

## OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS

### PART 1 GENERAL

- A. A properly functioning facility assures a comfortable, healthy and productive environment for the user. The Oklahoma State University Architecture Services' "Program Coordinator Representative" will be a member of the building design team. The Program Coordinator Representative will actively participate in the process, including review of all submittals contained herein. The following specification addresses mechanical, plumbing, electrical and building envelope commissioning. Commissioning of other systems will be addressed in a future edition.

#### 1.1 REFERENCES

- A. Associated Air Balance Council (AABC) ACG Commissioning Guideline (2005) Commissioning Guideline.
- B. National Environmental Balancing Bureau (NEBB) NEBB Commissioning Standard (1999) Procedural Standards for Building.
- C. Systems Commissioning Sheet Metal and Air Conditioning Contractors' National Association (SMACNA): SMACNA Commissioning Manual (1994, 1st Ed) HVAC Systems Commissioning Manual.
- D. U.S. Green Building Council (USGBC): LEED (2002; R 2005) Leadership in Energy and Environmental Design Green Building Rating System for New Construction (LEED-NC).

#### 1.2 COMMISSIONING DESCRIPTION & GENERAL REQUIREMENTS

- A. Perform Commissioning in accordance with the requirements of the standard under which the Commissioning Firm's qualifications are approved, i.e., ACG Commissioning Guideline, NEBB Commissioning Standard or SMACNA Commissioning Manual, unless otherwise stated herein. Use the Commissioning Standard or an approved system from a third party Commissioning Agent for all aspects of Commissioning, including qualifications for the Commissioning Firm and Specialist and calibration of Commissioning instruments. Where the instrument manufacturer calibration recommendations are more stringent than those listed in the Commissioning Standard, the manufacturer's recommendations will be adhered to. For systems or system components not covered in the Commissioning Standard, Commissioning procedures will be developed by the Commissioning Specialist. Where new procedures, requirements, etc., applicable to the Work requirements have been published or adopted by the body responsible for the Commissioning Standard used (ACG, NEBB, or The Testing, Adjusting and Balancing Bureau (TABB), the requirements and recommendations contained in these procedures and requirements will be considered mandatory.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- B. Formal LEED certification is not required; however, the Contractor is required to provide documentation that meets the LEED Energy & Atmosphere (EA) Prerequisite 1, Fundamental Commissioning. For New Construction and Major Revisions, provide documentation that meets EA Credit 3; Enhanced Commissioning. Provide documentation for as many LEED credits as possible to support LEED Silver certification of the project.
  
- C. Fundamental Commissioning of the Building Energy System - LEED Energy & Atmosphere (EA) Prerequisite 1:
  - 1. Intent: Required of all buildings to verify and ensure that fundamental building elements and systems are designed, installed and calibrated to operate as intended.
  
  - 2. Requirements:
    - a. Engage a Commissioning Authority: Either third party, a qualified person from the Owner's organization, or designer's firm. If a member of the design's firm is chosen, they must not be directly involved in the design or construction management and must report directly to the Owner.
  
    - b. There are six tasks required to meet the Fundamental Building Systems Commissioning prerequisite. These six tasks are:
      - i. Review design intent and basis of design documentation. This task requires the commissioning authority to document the Owner's requirements for each commissioned system in the building, including all HVAC and controls systems, ductwork and piping, renewable and alternative technologies, lighting controls and daylighting, waste heat recovery and any advanced technologies like thermal storage must be commissioned. Building envelope systems and testing, adjusting and balancing (TAB) will also be verified. The Owner's requirements for these systems may include efficiency targets and other performance criteria, such as temperature and lighting levels that will define the acceptance criteria for the functional performance testing that takes place at the end of construction. The commissioning authority must also document the basis of design for the commissioned systems, including any primary assumptions, applicable codes and standards, occupancy details, climatic assumptions and the key concepts used in the design to meet the Owner's requirements stated in the design intent document. These two documents are primary tasks that are commonly accomplished on a commissioned project.
  
