltage           | _____   | _____   | _____   |
| Voltage to ground | _____   | _____   | _____   |

4. Record the following information:

Ambient dry bulb temperature \_\_\_\_\_ degrees C  
 Ambient wet bulb temperature \_\_\_\_\_ degrees C  
 Entering chilled water temperature \_\_\_\_\_ degrees C  
 Leaving chilled water temperature \_\_\_\_\_ degrees C

Ambient dry bulb temperature \_\_\_\_\_ degrees F  
 Ambient wet bulb temperature \_\_\_\_\_ degrees F  
 Entering chilled water temperature \_\_\_\_\_ degrees F  
 Leaving chilled water temperature \_\_\_\_\_ degrees F

Functional Performance Test Checklist - Packaged Air Cooled Chiller

For Chiller: [\_\_\_\_\_]

5. Unusual vibration, noise, etc.

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6. 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 Chief Quality Control Representative

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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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Using Agency's Representative

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## Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following: Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

a. Start air handling unit. Verify control system energizes condensing unit start sequence. \_\_\_\_\_

b. Shut off air handling equipment to verify condensing unit de-energizes. \_\_\_\_\_

c. Restart air handling equipment one minute after condensing unit shut down. Verify condensing unit restart sequence. \_\_\_\_\_

2. Verify condensing unit amperage each phase and voltage phase to phase and phase to ground.

|                   | PHASE 1 | PHASE 2 | PHASE 3 |
|-------------------|---------|---------|---------|
| Amperage          | _____   | _____   | _____   |
| Voltage           | _____   | _____   | _____   |
| Voltage           | _____   | _____   | _____   |
| Voltage to ground | _____   | _____   | _____   |

3. Record the following information:

|                              |       |           |
|------------------------------|-------|-----------|
| Ambient dry bulb temperature | _____ | degrees C |
| Ambient wet bulb temperature | _____ | degrees C |
| Suction pressure             | _____ | kPa gauge |
| Discharge pressure           | _____ | kPa gauge |

|                              |       |           |
|------------------------------|-------|-----------|
| Ambient dry bulb temperature | _____ | degrees F |
| Ambient wet bulb temperature | _____ | degrees F |
| Suction pressure             | _____ | psig      |
| Discharge pressure           | _____ | psig      |

4. Unusual vibration, noise, etc.

\_\_\_\_\_  
\_\_\_\_\_

5. 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 Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing

\_\_\_\_\_

Functional Performance Test Checklist - Air Cooled Condensing Unit

For Condensing Unit: [\_\_\_\_\_]

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

# Functional Performance Test Checklist - Hot Water Boiler

For Boiler: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall demonstrate operation of hot water system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start hot water pump and establish hot water flow. Verify boiler hot water proof-of-flow switch operation. \_\_\_\_\_

b. Verify control system energizes boiler start sequence. \_\_\_\_\_

c. Verify boiler senses hot water temperature below set point and control system activates boiler start. \_\_\_\_\_

d. Shut off building heating equipment to remove load on hot water system. Verify boiler shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_

2. Verify boiler inlet/outlet pressure reading, compare to Test and Balance (TAB) Report, boiler design conditions, and boiler manufacturer's performance data.

|                                         | DESIGN | SYSTEM TEST | ACTUAL |
|-----------------------------------------|--------|-------------|--------|
| Boiler inlet pressure (kPa gauge)       | _____  | _____       | _____  |
| Boiler outlet pressure (kPa gauge)      | _____  | _____       | _____  |
| Boiler flow rate (L/s)                  | _____  | _____       | _____  |
| Flue-gas temperature at boiler outlet   |        | _____       | _____  |
| Percent carbon dioxide in flue-gas      |        | _____       | _____  |
| Draft at boiler flue-gas exit           |        | _____       | _____  |
| Draft or pressure in furnace            |        | _____       | _____  |
| Stack emission pollutants concentration | _____  | _____       | _____  |
| Fuel type                               | _____  | _____       | _____  |
| Combustion efficiency                   | _____  | _____       | _____  |

|                                         | DESIGN | SYSTEM TEST | ACTUAL |
|-----------------------------------------|--------|-------------|--------|
| Boiler inlet pressure (psig)            | _____  | _____       | _____  |
| Boiler outlet pressure (psig)           | _____  | _____       | _____  |
| Boiler flow rate (gpm)                  | _____  | _____       | _____  |
| Flue-gas temperature at boiler outlet   |        | _____       | _____  |
| Percent carbon dioxide in flue-gas      |        | _____       | _____  |
| Draft at boiler flue-gas exit           |        | _____       | _____  |
| Draft or pressure in furnace            |        | _____       | _____  |
| Stack emission pollutants concentration | _____  | _____       | _____  |
| Fuel type                               | _____  | _____       | _____  |
| Combustion efficiency                   | _____  | _____       | _____  |

