

SECTION 01810

COMMISSIONING

**PART 1 - GENERAL**

1.1 DESCRIPTION OF WORK

- A. Work includes the completion of formal commissioning procedures on selected equipment and systems, as listed under 1.2.A. below. Commissioning is defined as the process of verifying that the installation and performance of selected building systems meet the specified design criteria and therefore satisfies the design intent. The Contractor shall be responsible for participation in the commissioning process as outlined below, and in subsequent sectional references and attachments throughout the project documents. Commissioning procedures will be designed and coordinated under the direction of a Commissioning Consultant (CC). The CC shall be a totally independent firm under contract directly with the Owner or Owner's Representative, and shall not be contractually or otherwise financially associated with either the Design Team or any Contractor performing work on this project. The CC shall be directly responsible to the Owner and/or Owner's Representative. The Commissioning Consultant on this project shall be either the Owner's Representative or a third party commissioning service provider under contract with the owner.
- B. The Contractor responsible for completion of the work, within the sections as listed below under section 1.2.A., shall have specific responsibilities relating to demonstrating the equipment and systems provided have been installed and function per the contract Project Documents. These responsibilities are as follows:
  - 1. It is the Contractor's specific responsibility to complete their respective start-up and checkout procedures, and to insure the complete readiness of equipment and systems prior to the start of the functional performance-testing phase of the commissioning process.
  - 2. The Contractor shall provide written confirmation of system readiness for functional performance testing, in the form of a Pre-Functional Checklist provided by the CC (see attachments in Appendix A at the end of this section for draft versions). The Contractor shall complete, sign and return these forms and any required supporting documentation as an indication of compliance with all specified work.
  - 3. Once the CC is provided with written confirmation (Pre-Functional Test checklists) of related systems completion, the actual date and times for the functional performance testing phase will be confirmed. The Contractor shall be prepared at this time to demonstrate system performance to the Commissioning Consultant through completion of the functional performance testing process, per the procedures and acceptance criteria provided by the CC in the Commissioning Plan. The Contractor may be required to submit test forms and test plans to the CC for approval prior to functional testing. See Appendix B for a list of testing activities that details testing and documentation requirements.
  - 4. The Contractor shall be responsible for providing qualified representatives, material, equipment, tools, etc., required within the scope of their specialty, to facilitate successfully completing the functional performance testing process. The

Contractor shall budget and provide sufficient time and qualified personnel to participate on-site in this process until the process is successfully completed and all issues have been corrected or otherwise resolved.

5. Specified training on related systems and equipment operation and maintenance shall only commence after final performance testing is successfully completed, and systems are verified by the CC to be 100% complete and functional.
6. Owner shall not accept equipment and systems or make final payment, until all equipment and systems have been successfully commissioned and all specified requirements have been satisfied.

RELATED WORK

A. The following sections have start-up, testing and/or commissioning related activities.

Division 02

|       |            |
|-------|------------|
| 02910 | Irrigation |
|-------|------------|

Division 11

|       |  |
|-------|--|
| 11060 | Stage Equipment Contractor – Qualifications and Coordination |
| 11061 | Theatrical Rigging and Draperies                             |
| 11062 | Fire Safety Curtains   |
| 11130 | Audio System   |
| 11400 | Food Service Equipment                                       |
| 11610 | Fume Hoods   |

Division 15

|       |   |
|-------|---|
| 15010 | General Mechanical Requirements                           |
| 15060 | Pipes and Pipe Fittings                                   |
| 15100 | Valves  |
| 15140 | Supports and Anchors                                      |
| 15170 | Motors  |
| 15190 | Mechanical Identification                                 |
| 15240 | Mechanical Equipment Sound, Vibration and Seismic Control |
| 15250 | Insulation  |
| 15330 | Fire Protection Sprinkler System                          |
| 15375 | Standpipe Insulation                                      |
| 15420 | Plumbing Piping Systems                                   |
| 15440 | Plumbing Fixtures   |
| 15450 | Plumbing Equipment  |
| 15510 | Hydronic Piping Systems                                   |
| 15515 | Heating Water Systems                                     |
| 15540 | HVAC Pumps  |
| 15545 | Water Treatment   |
| 15560 | Boilers and Accessories                                   |
| 15620 | Fuel-Fired Heaters  |
| 15650 | Refrigeration- Air Conditioning                           |
| 15680 | Chilled Water Systems                                     |
| 15780 | Package Air Conditioning Units                            |

|       |   |
|-------|---|
| 15830 | Terminal Heat Transfer Equipment        |
| 15855 | Air Handling Units With Heat or Cooling |
| 15860 | Fans                                    |
| 15889 | Kitchen Hood System                     |
| 15890 | Ductwork                                |
| 15895 | Adjustable Frequency Drive              |
| 15910 | Ductwork Accessories                    |
| 15930 | Air Terminal Units                      |
| 15940 | Air Outlets and Inlets                  |
| 15950 | Controls                                |
| 15990 | Testing, Adjusting and Balancing        |
| 15995 | Mechanical Commissioning                |

Division 16

|       |   |
|-------|---|
| 16010 | General Electrical Provisions                       |
| 16110 | Conduits, Raceways and Fittings                     |
| 16120 | Building Wire and Cable                             |
| 16130 | Boxes   |
| 16135 | Cable Management System                             |
| 16140 | Wiring Devices                                      |
| 16190 | Supporting Devices                                  |
| 16400 | Circuit and Motor Disconnects                       |
| 16420 | Secondary Service and Distribution                  |
| 16450 | Grounding   |
| 16460 | Dry Type Transformers                               |
| 16470 | Panelboards   |
| 16475 | Overcurrent Protective                              |
| 16496 | Enclosed Transfer Switch                            |
| 16500 | Lighting  |
| 16580 | Stage and House Lighting Dimming and Control System |
| 16581 | Stage Lighting Distribution Devices                 |
| 16582 | Stage Lighting Fixtures and Accessories             |
| 16620 | Package Engine Generator Systems                    |
| 16720 | Fire Alarm  |
| 16741 | Data, Voice, Video and Cable Pathways               |
| 16995 | Electrical Systems Commissioning                    |

1.2 DEFINITION OF TERMS

- A. The Commissioning Plan is a detailed document prepared by the CC that defines the entire commissioning process. The Commissioning Plan includes the following:
1. Project overview.
  2. Commissioning consultant scope of work.
  3. Roles and responsibilities of all commissioning participants.
  4. A schedule and/or sequential description of all commissioning activities.
  5. A complete list and description of all equipment and systems to be commissioned.
  6. Pre-functional testing checklists.
  7. Equipment manufacturer's startup procedures and checklists.
  8. Installation verification data forms for systems and equipment to be commissioned.