      - ii. Insure that commissioning requirements are included in the Contract Documents, including the scope of commissioning for the project, the systems to be commissioned and the various requirements related to schedule, submittal reviews, testing, training, O&M manuals and warranty reviews. The delegation of the various tasks is up to the project team, so long as the responsibilities are clearly stated in the Contract Documents. Bidding Contractors must have a clear understanding of their roll in the Commissioning effort.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- iii. Develop and utilize a commissioning plan. Following eight components must be included in the commissioning plan for the project. These are an overview of the commissioning process for the project, a list of commissioned systems and features, primary commissioning participants and their roles, a communication and management plan, an outline of the scope of commissioning tasks, a list of work products, a schedule and a description of any commissioning testing activities. This plan will be created as early as possible in the project and will evolve over time as additional details become available.
  - iv. Verify installation, functional performance, training and documentation for each commissioned system or component. The Commissioning Authority and Contractor must verify proper installation, functional performance in accordance with the design intent, training of Owner's designated operation and maintenance personnel and completion of useful operation and maintenance manuals. Depending on the division of duties decided upon by the project team and described in the commissioning plan and Contract Documents, either the Contractor will perform the tasks with review or assistance by the commissioning authority or the commissioning authority may complete the task with or without assistance from the Contractors.
  - v. Complete a commissioning report. The Commissioning Authority must prepare a commissioning report and submit it to the Owner once the commissioning plan has been fully executed. If certain functional tests are incomplete due to seasonal delays, then the report can be submitted once all but those tests are finished. The commissioning report must contain the Commissioning Authority's analysis of whether each commissioned system or component meets the design intent, meets the specifications, was properly installed, passed the functional performance tests, was properly documented in the O&M manuals and was fully covered in the operator training. Any outstanding commissioning issues must also be included.
- c. Documentation: If building is to satisfy the LEED™ prerequisite, the team must provide documentation to the U.S. Green Building Council as evidence that the tasks were completed. The team must provide a copy of the commissioning plan, with the six tasks listed above highlighted. The Commissioning Authority must also provide a letter certifying that the plan was successfully executed and the design intent for the building was met.
3. Enhanced Commissioning of the Building Energy System - LEED Energy & Atmosphere (EA) Credit 3:
- a. Intent: Required where LEED™ Credit for Enhanced Commissioning is being sought. The official intent is to verify and ensure that the entire building is designed, constructed and calibrated to operate as intended.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- b. Requirements: To achieve the credit for Enhanced Commissioning, the following five tasks must be completed in addition to the six required for the Fundamental Building Systems Commissioning prerequisite:
- i. Complete a focused design review prior to the Contract Document Phase. For this task, a third party (non-design firm) Commissioning Authority must be used. The LEED™ Reference Guide Version 2.2 gives several guidelines for the qualifications necessary for an independent Commissioning Authority. The Commissioning Authority must review the designs for the project prior to the Contract Documents phase, providing feedback to the team on each commissioned system or feature. The review should concentrate on whether the design will or will not meet the Owner's goals for the building systems as stated in the design intent, such as energy efficiency, water efficiency, indoor environmental quality, etc.
  - ii. Complete focused design review of the Contract Documents. Like the previous task, this review must be completed by a third party Commissioning Authority. The review of Contract Documents takes place before completion of the Contract Documents, so that the Commissioning Authority can provide feedback on whether the commissioning requirements have been adequately included in the drawings and specifications. This is also the last opportunity for the Commissioning Authority to check that the previous review comments have been incorporated to ensure the designs will meet the Owner's requirements.
  - iii. Complete a selective submittal review for commissioned equipment. During the Construction Phase, an independent third party commissioning authority must review Contractor submittals for commissioned systems and equipment. Like the design reviews, the purpose of this review is to ensure that the selected equipment meets the Owner's requirements stated in the design intent. This may include not just the functionality of the equipment, but also its environmental characteristics.
  - iv. Create a recommissioning management manual. In addition to the traditional O&M manual, the Enhanced Commissioning credit requires the Commissioning Authority to create a recommissioning management manual. The LEED™ Reference Guide Version 2.2 lists the components that must be included in this manual, such as as-built sequences of operation for all equipment, descriptions of energy and water saving features, seasonal start-up and down procedures, a list of diagnostic tools, etc. This manual is intended to provide the Owner with in-depth tools and strategies for keeping the building running in optimal condition.
  - v. Contract for a warranty or post occupancy review. At the end of the Construction Phase, the Commissioning Authority must be under contract to return to the building at the 10-month point to review its operation for warranty issues. This task must include both a review of current operation to identify any potential warranty related problems before the typical 12 month warranty expiration, and an interview with building operating staff to identify their concerns.

## OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS

- c. Documentation: LEED™ requires three documents to prove compliance with the conditions described in the Additional Commissioning credit. A portion of the commissioning plan showing the five additional tasks must be submitted, along with a letter of certification from a third party Commissioning Authority stating that the first three tasks were completed successfully. A written report must also be included showing evidence of the design review results. If the third party Commissioning Authority also completed tasks four and five, then certification of their successful completion can be included in the letter. Otherwise, the person responsible for the completion of tasks four and five should submit a separate letter indicating the successful completion of those tasks.