3. Record the following information:

|                                |       |           |
|--------------------------------|-------|-----------|
| Ambient temperature            | _____ | degrees C |
| Entering hot water temperature | _____ | degrees C |
| Leaving hot water temperature  | _____ | degrees C |

Functional Performance Test Checklist - Hot Water Boiler

For Boiler: [\_\_\_\_\_]

|                                |       |           |
|--------------------------------|-------|-----------|
| Ambient temperature            | _____ | degrees F |
| Entering hot water temperature | _____ | degrees F |
| Leaving hot water temperature  | _____ | degrees F |

4. Verify temperatures in item 3 are in accordance with the reset schedule. \_\_\_\_\_

5. Verify proper operation of boiler safeties. \_\_\_\_\_

6. Unusual vibration, noise, etc. \_\_\_\_\_

7. Visually check refractory for cracks or spalling and refractory and tubes for flame impingement. \_\_\_\_\_

8. 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 Chief Quality Control Representative

Contractor's Mechanical Representative

Contractor's Electrical Representative

Contractor's Testing, Adjusting and Balancing Representative

Contractor's Controls Representative

Contracting Officer's Representative

Using Agency's Representative

## Functional Performance Test Checklist - Steam Boiler

For Boiler: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall demonstrate operation of steam heating system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.

a. Start steam heating system. Verify control system energizes boiler start sequence. \_\_\_\_\_

b. Verify boiler senses steam pressure below set point and control system activates boiler start. \_\_\_\_\_

c. Shut off building heating equipment to remove load on steam heating system. Verify boiler shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_

d. Verify that water level and makeup water system are operational. \_\_\_\_\_

2. Verify boiler inlet/outlet pressure reading, compare to boiler design conditions and manufacturer's performance data.

|                                                   | DESIGN | SYSTEM TEST | ACTUAL |
|---------------------------------------------------|--------|-------------|--------|
| Boiler inlet water temp (degrees F)               | _____  | _____       | _____  |
| Boiler outlet pressure (kPa gauge)                | _____  | _____       | _____  |
| Flue-gas temperature at boiler outlet (degrees C) | _____  | _____       | _____  |
| Percent carbon dioxide in flue-gas                | _____  | _____       | _____  |
| Draft at boiler flue-gas exit                     | _____  | _____       | _____  |
| Draft or pressure in furnace                      | _____  | _____       | _____  |
| Stack emission pollutants concentration           | _____  | _____       | _____  |
| Fuel type                                         | _____  | _____       | _____  |
| Combustion efficiency                             | _____  | _____       | _____  |

|                                                   | DESIGN | SYSTEM TEST | ACTUAL |
|---------------------------------------------------|--------|-------------|--------|
| Boiler inlet water temp (degrees F)               | _____  | _____       | _____  |
| Boiler outlet pressure (psig)                     | _____  | _____       | _____  |
| Flue-gas temperature at boiler outlet (degrees F) | _____  | _____       | _____  |
| Percent carbon dioxide in flue-gas                | _____  | _____       | _____  |
| Draft at boiler flue-gas exit                     | _____  | _____       | _____  |
| Draft or pressure in furnace                      | _____  | _____       | _____  |
| Stack emission pollutants concentration           | _____  | _____       | _____  |
| Fuel type                                         | _____  | _____       | _____  |
| Combustion efficiency                             | _____  | _____       | _____  |

3. Record the following information:

Ambient temperature \_\_\_\_\_ degrees C  
Ambient temperature \_\_\_\_\_ degrees F

4. Verify proper operation of boiler safeties. \_\_\_\_\_

5. Unusual vibration, noise, etc.

Functional Performance Test Checklist - Steam Boiler

For Boiler: [\_\_\_\_\_]

\_\_\_\_\_  
\_\_\_\_\_  
6. Visually check refractory for cracks or spalling and refractory and tubes for flame impingement. \_\_\_\_\_

7. 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 Chief Quality Control Representative

Contractor's Mechanical Representative

Contractor's Electrical Representative

Contractor's Testing, Adjusting and Balancing Representative

Contractor's Controls Representative

Contracting Officer's Representative

Using Agency's Representative



## Functional Performance Test Checklist - Fan Coil Units

The Contracting Officer will select fan coil units to be spot-checked during the functional performance test. The number of terminals shall not exceed [2] [10] [10 percent].