9. Functional performance test criteria, draft test forms and data forms for systems and equipment designated to be functionally tested including trending needed for the performance period..
  10. A sample copy of the commissioning issues list.
- B. Pre-Functional Test Checklists: These checklists are provided by the CC and include equipment installation and start-up items to be performed by the Contractor. These checklists shall be completed by the Contractor and returned to the CC prior to the functional performance testing process. Draft versions of these checklists are included in Appendix "A" of this section.
- C. Manufacturer's Startup Checklists: These checklists are provided by the equipment manufacturer and include installation and start-up procedures and documentation to be completed by the Contractor prior to the functional testing process. These checklists are submitted by the contractor to the CC for review and approval one month prior to start-up. The approved checklists shall be completed by the Contractor and returned to the CC prior to the functional performance testing process.
- D. Installation Verification Process: This process includes the on-site review of related system components for conformance to the bid Project Documents. The CC will conduct this review and verify system readiness for functional testing procedures prior to the start of functional testing. The CC will document issues identified during this process and assign them to the appropriate party for resolution.
- E. Functional Performance Testing Process: This process includes the documented testing of system parameters, under actual or simulated operating conditions. Final performance testing of systems will begin only after the Contractor certifies that systems are 100% complete and ready for functional testing, by providing completed and signed-off copies of the Pre-Functional Test Checklists and CC has completed the subsequent Installation Verification process for the systems to be tested. Contractors will be required to schedule, coordinate and participate in functional performance test procedures as defined by the CC and presented in the Commissioning Plan. The CC will participate in all functional tests and document issues discovered through the functional testing process for resolution by the appropriate party. An outline of the functional test methods to be used in the Commissioning Plan and related Contractor responsibilities are included in Appendix "B" of this section.
- F. Commissioning Issues List: This list, generated and maintained by the CC, includes the description of all concerns discovered as a result of the commissioning process. The list also includes the current status of issues, assignment to the responsible party and the date of final resolution as confirmed by the CC. Items listed may include issues where design, products, execution or performance does not appear to satisfy the Project Documents and/or the design intent. The resolution of issues identified on this list may or may not be the responsibility of the Contractor.
- G. Back-Checking: Back-checking is the process of verifying commissioning related issues have been resolved according to the responsible party. The back-checking process takes place once the commissioning issues list has been returned by the Contractor with signatures indicating that all commissioning issues assigned to the Contractor have been resolved.

- H. Performance Period: The performance period is a set length of time designated to demonstrate proper facility operation prior to acceptance. The performance period commences after successful completion of all functional testing. Parameters evaluated typically include zone temperature stability, optimum start/stop, warm-up period and other related functions. As part of this process the contractor will be required to set up and provide trends of control system parameters per the direction of the CC. The specific trending needed will be outlined in the commissioning plan.
- I. Off-Season Testing: This testing is completed during seasonal temperature conditions opposite of those when initial functional testing took place. The tests are a limited sub-set of the original tests and are designed to evaluate capacity and interrelationships of systems. The level of off-season testing is dependent on the seasonal conditions encountered during testing, the CCs scope of work and other factors. Contractors will be required to participate in this process as needed to complete the tests.
- J. Final Commissioning Report: This report includes the overall final commissioning document, prepared by the Commissioning Consultant, which details the actual commissioning procedures performed, inspection and testing results. The report will also include the final version of the Commissioning Issues List, indicating that all issues discovered through the commissioning process have been verified as resolved or otherwise accounted for to the satisfaction of the owner.
- K. Project Documents: These documents include all specifications, drawings, addenda as provided by the design team for the purposes of bidding the project.
- L. Initial Commissioning Coordination Meeting: This meeting is intended to present the Commissioning Plan to the Contractor and is typically scheduled to occur after bid award and prior to installation of commissioned systems.

### 1.3 CONSTRUCTION PHASE COMMISSIONING PROCESS OVERVIEW

- A. Upon request, the Contractor is responsible for providing the CC with copies of all approved submittals, manufacturer's installation/start-up documents and proposed testing formats. The CC will review and approve this material for commissioning related activities.
- B. As soon as possible after the bid award and approval of all mechanical and electrical submittals, the Commissioning Consultant will conduct a pre-installation commissioning coordination meeting with the Contractors, Owner's Representative and the Design Team. The CC will explain the commissioning process in detail, and identify specific commissioning related responsibilities. The commissioning plan provided at this time will include the final versions of the pre-functional checklists along with installation verification checklists and draft functional performance test procedures.
- C. Commissioning status meetings shall be scheduled to occur during the construction and closeout phase to monitor progress and to help facilitate the commissioning process. Contractor representatives for commissioned systems shall be required to attend these meetings.
- D. The CC shall perform periodic site visits during construction and identify potential issues in a site report. The contractor shall review these site reports and make corrections during construction to resolve issues as needed and deemed appropriate in consultation with the owner, CC and design team.

- E. The CC may want to witness equipment start up and testing performed during construction. The tests needing witnessing will be identified in the pre-functional testing forms as part of the Commissioning Plan. The contractor shall notify the CC in writing at least 3 days in advance of these testing dates so that the CC can attend. If the CC is not notified in advance of a scheduled start-up or testing activity, the start-up or testing shall be rescheduled and repeated to the satisfaction of the CC.
- F. Once the Contractor has provided the CC with written verification (Pre-Functional Test Checklists, outlined in Appendix A, Manufacturer's Startup Documentation and preliminary test and balance report) indicating completion of installation and startup procedures, the Commissioning Consultant will conduct an on-site system readiness review of the specific systems and equipment using the Installation Verification Checklists. Issues noted during this process will be documented by the CC in the Commissioning Issues List.
- G. Upon confirmation of system readiness, the CC will schedule with the Contractor to perform functional performance tests, as appropriate, to verify functional compliance with the Project Documents. Functional testing will not commence until all issues identified during the Installation Verification Process are resolved. The Commissioning Consultant will oversee the Functional Performance Testing Process and will provide or approve the format and documentation for these tests as outlined in Appendix B.
- H. Issues noted during these tests will be documented by the CC. When easily corrected, issues will be resolved at the time of discovery. The appropriate Contractor will resolve all other issues at a later time. Issues will be tracked by issue number, responsible Contractor, status and activity date. The Contractor shall be responsible for reporting, in writing, to the CC when issues have been resolved so that the CC can verify the resolution.
- I. The construction phase commissioning process will be complete when all noted issues have been corrected, proved to be in compliance with the Project Documents or otherwise resolved to the satisfaction of the owner.

#### 1.4 POST CONSTRUCTION PHASE COMMISSIONING PROCESS OVERVIEW

- A. Post construction contractor responsibilities include completion and submission of the Project Closeout Checklist, outlined in Appendix C, to the CC for verification of completing contracted obligations for the owner.
- B. Training on related systems and equipment operation and maintenance shall only be scheduled to commence after commissioning is satisfactorily completed, O&M manuals have been delivered, and systems are verified to be 100% complete and functional. Each Contractor is responsible to provide a topical outline of all subjects to be covered in the training session(s), the expected length of time for the training sessions, and a brief resume listing the qualifications of the proposed training presenters. The CC will review and approve the proposed training outline and verify training is in compliance with the Project Documents.
- C. Upon request, the Contractor is responsible for providing the CC with copies of all balancing reports, as-built drawings and O&M manuals relevant to the systems commissioned. The CC will review this material for compliance with Project Documents and will note and report all issues for resolution by the responsible party.

- D. When seasonal testing is required by the Project Documents, testing will be conducted by the CC in the opposite season from original commissioning. The Contractor is responsible to support seasonal testing and resolve contractor related issues discovered.
- E. Upon completion of all commissioning activities the CC will prepare and submit to the owner the Final Commissioning Report detailing the commissioning plan and all commissioning activities.

#### 1.5 DUTIES AND RESPONSIBILITIES OF OTHERS FOR COMMISSIONING

- A. The commissioning process may require the active participation of persons qualified to represent the following interests: Owner, Project Manager, Architect, Mechanical Engineer, Electrical Engineer, General Contractor, Equipment Manufacturer's Representatives, Mechanical Contractor, HVAC Contractor, Controls Contractor, TAB Contractor, Electrical Contractor, and other specific Sub-Contractors, as deemed appropriate.
- B. The General Contractor will support the commissioning process by integrating it into the construction process and schedule.
- C. The General Contractor will assure the participation and co-operation of Sub Contractors under their jurisdiction, as required to complete the commissioning process.