### 1.3 TYPICAL SYSTEMS/EQUIPMENT TO BE COMMISSIONED

- A. Scope of work is usually determined by the Owner. However, the following systems/equipment are typically included:
  1. Mechanical Systems
    - HVAC (Heating, Ventilation, Air Conditioning, Ducting & Accessories)
    - Piping Systems (Piping, Valves, Instrumentation, etc.)
    - Plumbing (Piping, Valves, Equipment, and Fixtures)
    - DDC Controls (Software Programming and Hardware)
  2. Electrical Systems
    - Switchgear/Transformers
    - Grounding/Bonding
    - Circuiting
    - Lighting and lighting control
  3. Specialty Systems
    - Security Systems and Fire Alarm
    - Voice/Data Systems
  4. Recommended but not Required
    - Building Envelope
    - Water-using Systems

### 1.4 SUBMITTALS

- A. Commissioning Plan prepared in accordance with Commissioning Standard, no later than 28 days after the approval of the Commissioning Specialist.
- B. Pre-Functional Performance Test Checklists will be submitted at least 28 days prior to the start of Pre-Functional Performance Test Checks. Submit the schedule for the test checks at least 14 days prior to the start of Pre-Functional Performance Test Checks.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- C. Functional Performance Tests: Submit test procedures at least 28 days prior to the start of Functional Performance Tests. The schedule for the tests at least 14 days prior to the start of Functional Performance Tests.
- D. Commissioning Report will be submitted no later than 14 days after completion of Functional Performance Tests.
- E. Commissioning Firm Certificate: Certification of the proposed Commissioning Firm's qualifications by one of the following ACG, NEBB or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. Include in the documentation the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Firm or disciplinary action taken by ACG, NEBB or TABB against the proposed Commissioning Firm will be described in detail.
- F. Commissioning Specialist Certification: Certification of the proposed Commissioning Specialist's qualifications by one of the following ACG, NEBB or TABB to perform the duties specified herein and in other related Sections, no later than 21 days after the Notice to Proceed. The documentation will include the date that the Certification was initially granted and the date when the current Certification expires. Any lapses in Certification of the proposed Commissioning Specialist or disciplinary action taken by ACG, NEBB or TABB against the proposed Commissioning Specialist will be described in detail.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

1.5 QUALIFICATIONS

A. Who Can Be a Commissioning Authority:

**LEED 2.2 New Construction EA PR1; C3  
01/03/06 LEED 2.2 Subcommittee**

Parting Acting as the Commissioning Authority (CxA)	Fundamental Commissioning Prerequisite [2, 4, 5]		Enhanced Commissioning Credit [3, 4, 5]
	25k to 50k sf	> 50k sf	
1. Employee of subcontractor of the General Contractor with construction responsibility.	Y		
2. Employee or subcontractor, with construction responsibilities, or the Construction Manager (CM) who holds construction contracts.	Y		
3. Employee or subcontractor, with project design responsibilities, or Architect or Engineer of Record (A/E).	Y		
4. Disinterested [I] employee or a subcontractor of the General Contractor or CM.	Y	Y	
5. Disinterested [I] employee of the A/E.	Y	Y	
6. Disinterested [I] subcontractor to the A/E.	Y	Y	Y
7. Construction Manager not holding construction contracts.	Y	Y	Y
8. Independent consultant contracted to Owner.	Y	Y	Y
9. Owner employee or staff.	Y	Y	Y

B. Commissioning Firm: Provide a Commissioning Firm that is either a member of ACG or certified by the NEBB or the TABB and certified in all categories and functions where measurements or performance are specified on the plans and specifications. The certification will be maintained for the entire duration of duties specified herein. If, for any reason, the firm loses subject certification during this period, immediately notify the OSU Program Coordinator and submit another Commissioning Firm for approval. Any firm that has been the subject of disciplinary action by the ACG, the NEBB or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the

## OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS

HVAC systems, including Commissioning. All work described in this Section and in other related Sections to be performed by the Commissioning Firm will be considered invalid if the Commissioning Firm loses its certification prior to Contract completion and must be performed by an approved successor. These Commissioning services are to assist the Design Team and prime Contractor in performing the quality oversight for which it is responsible.