1. Functional Performance Test: Contractor shall demonstrate operation of selected fan coils as per specifications including the following:

a. Cooling only fan coils:

- (1) Verify fan coil unit response to room temperature set point adjustment. Changes to be cooling set point to cooling set point minus 10 degrees and return to cooling set point. \_\_\_\_\_
- (2) Check blower fan air flow. \_\_\_\_\_ L/s  
Check blower fan air flow. \_\_\_\_\_ cfm
- (3) Check cooling coil water flow. \_\_\_\_\_ L/s  
Check cooling coil water flow. \_\_\_\_\_ gpm
- (4) Verify proper operation of cooling water control valve. \_\_\_\_\_

b. Cooling/heating fan coils:

- (1) Verify fan coil unit response to room temperature set point adjustment. Changes to be cooling set point to heating set point and return to cooling set point. \_\_\_\_\_
- (2) Check blower fan air flow. \_\_\_\_\_ L/s  
Check blower fan air flow. \_\_\_\_\_ cfm
- (3) Check cooling coil water flow. \_\_\_\_\_ L/s  
Check cooling coil water flow. \_\_\_\_\_ cfm
- (4) Verify proper operation of cooling water control valve. \_\_\_\_\_
- (5) Check cooling mode inlet air temperature. \_\_\_\_\_ degrees C  
Check cooling mode inlet air temperature. \_\_\_\_\_ degrees F
- (6) Check cooling mode outlet air temperature. \_\_\_\_\_ degrees C  
Check cooling mode outlet air temperature. \_\_\_\_\_ degrees F
- (7) Check heating coil water flow. \_\_\_\_\_ L/s  
Check heating coil water flow. \_\_\_\_\_ gpm
- (8) Verify proper operation of heating water control valve. \_\_\_\_\_
- (9) Check heating mode inlet air temperature. \_\_\_\_\_ degrees C  
Check heating mode inlet air temperature. \_\_\_\_\_ degrees F
- (10) Check heating mode outlet air temperature. \_\_\_\_\_ degrees C  
Check heating mode outlet air temperature. \_\_\_\_\_ degrees F

2. 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.

Functional Performance Test Checklist - Fan Coil Units

Signature and Date

Contractor's Chief Quality Control Representative

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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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Using Agency's Representative

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## Functional Performance Test Checklist - Unit Heaters

The Contracting Officer will select unit heaters to be spot-checked during the functional performance test. The number of terminals shall not exceed [2] [10] [10 percent].

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters as per specifications including the following:

a. Verify unit heater response to room temperature set point adjustment. Changes to be heating set point to heating set point minus 10 degrees and return to heating set point. \_\_\_\_\_

b. Check blower fan speed. \_\_\_\_\_rpm

c. Check heating mode inlet air temperature. \_\_\_\_\_ degrees C Check heating mode inlet air temperature. \_\_\_\_\_ degrees F

d. Check heating mode outlet air temperature. \_\_\_\_\_ degrees C Check heating mode outlet air temperature. \_\_\_\_\_ degrees F

2. 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 Chief Quality Control Representative

\_\_\_\_\_

Contractor's Mechanical Representative

\_\_\_\_\_

Contractor's Electrical Representative

\_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative

\_\_\_\_\_

Contractor's Controls Representative

\_\_\_\_\_

Contracting Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

Functional Performance Test Checklist - Steam/Hot Water Converter

For Converter: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall demonstrate operation of heating system as per specifications including the following: Start building heating equipment to provide load for converter.

- a. Verify control system energizes. \_\_\_\_\_
- b. Verify converter senses hot water temperature below set point and control system modulates steam valve. \_\_\_\_\_
- c. Shut off building heating equipment to remove load on heating system. Verify converter steam valve closes after load is removed. \_\_\_\_\_

2. Verify converter inlet/outlet pressure reading, compare to converter design conditions and manufacturer's performance data.

|                                                                                   | DESIGN | ACTUAL |
|-----------------------------------------------------------------------------------|--------|--------|
| Converter inlet water temp (degrees C)                                            | _____  | _____  |
| Converter outlet water temp (degrees F)                                           | _____  | _____  |
| Converter inlet steam pressure (psig)                                             | _____  | _____  |
| Determine water flow rate based on pressure drop through converter                | _____  | _____  |
| Determine water flow rate with flow measuring device                              | _____  | _____  |
| Verify that temperature of water is in accordance with outdoor air reset schedule | _____  | _____  |

|                                                                                   | DESIGN | ACTUAL |
|-----------------------------------------------------------------------------------|--------|--------|
| Converter inlet water temp (degrees F)                                            | _____  | _____  |
| Converter outlet water temp (degrees F)                                           | _____  | _____  |
| Converter inlet steam pressure (psig)                                             | _____  | _____  |
| Determine water flow rate based on pressure drop through converter                | _____  | _____  |
| Determine water flow rate with flow measuring device                              | _____  | _____  |
| Verify that temperature of water is in accordance with outdoor air reset schedule | _____  | _____  |

- 3. Verify proper operation of converter safeties. \_\_\_\_\_
- 4. Check and report unusual vibration, noise, etc. \_\_\_\_\_

5. 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.