#### 1.6 LIMITS TO BACK-CHECKING

- A. The CC will conduct initial observations and tests, and document all potential deficiencies on the Commissioning Issues List. Upon receipt of the signed-off issues list, the CC will back-check these issues on a one-time-per-issue basis to verify they have been corrected by the Contractor. In the event that an issue previously signed-off by the Contractor as corrected fails to meet the criteria as set forth in the Commissioning Plan and Project Documents, the Contractor shall reimburse the Owner for all costs associated with any additional efforts required to re-test or otherwise verify satisfactory resolution of the issue. These costs shall include salary, travel costs and per diem lodging costs (where applicable) for the Commissioning Consultant. Rates to be used:

|                             |              |
|-----------------------------|--------------|
| Mileage:                    | .345 \$/Mile |
| Per Diem Meals and Lodging: | \$200.00/Day |
| Salary:                     | \$95.00/Hour |

### **PART 2 – PRODUCTS**

#### 2.1 PRE-FUNCTIONAL TEST CHECKLIST FORMS

- A. The Contractor shall be responsible for maintaining and completing copies of the Pre-Functional Test Checklist forms as provided by the CC. Attachment "A" at the end of this section contains draft versions of the Pre-Functional Test Checklists. Final checklists based on actual submittal data and equipment lists will be provided with the Commissioning Plan prior to commencement of commissioning activities. Checklist forms and supporting documents shall be signed by the Contractor and returned to the CC upon completion of all listed items.
- B. The checklist forms as provided at the end of this section are not intended to list every requirement of the Project Documents. Completion of these checklist items shall in no way

release the Contractor from their responsibility to complete other specified requirements of the Project Documents.

## 2.2 EQUIPMENT MANUFACTURER'S STARTUP FORMS

- A. Any installation and start-up check lists that are provided by the manufacturer shall be submitted to the CC for review and approval one month prior to system startup. The contractor shall notify the CC prior to any system start-up as outlined in the Pre-Functional Test Checklists so that the CC can witness selected start-up activities. The approved startup documentation shall be completed by the responsible Contractor during startup shall be completed by the responsible Contractor and a copy of the completed document shall be given to the CC for review and inclusion within the Final Commissioning Report.

## 2.3 CONTRACTOR PROVIDED FUNCTIONAL TEST FORMS

- A. The contractor has specific responsibilities for developing, performing and documenting functional test procedures as directed by the CC. See Appendix "B" for minimum testing and documentation requirements.
- B. In addition to the testing outlined in Appendix "B", wherever the Project Documents require testing, test reports, checklists, verifying operation, demonstrating proper operation or other similar language, written testing procedures and documentation of tests will be required.
- C. The contractor shall submit all proposed test documents to the CC for approval prior to conducting tests. The CC will advise and assist the contractor with test form development if requested.

## 2.4 TRAINING AGENDA AND SCHEDULE

- A. The individual contractors responsible for training under their respective sections shall provide a training agenda to the CC for approval prior to conducting training. The training agenda shall contain the instructors qualifications, topical outline, schedules, instruction durations, sign-in sheets and any forms as required by the contract documents.

# **PART 3 – EXECUTION**

## 3.1 DOCUMENTATION

- A. All checklists, start-up documentation, test forms and other commissioning related documentation required by contract shall be neatly completed and provided to the CC in a clear and easily readable condition.
- B. All required checklists, start-up documentation, test forms and other commissioning related documentation shall be provided to the CC in a timely fashion and according to the commissioning and construction schedule.
- C. If the project is phased, Contractor shall submit documentation as each phase is completed.
- D. In every case where the Contractor is unable to comply with an item as listed on the checklist or form, the Contractor shall immediately notify the CC in writing as to the reasons for non-compliance.

### 3.2 INSTALLATION VERIFICATION

- A. After all Pre-Functional Test Checklists and start-up documents are received from the Contractor, the CC will conduct installation verifications on selected systems using forms and checklists developed by the CC. Discrepancies discovered will be reported on the Commissioning Issues List.

### 3.3 FUNCTIONAL PERFORMANCE TESTS

- A. Functional performance testing of commissioned systems shall begin after all critical issues discovered during the installation verification process have been corrected. The CC and/or Contractor shall conduct functional performance tests on selected systems to verify functional performance criteria as outlined in Appendix "B" and as required in the Project Documents. Discrepancies discovered will be reported on the Commissioning Issues List.
- B. In addition to participating in functional tests developed by the CC, the Contractor shall also be required to complete all other start-up and testing procedures as specified elsewhere in the Project Documents, including Appendix "B".

### 3.4 ISSUE CORRECTION

- A. Once issues have been identified and assigned to a Contractor on the Commissioning Issues List, the Contractor shall be required to investigate and resolve these issues in a timely manner. After correcting issues noted on the Commissioning Issues List, the Contractor shall sign off on each issue and return the list to the CC.

### 3.5 PERFORMANCE PERIOD

- A. The CC shall prepare a performance period test plan including measured variables and success criteria based on performance characteristics described in the Project Documents. The CC will provide the control contractor with a list of trend log definitions based on the performance period test plan included in the Commissioning Plan.
- B. The Contractor will review the performance period test plan and set up the trend log definitions from the CC. The trending shall be provided by the contractor in both a text and graphic format with related system parameters grouped together for easy comparison. If DDC system resident memory is limited or there are other issues with the trending requirements, the Contractor will work with the CC to redefine the test plan.
- C. The performance period will commence within one week of the final functional tests and run for a minimum of 14 days. If failures are encountered, the performance period shall be aborted. After corrections are made, the performance period shall be re-started at day one.

### 3.6 OFF-SEASON TESTING

- A. If during functional performance testing it is determined by the CC that seasonal conditions did not adequately demonstrate building system capacity and interrelationships, then an off-seasonal testing routine shall be scheduled and conducted.

- B. The Contractor shall support off-season testing and make corrections to any Contractor related issues discovered.

3.7 SYSTEM ACCEPTANCE

- A. Equipment and systems shall not be accepted by the Owner, and final payment shall not be made by the Owner, until all commissioning activities are complete and the performance period standards have been met.

**END OF SECTION**

**(PRE-FUNCTIONAL TEST CHECKLIST ATTACHMENTS TO FOLLOW IN APPENDIX A)**

**(FUNCTIONAL TEST AND VERIFICATION OUTLINE TO FOLLOW IN APPENDIX B)**

**Contractor Pre-Functional Test Check Lists**

Contractor Pre-Functional Test Check Lists are included in this appendix. The Contractor responsible for delivery of each of these systems will shall be responsible for completion of the Contractor Pre-Functional Test Check Lists . The checklists included within this appendix are draft versions and are only representative of what will be included in the final Commissioning Plan. The Contractor is responsible to demonstrate the proper operation of all installed systems and the final Pre-Functional Test Check Lists may contain additional requirements to document these demonstrations. In no case will the checklists require performance criteria more stringent than specified by the Project Documents.

**Summary Listing of Checklists and CC Witnessing Requirements**

The following summary listing identifies the Pre-Functional Checklists that are included within this appendix. Systems or equipment identified with an “X” in the “W” column require witnessing or participation by the Commissioning Consultant during a Contractor performed activity. It is the Contractor’s responsibility to notify the Commissioning Consultant in advance of the scheduled activity, testing or startup date. A minimum of 3 working days advance notification is required. If the CC is not notified in advance of a scheduled start-up or testing activity, the start-up or testing shall be rescheduled and repeated to the satisfaction of the CC.