- C. The Commissioning Specialist will be an ACG Certified Commissioning Agent, a NEBB Qualified Commissioning Administrator or a TABB Certified Commissioning Supervisor and will be an employee of the approved Commissioning Firm. The certification will be maintained for the entire duration of duties specified herein. If, for any reason, the Commissioning Specialist loses subject certification during this period, immediately notify the Contracting Officer and submit another Commissioning Specialist for approval. Any individual that has been the subject of disciplinary action by the ACG, the NEBB or the TABB within the five years preceding Contract Award is not eligible to perform any duties related to the HVAC systems, including Commissioning. All work specified in this Section and in other related Sections performed by the Commissioning Specialist will be considered invalid if the Commissioning Specialist loses his certification prior to Contract completion and must be performed by the approved successor.
- D. Perform all Commissioning under the direct guidance of the Commissioning Specialist. The Commissioning Specialist will prepare the Commissioning Plan, which will be a comprehensive schedule and will include all submittal requirements for procedures, notifications, reports and the Commissioning Report. After approval of the Commissioning Plan, revise the Contract NAS schedule to reflect the schedule requirements in the Commissioning Plan.

### 1.6 SEQUENCING AND SCHEDULING

- A. Begin the work described in this Section only after all work required in related Sections has been successfully completed and all test and inspection reports and operation and maintenance manuals required in these Sections have been submitted and approved. Pre-Functional Performance Test Checklists shall be performed at appropriate times during the design and construction phases of the Contract.

### PART 2 PRODUCTS

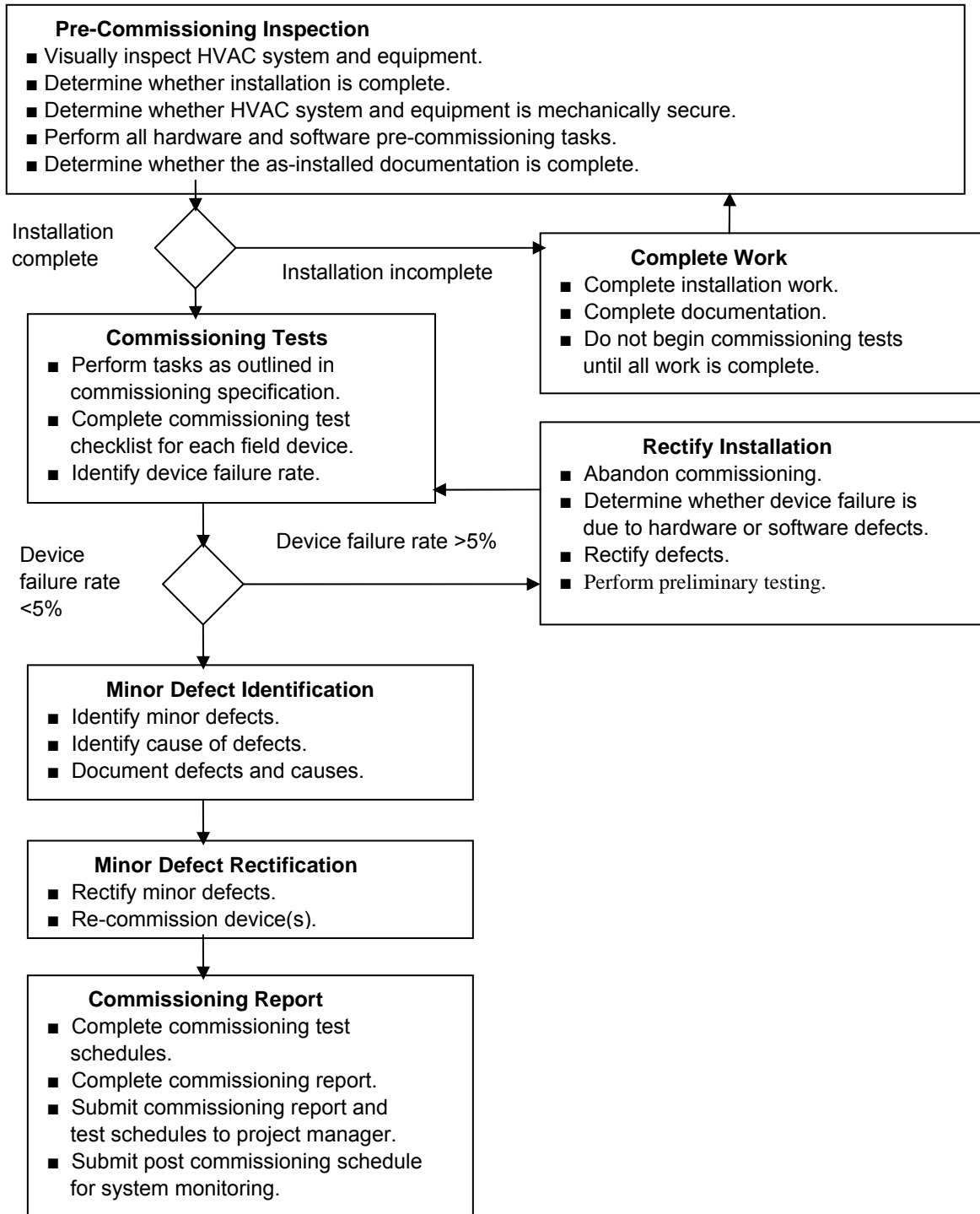
- A. Not Applicable.