Contractor's Chief Quality Control Representative \_\_\_\_\_

Signature and Date

Functional Performance Test Checklist - Steam/Hot Water Converter

For Converter: [\_\_\_\_\_]

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contracting Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

Functional Performance Test Checklist - Computer Room Unit

For Computer Room Unit: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall verify operation of computer room unit as per specification including the following:

- a. System safeties allow start if safety conditions are met. \_\_\_\_\_
- b. Verify cooling and heating operation by varying thermostat set point from space set point to space set point plus 10 degrees, space set point minus 10 degrees, and returning to space set point. \_\_\_\_\_
- c. Verify humidifier operation by varying humidistat set point from space set point to space set point plus 20 percent RH, and returning to space set point. \_\_\_\_\_
- d. Verify that airflow is within +10/-0 percent of design airflow. \_\_\_\_\_
- e. Verify unit shut down during fire event initiated by smoke/heat sensors. \_\_\_\_\_

2. 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 Chief Quality Control Representative \_\_\_\_\_

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Contracting Officer's Representative \_\_\_\_\_

Using Agency's Representative \_\_\_\_\_

## Functional Performance Test Checklist - HVAC Controls

For HVAC System: [\_\_\_\_\_]

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed [2] [10] [10 percent].

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the following tests:

a. Verify that controller is maintaining the set point by manually measuring the controlled variable with a thermometer, sling psychrometer, inclined manometer, etc.

b. Verify sensor/controller combination by manually measuring the controlled medium. Take readings from control panel display and compare readings taken manually. Record all readings.

Sensor \_\_\_\_\_  
Manual measurement \_\_\_\_\_  
Panel reading value \_\_\_\_\_

c. Verify system stability by changing the controller set point as follows:

- (1) Air temperature - 10 degrees F
- (2) Water temperature - 10 degrees F
- (3) Static pressure - 10 percent of set point
- (4) Relative humidity - percent (RH)

The control system shall be observed for 10 minutes after the change in set point. Instability or excessive hunting will be unacceptable.

d. Verify interlock with other HVAC controls.

e. Verify interlock with fire alarm control panel.

f. Verify interlock with EMCS.

[g. Change controller set point 10 percent with EMCS and verify correct response.]

2. Verify that operation of control system conforms to that specified in the sequence of operation.

3. 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 Chief Quality Control Representative \_\_\_\_\_

Contractor's Mechanical Representative \_\_\_\_\_

Functional Performance Test Checklist - HVAC Controls

For HVAC System: [\_\_\_\_\_]

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing, Adjusting and Balancing Representative  
\_\_\_\_\_

Contractor's Controls Representative  
\_\_\_\_\_

Contractor's Officer's Representative  
\_\_\_\_\_

Using Agency's Representative  
\_\_\_\_\_



## Functional Performance Test Checklist - Energy Recovery System

For Energy Recovery System: [\_\_\_\_\_]

1. Functional Performance Test: Contractor shall demonstrate operation of energy recovery system as per specifications including the following: Start equipment to provide energy source for recovery system.

- a. Verify energy source is providing recoverable energy. \_\_\_\_\_
- b. Verify recovery system senses available energy and activates. \_\_\_\_\_
- c. Verify that recovery system deactivates when recoverable energy is no longer available. \_\_\_\_\_

2. Verify recovery system inlet/outlet readings, compare to design conditions and manufacturer's performance data.

|                                        | Design | Actual |
|----------------------------------------|--------|--------|
| Primary loop inlet temp (degrees C)    | _____  | _____  |
| Primary loop outlet temp (degrees F)   | _____  | _____  |
| Primary loop flow rate                 | _____  | _____  |
| Secondary loop inlet temp (degrees)    | _____  | _____  |
| Secondary loop outlet temp (degrees C) | _____  | _____  |
| Energy recovered (kJ)                  | _____  | _____  |

|                                        | Design | Actual |
|----------------------------------------|--------|--------|
| Primary loop inlet temp (degrees F)    | _____  | _____  |
| Primary loop outlet temp (degrees F)   | _____  | _____  |
| Primary loop flow rate                 | _____  | _____  |
| Secondary loop inlet temp (degrees F)  | _____  | _____  |
| Secondary loop outlet temp (degrees F) | _____  | _____  |
| Energy recovered BTU's)                | _____  | _____  |

3. Check and report unusual vibration, noise, etc.

4. 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 Chief Quality Control Representative \_\_\_\_\_

Contractor's Mechanical Representative \_\_\_\_\_

Contractor's Electrical Representative \_\_\_\_\_

Contractor's Testing , Adjusting and Balancing Representative \_\_\_\_\_

Contractor's Controls Representative \_\_\_\_\_

Functional Performance Test Checklist - Energy Recovery System

For Energy Recovery System: [\_\_\_\_\_]

Contractor's Officer's Representative

\_\_\_\_\_

Using Agency's Representative

\_\_\_\_\_

-- End of Section --