The following table will be completed during the Initial Commissioning Coordination Meeting by assigning an individual Contractor responsible for the activities associated with each Pre-Functional Test Checklist.

Division 02

| Description | W | Contractor |
|-------------|---|------------|
| Irrigation  | X |            |

Division 11

| Description            | W | Contractor |
|------------------------|---|------------|
| Theatrical Rigging     |   |            |
| Audio System           |   |            |
| Food Service Equipment |   |            |
| Fume Hoods             |   |            |

Division 15

| Description                       | W | Contractor |
|-----------------------------------|---|------------|
| Fire Protection Sprinkler Systems | X |            |
| Natural Gas System                |   |            |
| Hydronic Piping and Appurtenances | X |            |
| HVAC Pumps                        |   |            |
| Boilers                           | X |            |
| Unit Heaters – Hydronic           |   |            |
| Unit Heaters – Gas Fired          |   |            |
| Air Cooled Chiller                | X |            |
| Package Air Conditioning Units    |   |            |
| Air Handling Units                |   |            |
| Fan Coil Units                    |   |            |

|   |   |  |
|---|---|--|
| Fan Powered Terminal Units              |   |  |
| Terminal Units                          |   |  |
| Exhaust Fans                            |   |  |
| Ductwork and Smoke/Fire Control Dampers | X |  |
| Testing, Adjusting and Balancing        |   |  |
| Variable Speed Drive Systems            | X |  |
| Building Control System                 |   |  |

Division 16

| <b>Description</b>                      | <b>W</b> | <b>Contractor</b> |
|---|----------|-------------------|
| Electrical Distribution                 |          |                   |
| Fire Alarm and Detection Systems        |          |                   |
| Stage and House Lighting Control System |          |                   |
| Engine Generator and Controls           |          |                   |

**Irrigation**  
**Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

1. Notify Commissioning Consultant of cleaning, flushing and pressure testing.

**Pre-Functional Test Check List:**

- ? Layout has been approved by Architect.
- ? Piping installed with slope to drain.
- ? Automatic drains are installed at all low points.
- ? Unions installed on all equipment requiring disconnects for servicing.
- ? Dielectric unions installed on all dissimilar metallic materials.
- ? Strainers installed at all specified locations.
- ? Strainers cleaned.
- ? Valves provided and installed per specification in regards to connection style and size.
- ? Valves installed for area and group isolation, maintenance isolation and service disconnects.
- ? Systems have been cleaned and flushed per project documents.
- ? Systems have been pressure tested per project documents.
- ? Existing utilities have been located and identified per project documents.
- ? System has been tested for proper coverage.
- ? Spare and additional wiring has been installed per project documents.
- ? Rain shut-off devices and controls have been installed and tested.
- ? Manufacturer's installation procedures were followed.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged heads, pipe and accessories have been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Theatrical Rigging  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None

**Pre-Functional Test Check List:**

- ? Counterweights have been installed and verified operational.
- ? All hardware and rigging has been installed plumb, parallel and runs freely without unnecessary friction..
- ? All equipment has been checked for correct, smooth and safe operation.
- ? Manufacturer's installation procedures were followed
- ? Damaged equipment has been repaired or replaced.
- ? Equipment and systems have been labeled per project documents.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Audio Systems  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the Contractor shall be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Acceptance test plan has been submitted and approved by CC.
- ? All audio related conductors have been installed and tested prior to audio equipment installation.
- ? All specified audio equipment is installed.
- ? Manufacturer's required maintenance clearance provided.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Work area cleaned and construction materials removed.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Food Service Equipment  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the Contractor shall be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Identification labels installed on all switches furnished with fabricated equipment.
- ? Equipment equipped with utility disconnects for equipment removal without disassembly.
- ? Equipment connected to all utilities with shutoff.
- ? Equipment operates without objectionable sound or vibration.
- ? Refrigeration systems cleaned, dehydrated, vacuum tested and properly charged.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Work area cleaned and construction materials removed.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Fume Hoods  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Inspection and access doors are operable.
- ? Ductwork is complete including back draft dampers.
- ? The exterior and interior of the system has been cleaned of dust, dirt, labels and marks.
- ? Unit has been lubricated.
- ? Belts have been properly adjusted.
- ? Motor rotation has been verified.
- ? Air flow direction is confirmed.
- ? Electrical, gas, water and waste connects are complete and tested.
- ? Fire extinguisher system is charged.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Plumbing Systems  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

Cleaning, flushing and pressure testing.

**Pre-Functional Check List:**

- ? Unions installed on all equipment requiring disconnects for servicing.
- ? Dielectric unions installed on all dissimilar materials.
- ? Pressure and temperature gages installed at all specified points, gage range as specified.
- ? Mechanical supporting devices installed at specified locations and spacing.
- ? Valves provided and installed per specification in regards to connection style and size.
- ? Valves installed for area and group isolation, maintenance isolation and service disconnects.
- ? Domestic water piping is complete, flushed, and pressure tested.
- ? Insulation is complete.
- ? Piping systems labeled per project documents including direction of flow.
- ? Access panels installed where applicable for all serviceable components.
- ? Double detector check valve is complete, tested and tagged.
- ? Water heaters installed and verified operational.
- ? All fixtures installed and verified operational.
- ? Drain and waste piping complete and pressure tested.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Fire Protection Sprinkler Systems  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the commissioning consultant. Contractor is to notify commissioning consultant at least 3 days prior to the activity for items listed below.

Cleaning, flushing and pressure testing.

**Pre-Commissioning Check List:**

- ? Piping installed with slope to drain.
- ? All dry pipe systems are equipped with auxiliary drains located at all low points and are clearly identified.
- ? Unions installed on all equipment requiring disconnects for servicing.
- ? Dielectric unions installed on all dissimilar materials.
- ? Pressure gages installed at all specified points, gage range as specified.
- ? Mechanical supporting devices installed at specified locations and spacing.
- ? Valves provided and installed per specification in regards to connection style and size.
- ? Valves installed for area and group isolation, maintenance isolation and service disconnects.
- ? Air compressor with associated piping and wiring installed including labeled disconnect.
- ? Piping is complete, flushed, and pressure tested.
- ? Double detector check valve is complete, tested and tagged.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Natural Gas System  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance test phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Main gas train installed including meter, manual shut off valves, vents and concrete pad.
- ? Drip legs installed at all gas fired equipment.
- ? Piping air pressure tested per Project Documents.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Piping identified with labels and arrows indicating flow direction located at intervals and locations required by Project Documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Hydronic Piping and Appurtenances  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

1. Notify Commissioning Consultant of cleaning, flushing and water treatment.

**Pre-Functional Test Check List:**

- ? Piping installed with slope to drain.
- ? Hose end drain valves installed at all low points.
- ? Air vents with valves installed at all high points of the hot water systems.
- ? Unions installed on all equipment requiring disconnects for servicing.
- ? Dielectric unions installed on all dissimilar materials.
- ? Pressure and temperature gages installed at all specified points.
- ? Pressure and temperature gage ranges per specifications.
- ? P/T ports installed at locations specified.
- ? Relief valves installed on all pressure vessels as specified.
- ? Strainers installed at all specified locations including blow-off valve and cap.
- ? Strainers cleaned prior to balancing.
- ? Air separators, expansion tanks and suction diffusers installed.
- ? Mechanical supporting devices installed at specified locations and spacing.
- ? Valves provided and installed per specification in regards to connection style and size.
- ? Valves installed for area and group isolation, maintenance isolation and service disconnects.
- ? Valves installed with stems oriented up.
- ? Hydronic systems have been pressure tested per project documents.
- ? Hydronic systems have been cleaned and flushed per project documents.
- ? Hydronic systems have had initial chemical treatment application.
- ? All specified equipment and piping is insulated.
- ? Removable insulation heads installed for accessing all serviceable equipment elements.
- ? Coil fins have been combed out if necessary.
- ? All valves tagged with number and function, valve index posted.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.

- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Piping identified with labels and arrows indicating flow direction located at intervals and locations required by Project Documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**HVAC Pumps  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance test phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Pumps installed, leveled, grouted and plumbed.
- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Pumps have been lubricated.
- ? Pumps have been aligned.
- ? Unit disconnects within sight of unit, power available to unit.
- ? Motor rotation has been verified.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Boilers  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance test phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

1. Notify Commissioning Consultant of boiler start-up.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Inspection and access doors are operable.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Boiler assembly has been flushed and hydrostatically tested per project documents.
- ? Remote boiler shut-down switch has been installed and tested.
- ? Combustion dampers and actuators installed and verified operational.
- ? Unit disconnect within sight of unit, power available to unit.
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Air Cooled Chiller  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance test phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

1. Notify Commissioning Consultant of chiller start-up

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Inspection and access doors are operable.
- ? Associated piping, shutoff valves, control valves, thermostats, flow switches and insulation are complete.
- ? Unit disconnects within sight of unit, power available to unit.
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Unit Heaters - Hydronic  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Coil fins have been combed out if necessary.
- ? Unit disconnect within sight of unit, power available to unit.
- ? Motor rotation has been verified.
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Unit Heaters – Gas Fired  
Contractor’s Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Associated piping, shutoff valves and control valves.
- ? Unit disconnect within sight of unit, power available to unit.
- ? Motor rotation has been verified.
- ? Controls installed and verified operational.
- ? Unit has been installed level and louvers have been adjusted per project documents.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Package Air Conditioning Units  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below: None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Inspection and access doors are operable.
- ? Condensate drain with P-trap and cleanout is installed and unobstructed.
- ? Dampers and actuators installed and verified operational.
- ? Temporary filters have been removed and new installed.
- ? Ductwork is complete including access to all serviceable components.
- ? Plenum and casings have been cleaned.
- ? Pipe and conduit penetrations have been caulked.
- ? Unit is level and secured.
- ? Unit has been lubricated.
- ? Belts have been properly adjusted.
- ? Coil fins have been combed out if necessary.
- ? Unit disconnect within sight of unit, power available to unit.
- ? Motor rotation has been verified.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Heating Coils  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the Contractor shall be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Inspection and access doors are operable.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Ductwork is complete including access to all serviceable components.
- ? Plenum and casings have been cleaned.
- ? Pipe and conduit penetrations have been caulked.
- ? Unit is level and secured.
- ? Coil fins have been combed out if necessary.
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Finned Tube Radiators  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the Contractor shall be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Pipe and conduit penetrations have been caulked.
- ? Unit is level and secured.
- ? Fins have been combed out if necessary.
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Fan Coil Units – Hydronic  
Contractor’s Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the Contractor shall be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below: None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Inspection and access doors are operable.
- ? Condensate drain with P-trap and cleanout is installed and unobstructed.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Dampers and actuators installed and verified operational.
- ? Temporary filters have been removed and new installed.
- ? Ductwork is complete including access to all serviceable components.
- ? Plenum and casings have been cleaned.
- ? Pipe and conduit penetrations have been caulked.
- ? Unit is level and secured.
- ? Unit has been lubricated.
- ? Belts have been properly adjusted.
- ? Coil fins have been combed out if necessary.
- ? Unit disconnect within sight of unit, power available to unit.
- ? Motor rotation has been verified.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Lake Oswego School District  
Lake Oswego High School  
PROJECT NO.

SECTION 01810  
COMMISSIONING

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Fan Coil Units with DX Cooling  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

The following check list applies to FCU and associated condensing unit

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Inspection and access doors are operable.
- ? Condensate drain with P-trap and cleanout is installed and unobstructed.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Dampers and actuators installed and verified operational.
- ? Temporary filters have been removed, new installed, spares provided.
- ? Ductwork is complete including access to all serviceable components.
- ? Plenum and casings have been cleaned.
- ? Unit has been lubricated.
- ? Belts have been properly adjusted.
- ? Coil fins have been combed out if necessary.
- ? Unit disconnect within sight of unit, power available to unit.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Motor rotation has been verified.
- ? All options and accessories installed per Project Documents.
- ? Split system is installed and complete with valves, strainers, filter driers and sight glasses as required.
- ? Refrigeration system has been cleaned, evacuated, charged and tested per Project Documents.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.

- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Air Handling Units – 4-Pipe  
Contractor’s Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the Contractor shall be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below: None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Inspection and access doors are operable.
- ? Condensate drain with P-trap and cleanout is installed and unobstructed.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Dampers and actuators installed and verified operational.
- ? Temporary filters have been removed and new installed.
- ? Ductwork is complete including access to all serviceable components.
- ? Plenum and casings have been cleaned.
- ? Pipe and conduit penetrations have been caulked.
- ? Unit is level and secured.
- ? Unit has been lubricated.
- ? Belts have been properly adjusted.
- ? Coil fins have been combed out if necessary.
- ? Unit disconnect within sight of unit, power available to unit.
- ? Motor rotation has been verified.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

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**Fan Powered Terminal Units  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below: None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float.
- ? Inspection and access doors are operable.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Dampers and actuators installed and verified operational.
- ? Temporary filters have been removed, new installed, spares provided.
- ? Ductwork is complete including access to all serviceable components.
- ? Plenum and casings have been cleaned.
- ? Unit has been lubricated.
- ? Belts have been properly adjusted.
- ? Coil fins have been combed out if necessary.
- ? Unit disconnect within sight of unit, power available to unit.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Motor rotation has been verified.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Terminal Units  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Inspection and access doors are operable.
- ? Associated piping, shutoff valves, control valves and insulation are complete.
- ? Dampers and actuators installed and verified operational.
- ? Ductwork is complete including access to all serviceable components.
- ? Plenum and casings have been cleaned.
- ? Coil fins have been combed out if necessary.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Exhaust Fans  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Inspection and access doors are operable.
- ? Ductwork is complete including back draft dampers.
- ? Curb mounted fans are bolted to the curb and sealed per project documents.
- ? Plenum and casings have been cleaned.
- ? Unit has been lubricated.
- ? Belts have been properly adjusted.
- ? Unit disconnect within sight of unit, power available to unit.
- ? Motor rotation has been verified.
- ? Air flow direction is confirmed.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

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**Kitchen Hood System  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below: None.

**Pre-Functional Test Check List:**

- ? Manufacturer's required maintenance clearance provided.
- ? Inspection and access doors are operable.
- ? Ductwork is complete including back draft dampers.
- ? Cleanouts are provide per project documents.
- ? Grease receivers and covers are provided per project documents.
- ? The exterior and interior of the system has been cleaned of dust, dirt, labels and marks.
- ? Unit has been lubricated.
- ? Belts have been properly adjusted.
- ? Motor rotation has been verified.
- ? Air flow direction is confirmed.
- ? Electrical, gas, water and waste connects are complete and tested.
- ? Fire extinguisher system is charged.
- ? All motors meet or exceed the specified Minimum Nominal Full-Load Efficiency
- ? Controls installed and verified operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

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Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Ductwork and Smoke Control Dampers  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance test phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

1. Duct pressure testing.

**Pre-Functional Test Check List:**

- ? Commissioning Consultant provided with testing plan and forms for duct pressure testing.
- ? Fire/smoke damper shafts marked with blade position prior to installation.
- ? Access doors installed in ductwork for all coils, fire/smoke dampers and motorized dampers and equipment as specified.
- ? Fire/smoke damper operation (open/close) verified. Fire/smoke dampers powered open.
- ? Fire/smoke damper doors labeled and motors accessible for service (replacement).
- ? All ductwork has been thoroughly cleaned of debris, dust, marks, tags and labels removed.
- ? All ductwork is sealed as specified.
- ? Ductwork has been pressure tested per Project Documents.
- ? All ductwork has been sealed and tested for leaks prior to insulating.
- ? All specified equipment and ductwork is insulated.
- ? Removable insulation heads installed for accessing all serviceable equipment elements.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Testing, Adjusting and Balancing  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance test phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

1. The TAB contractor will demonstrate compliance with design by measuring and demonstrating 10% of the system as selected and witnessed by the commissioning agent.

**Pre-Functional Check List:**

- ? Balancing agenda provided to engineer, provide copy to CC also.
- ? All equipment has been checked prior to balancing.
- ? Fan belt tension and fan rotation verified prior to balancing.
- ? Duct pressure testing complete prior to balancing.
- ? Construction filters removed, filters clean, damper position and operation checked prior to balancing.
- ? Hydronic system has been cleaned and treated prior to balancing.
- ? Automatic fill valves set for required pressure.
- ? Expansion tanks are properly pressurized and not water logged.
- ? Air vents installed and operational.
- ? Equipment settings and control positions marked for final balancing positions.
- ? Preliminary report has been provide, attach copy
- ? All defects and deficiencies have been noted in report.
- ? All TAB procedures are complete and ready for the system balance demonstration. The TAB contractor will demonstrate proper balance by measuring and verifying 10% of the systems as selected and witnessed by the Commissioning Consultant.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Variable Speed Drive Systems  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance test phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

1. Notify Commissioning Consultant of VSD Startup

**Pre-Functional Test Check List:**

- ? VSD start-up and test forms have been submitted and approved by CC.
- ? Controlled parameter sensor (air or water) installed and configured through control system.
- ? Control interface connected and tested.
- ? Proper ventilation has been provided to over temperature nuisance trips.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? Damaged Casing and insulation has been repaired or replaced.
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Electrical Distribution  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to commencement of the installation verification and functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**Start-Up/Tests Requiring Commissioning Consultant Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Consultant. Contractor is to notify Commissioning Consultant at least 5 days prior to the activity for items listed below:

None.

**Pre-Functional Test Check List:**

- ? Concrete housekeeping pads installed under all freestanding equipment and transformers.
- ? Transformers installed with flexible connections and seismic restraints.
- ? All panel boards are installed, plumb and complete including any filler plates.
- ? All wiring devices are installed, adjusted for flush and plumb and wall plates installed after final finishes.
- ? All operating mechanisms adjusted, tightened and operational.
- ? Circuit breakers trip and time delay adjusted and set to specified values.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Panelboards, switchboards and controls labeled with permanent labels.
- ? All panelboards and distribution systems provided with typed indexes indicating branch services and loads served.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Fire Alarm and Detection Systems  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Authority prior to commencement of the functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Authority.

**Start-Up/Tests Requiring Commissioning Authority Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Authority. Contractor is to notify Commissioning Authority at least 5 days prior to the activity for items listed below:

1. Complete system testing and documentation prior to acceptance testing by the AHJ is required. The commissioning authority will witness this testing performed by the contractor. The contractor must submit proposed test forms for approval by the commissioning agent prior to testing.

**Pre-Commissioning Check List:**

- ? Proposed test documentation has been submitted to the commissioning agent for approval.
- ? Pre-installation meeting is complete, report submitted to Architect, attach copy of report.
- ? All system wiring is complete, input/output devices installed and system programmed.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? All system components labeled per contract documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

Contractor responsible for work within this section or General Contractor shall sign below and return form to the Commissioning Authority as an indication that all the above criteria have been completed per the contract specifications.

**Please note:** This checklist is not intended to represent all the requirements of the specifications within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

**Stage and House Lighting Control  
Contractor's Pre-Functional Test Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Authority prior to commencement of the functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Authority.

**Start-Up/Tests Requiring Commissioning Authority Witness:**

The following start-up or testing activities are to be witnessed by the Commissioning Authority. Contractor is to notify Commissioning Authority at least 5 days prior to the activity for items listed below:

None. Contractor is to provide sample test forms to be used during testing.

**Pre-Commissioning Check List:**

- ? Acceptance test plan has been submitted and approved by CC including point-to-point verification.
- ? System programming sheets have been submitted and approved by Design Team, Owner and CC.
- ? All lighting system wiring, dimmer packs, control panels, cabinets, fixtures and related equipment is installed and complete.
- ? All system programming is complete.
- ? Control wiring, panels and all system components are permanently labeled, including point address designation, system reference and descriptions.
- ? All sensors have been calibrated including temperature, pressure, flow and metering devices.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment and systems are labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

Contractor responsible for work within this section or General Contractor shall sign below and return form to the Commissioning Consultant as an indication that all the above criteria have been completed per the contract specifications.

**Please note:** This checklist is not intended to represent all the requirements of the specifications within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_

### Engine Generator and Controls Contractor's Pre-Functional Test Checklist

#### Instructions:

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Authority prior to commencement of the functional performance testing phase of the commissioning process. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Authority.

#### Start-Up/Tests Requiring Commissioning Authority Witness:

The following start-up or testing activities are to be witnessed by the Commissioning Authority. Contractor is to notify Commissioning Authority at least 5 days prior to the activity for items listed below:

1. Functional testing with load bank
2. Operational testing under simulated power failure

#### Pre-Commissioning Check List:

- ? A copy of the proposed testing forms for Pre-operation, Pre-functional, Functional and Operation tests has been submitted to, and approved by, the commissioning authority.
- ? The system installer is factory trained and authorized per the specifications. Attach copy of certification.
- ? Manufacturer's required maintenance clearance provided.
- ? Vibration isolation devices installed, adjusted and free to float, shipping blocks removed.
- ? Associated piping and appurtenances are installed and complete.
- ? Associated power and control connections are complete.
- ? System fluids and lubrication have been checked.
- ? Controls and remote annunciator installed and verified operational.
- ? Battery charger and heater installed and operational.
- ? Voltage output and engine speed are adjusted.
- ? Engine heater installed and operational.
- ? Manufacturer's installation and start-up procedures were followed. Attach completed and signed copy of any manufacturer's checklists.
- ? Damaged factory finishes have been replaced, repaired or touched up.
- ? Equipment has been labeled per project documents.
- ? Equipment not painted at factory has been painted with a finish coat of paint (no primer).
- ? All known issues have been corrected or reported to the Commissioning Consultant and the systems are ready for the functional performance test phase of commissioning.

Contractor responsible for work within this section or General Contractor shall sign below and return form to the Commissioning Consultant as an indication that all the above criteria have been completed per the contract specifications.

**Please note:** This checklist is not intended to represent all the requirements of the specifications within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

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### **Functional Performance Tests**

- 1 The draft versions of the Functional Performance Test and Verification Outline sheets contained in this appendix define the individual systems to be tested and Contractor responsibilities based on the specific method of commissioning. These draft Functional Performance Test and Verification Outline sheets represent information available at the time of commissioning specification development. The final versions may be somewhat different and will be included within the Commissioning Plan as presented at the initial commissioning coordination meeting.
- 2 The methods of functional performance test and verification are listed in Table 1 of this appendix. The Contractor will be responsible for supporting the testing activity as indicated. This may include developing the test plan and functional performance test forms for approval by the Commissioning Consultant, performing testing to be witnessed by the CC or providing support during functional performance testing conducted by the CC or their sub-consultants.
- 3 Contract documents state that the Contractor is responsible to demonstrate that all systems comply with contract requirements and meet the project design intent. The scope of testing outlined in the following Functional Performance Test and Verification Outline sheets in this appendix represent the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. If systems fail the initial tests additional testing may be required.

**Table 1 – Functional Test and Verification Methods**

**Test Method A – Contractor Written and Conducted, CC Approved and Witnessed**

The test plan and test data sheets are developed by the contractor responsible for the system and submitted to the CC for approval. These can be the system manufacturer's stock test forms if appropriate. CC will assist contractor in development of test forms if requested to do so. After the CC has approved the test plan and data sheets, the contractor will conduct the tests per the plan, document results and submit completed test forms to the CC. The CC will witness all or portions of the tests during contractor testing. In the event the CC is not available for witness, Method B may be used.

**Test Method B – Contractor Written and Conducted, CC Approved and Spot Check**

Same as Method A, except CC will spot check results instead of witness. Once the completed test forms are received, the CC will perform functional tests on a percentage of the systems using the same test plan and data sheets. If inconsistencies are found to exceed the stated failure rate, the contractor will be asked to correct the problems and re-conduct the entire functional test and verification.

**Test Method C – Contractor Written, Conducted and Demonstrated, CC Approved and Witness Demonstration**

Same as Method A, except the CC will not witness during initial contractor testing. The contractor will complete and document 100% of the required testing. Once the test report is received, the contractor will be required to duplicate some of the testing by demonstrating a percentage of the system as selected and witnessed by the CC. If inconsistencies are found to exceed the stated failure rate, the contractor will be asked to correct the problems and re-conduct the entire functional test and verification.

**Test Method D – CC Written and Conducted, Contractor Supports**

The test plan and test data sheets are developed by the CC. After the CC has received the pre-functional checklists and other start-up documentation, the CC will conduct the tests per the plan, document results and notify contractor of any issues found. The contractor will support the CC during testing, including but not limited to: scheduling, sequencing and adequate time for CC testing, on-site support during testing, testing instruments and equipment, setting up trend logs, providing access to equipment, providing access to control systems both on-site and via remote dial-up.

**Test Method E – CC Written, Contractor Conducts, CC Witness**

The test plan and test data sheets are developed by the CC. The CC will turn over the test plan and test data sheets to the contractor. After the CC has received the pre-functional checklists and start-up documentation, the contractor will conduct the tests on all or a sample portion of the systems as directed and witnessed by the CC.

**Test Method F – CC Written, Contractor Conducts, CC Re-conducts**

The test plan and test data sheets are developed by the CC. The CC will turn over the test plan and test data sheets to the contractor. The contractor will conduct the tests on all or a sample portion of the systems as directed by the CC. After the CC has received the pre-functional checklists, start-up documentation and the contractor's completed test forms, the CC will conduct all the tests per the plan, document results and notify contractor of any issues found. The contractor will support the CC during testing, including but not limited to: scheduling and sequencing and adequate time for CC testing, on-site support during testing, testing instruments and equipment, setting up trend logs, providing access to equipment, providing access to control systems both on-site and via remote dial-up.

**Irrigation Systems**  
**Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** E – CC Written, Contractor Conducts, CC Witness

**Functional Tests:**

- 1) Operation
- 2) Zone programming
- 3) Coverage
- 4) Volume delivery

**Theatrical Rigging  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** E – CC Written, Contractor Conducts, CC Witness

**Functional Tests:**

- 1) Curtains and draperies
  - a) Operation
  
- 2) Rigging
  - a) Manual counterweight rigging operation with simulated weight
  - b) Motorized counterweight assist rigging operation with simulated weight
  
- 3) Projection screen
  - a) Operation

**Audio System  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** A – Contractor Written and Conducted, CC Approved and Witnessed

**Functional Tests:**

- 1) System Signal Flow
- 2) Oscilloscope Channel Tests
  - a) Polarity
  - b) Distortion
  - c) Parasitic oscillation
- 3) Loudspeaker
  - a) Polarity
  - b) Impedance
  - c) Balance
  - d) Level control
- 4) Microphones
  - a) Polarity
- 5) Remote Control
- 6) Pink noise and FFT analysis support (test provided by others)
- 7) Energy Time Curves
- 8) Reflections during “SMARRT” analysis
- 9) Equalization

**Test Method:** C – Contractor Written, Conducted and Demonstrated, CC Approved and Witness Demonstration

**Functional Tests:**

- 1) Complete System Operation

**Food Service Equipment  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

All Food Service Equipment must be tested by a factory authorized representative. The name and qualifications of the start-up representative will be requested with the test submittals.

**Test Method:** A – Contractor Written and Conducted, CC Approved and Witnessed

**Functional Tests:**

- 1) Class 1 grease hood
  - a) Field inspection with report
  - b) Full functional testing and demonstration

The Class 1 Grease Hood tests must be successfully completed prior to the operation of any kitchen equipment.

**Testing Method:** E – CC Written, Contractor Conducts, CC Witness

**Functional Tests:**

- 1) Refrigeration
  - a) All functions
  - b) 72 Hour operation and temperature control
- 2) Equipment Operation
  - a) On/Off
  - b) Safeties
  - c) Control

**Fume Hoods**  
**Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Test Method A – Contractor Written and Conducted, CC Approved and Witnessed**

**Functional Tests:**

- 1) Face velocity
- 2) Entrainment
- 3) Balance
- 4) Smoke bomb
- 5) Alarms

**Test Method E – CC Written, Contractor Conducts, CC Witness**

**Functional Tests:**

- 1) Electrical
  - a) Polarity
  - b) Continuity
- 2) Water
- 3) Waste
- 4) Gas
  - a) Pressure
  - b) Operation

**Domestic Water Systems  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** E – CC Written, Contractor Conducts, CC Witness

**Functional Tests:**

- 1) Distribution
  - a) Pump Operation
  
- 2) Fixture Operation
  - a) Faucets
  - b) Showers
  - c) Toilets
  - d) Drinking Fountains
  - e) Automatic fixtures
  
- 3) Water Heater
  - a) Temperature control
  - b) Relief
  
- 4) Mixing Valves
  - a) Temperature control

**Waste Water Systems  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** E – CC Written, Contractor Conducts, CC Witness

**Functional Tests:**

- 1) Drain verification
  - a) Sinks
  - b) WC and Urinals
  - c) Showers
  - d) Fountains
  - e) Floor drains
  - f) Roof drains
  - g) Catch basins

**Fire Protection Sprinkler Systems  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Test Method:** C – Contractor Written, Conducted and Demonstrated, CC Approved and Witness Demonstration

Note: This testing is to take place prior to demonstration to Authority Having Jurisdiction.

- 1) Wet System
  - a) System trip
  - b) Water gong or alarm
  - c) Alarm reporting
  - d) Tamper reporting
  
- 2) Dry System
  - a) System trip
  - b) Water gong or alarm
  - c) Alarm reporting
  - d) Tamper reporting
  - e) System drain and reset
  - f) Compressor operation
  - g) Low air alarm

**Heating Water Systems  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** A – Contractor Written and Conducted, CC Approved and Witnessed

**Functional Tests:**

- 1) Boilers
  - a) Operation.
  - b) All safeties and alarm reporting.
  - c) Efficiency.
  - d) Temperature control.
  - e) BCS Interface
  
- 2) Pumps
  - a) Pump performance
  - b) Motor operation and parameters
  - c) On/off operation.
  
- 3) Valves
  - a) Valve control
  - b) Valve indication
  - c) Flow

**Chilled Water Systems  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** E – CC Written, Contractor Conducts, CC Witness

**Functional Tests:**

- 1) Chiller
  - a) Operation.
  - b) All safeties and alarm reporting.
  - c) Efficiency.
  - d) Temperature control.
  - e) BCS interface
- 2) Pumps
  - a) Pump performance
  - b) Motor operation and parameters
  - c) On/off operation.
- 3) Valve control
  - a) Valve control
  - b) Valve indication
  - c) Flow

**Kitchen Hood System**  
**Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Test Method E – CC Written, Contractor Conducts, CC Witness**

**Functional Tests:**

- 1) Operational (functions)
- 2) Smoke removal

**Air Distribution Systems  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Preliminary Activities:**

The contractor will be responsible for marking the motorized smoke control damper shaft ends with the damper blade orientation and providing access (ladders, lifts, etc.) to the motorized dampers during testing.

**Testing Method:** A – Contractor Written and Conducted, CC Approved and Witnessed

**Functional Tests:**

Duct Systems

- 1) Leakage

**Test Method E – CC Written, Contractor Conducts, CC Witness**

Fire and Smoke Control

- 1) Smoke and Fire/Smoke Damper Operation

**Balancing Air and Water Systems  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** Test Method C – Contractor Written, Conducted and Demonstrated, CC Approved and Witness Demonstration

**Functional Tests:**

- 1) 10% verification of air and water side balance.
- 2) Building pressurization in various modes of operation.

The testing and air balancing contractor will be required to demonstrate a properly balanced system by measuring and verifying 10% of the previously balanced systems as selected and witnessed by the Commissioning Consultant. The TAB contractor will also demonstrate the proper pressure relationship of the spaces to each other and the outside.

In the event that the testing and balance verification values are off by more than 10% of original testing values, the balancing contractor will be required to readjust the systems to the satisfaction of the owner and design team.

**Electrical Systems  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** A – Contractor Written and Conducted, CC Approved and Witnessed

**Functional Tests:**

- 1) Wire and Cable
  - a) Insulation resistance
  
- 2) Wiring Devices
  - a) Continuity
  - b) Polarity
  - c) Ground
  - d) GFI
  
- 3) Secondary Service and Distribution
  - a) Insulation resistance
  - b) Lug torque
  - c) Key interlocks
  
- 4) Grounding System
  - a) Ground Resistance
  
- 5) Lighting
  - a) Operation

**Engine Generator and Controls  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** A – Contractor Written and Conducted, CC Approved and Witnessed

**Functional Tests:**

- 1) Load Bank
- 2) Trending
  - a) Kilowatts
  - b) Amperes
  - c) Voltage
  - d) Coolant temperature
  - e) Room temperature
  - f) Frequency
  - g) Oil pressure
- 3) Operation during power outage simulation
- 4) Alarms

**Stage and House Lighting Control System  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** A – Contractor Written and Conducted, CC Approved and Witnessed

**Functional Tests:**

- 1) Wiring
  - a) Continuity
  - b) Polarity
  - c) Ground
- 2) Lighting
  - a) Load Operation, Continuity and ID Verification
  - b) Dimmer operation (75% load)

**Fire Alarm System  
Functional Test and Verification Outline**

The testing outlined below represents the minimum expected level of testing to be performed during commissioning. The contractor shall be required to conduct and document any tests as necessary to prove all systems comply with the design intent. Table 1 in Appendix B details the various methods of accomplishing functional testing.

**Testing Method:** A – Contractor Written and Conducted, CC Approved and Witnessed

Note: These tests to take place prior to demonstration to Authority Having Jurisdiction

**Functional Tests:**

- 1) Wiring
  - a) Grounding resistance
  - b) Absence of voltage.
  - c) Short circuits.
  - d) Circuit resistance.
  
- 2) System Tests
  - a) Initiating and indicating open circuit.
  - b) Full testing of all functions, initiating devices and reporting devices.
  - c) Dial up
  - d) Secondary power operation.
  - e) Battery capacity

**Project Closeout**

Contractor Project Closeout Check Lists are included in this appendix. The Contractor responsible for the delivery of each of the listed systems shall be responsible for completion of the Project Closeout Check Lists. The checklists included within this appendix are draft versions and are only representative of what will be included in the final Commissioning Plan. The Contractor is responsible to demonstrate compliance with all closeout requirements and the final Check Lists may contain additional requirements to document this compliance. In no case will the checklists require performance criteria more stringent than specified by the Project Documents.

| <b>Description</b>                 |
|------------------------------------|
| Irrigation                         |
| Theatrical Rigging                 |
| Audio                              |
| Food Service Equipment             |
| Fume Hood                          |
| Fire Protection System             |
| Natural Gas System                 |
| Hydronic Piping and Appurtenances  |
| HVAC Pumps                         |
| Boilers                            |
| Unit Heaters - Hydronic            |
| Unit Heaters – Gas Fired           |
| Air Cooled Chiller                 |
| Air Handling Units                 |
| Fan Coil Units                     |
| Fan Powered Terminal Units         |
| Terminal Units                     |
| Exhaust Fans                       |
| Kitchen Hoods                      |
| Ductwork and Smoke Control Dampers |
| Testing, Adjusting and Balancing   |
| Variable Speed Drive Systems       |
| Building Control System            |
| Electrical Distribution            |
| Fire Alarm and Detection Systems   |
| Stage and house lighting control   |
| Lighting Control                   |
| Engine Generator and Controls      |
| Security System                    |

**Project Closeout  
Contractor's Checklist**

**Instructions:**

Contractor shall complete all specified items as listed on the following checklist and return the signed checklist to the Commissioning Consultant prior to substantial completion. In addition, the contractor may be required to demonstrate compliance with specified criteria on-site, as deemed appropriate by the Commissioning Consultant.

**System:** \_\_\_\_\_

**Project Closeout Checklist:**

- ? Training agenda has been developed and submitted to owner. Attach copy.
- ? Warranties have been submitted to owner.
- ? O&M Manuals are complete and submitted.
- ? All spares have been submitted to owner and receipt of materials signed.
- ? As-built drawings, material list, technical literature, list of recommend spare parts, system description, and sequence of operation have been updated and included in the O&M manuals.
- ? Owner provided with specified chemicals and any service contracts.

**Please note:** This checklist is not intended to represent all the requirements of the Project Documents within this section. Completion of the items on this checklist does not release the contractor from their contractual obligation to complete all the work as detailed within the entire specification section.

Signed: \_\_\_\_\_ Date: \_\_\_\_\_ Company: \_\_\_\_\_