### PART 3 EXECUTION

- A. Commissioning Team and Test Forms and Checklists: Designate Contractor team members to participate in the Pre-Functional Performance Test Checklists and the Functional Performance Tests specified herein. In addition, the OSU Architecture Services' Program Coordinator's team members will be included.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

B. Commissioning Flow Chart: The following depicts the Commissioning process:



**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- C. Minimum Commission Requirements: Appendices A and B shall be completed by the commissioning team. Acceptance by each commissioning team member of each Pre-Functional Performance Test Checklist item shall be indicated by initials and date unless an "X" is shown indicating that participation by that individual is not required. Acceptance By each commissioning team member of each functional performance test item will be indicated by signature and date.
- D. Tests: Perform the pre-functional performance test checklists and functional performance tests in a manner that essentially duplicates the checking, testing, and inspection methods established in the related Sections. Where checking, testing, and inspection methods are not specified in other Sections, establish methods which will provide the information required. Testing and verification required by this section shall be performed during the Commissioning phase. Requirements in related Sections are independent from the requirements of this Section and shall not be used to satisfy any of the requirements specified in this Section. Provide all materials, services, and labor required to perform the pre-functional performance tests checks and functional performance tests. A functional performance test shall be aborted if any system deficiency prevents the successful completion of the test or if any participating non-Government commissioning team member of which participation is specified is not present for the test.
- E. Pre-Functional Performance Test Checklists: Perform pre-functional performance test checklists for the items indicated in Appendix A. Correct and re-inspect deficiencies discovered during these checks in accordance with the applicable contract requirements. Functional Performance Tests Perform Functional Performance Tests for the items indicated in Appendix B. Begin Functional Performance Tests only after all Pre-Functional Performance Test Checklists have been successfully completed. Tests shall prove all modes of the sequences of operation, and shall verify all other relevant contract requirements. Begin Tests with equipment or components and progress through subsystems to complete systems. Upon failure of any Functional Performance Test item, correct all deficiencies in accordance with the applicable contract requirements. The item shall then be retested until it has been completed with no errors.
- F. Commissioning Report: The Commissioning Report shall consist of completed Pre-Functional Performance Test Checklists and completed Functional Performance Tests organized by system and by subsystem and submitted as one package. The Commissioning Report shall also include all HVAC systems test reports, inspection reports (Preparatory, Initial and Follow-up inspections), start-up reports, TAB report, TAB verification report, Controls start-up test reports and Controls Performance Verification Test (PVT) report. The results of failed tests shall be included along with a description of the corrective action taken.

## OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS

### APPENDIX A

#### OWNER'S PROJECT REQUIREMENTS (OPR) for the Building's Exterior Enclosure

##### 1. COMMENTARY

- A. This appendix is intended to provide information and examples about the structure and contents of the Owner's Project Requirements as they apply to the building's exterior enclosure. This appendix contains one sub-appendix: An example checklist of contents of the OPR for the building exterior enclosure. This is the type of product used in practice by firms that place high priority on commissioning activities for the exterior enclosure.
1. Building Objectives: List the objectives that are unique to the exterior enclosure and that expand upon the objectives and goals described in Whole Building Commissioning.
  2. Site Description: List criteria that have a major influence on the Architectural Requirements development of the building design. Coordinate with Site/Civil.
  3. Neighborhood/Context: Describe the influence of the project site, neighborhood and context on the building design.
  4. Existing Buildings: Describe existing buildings and their influence on the design.
  5. Master Plan: Describe existing or in progress master planning issues which affect the design.
  6. Circulation / Access: Describe the opportunities and constraints imposed by circulation issues and required access.
    - a. Major Building Access:
    - b. Secondary Building Access: Deliveries and Services:
      - Trash Docks and Compactors.
      - Kitchen, Cafeteria or other food service Deliveries and Services.
      - Lab, Animal, GMP or other special Deliveries and Services.
      - Ambulance or Emergency Service.
  7. Zoning: Describe the allowable building footprint, maximum height, FAR, and other zoning issues that affect the design. Coordinate with the Site/Civil Section.
    - Buildable Dimensions and Area:
    - Maximum FAR:
    - Maximum Height:
    - Upper Level Setbacks:

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

8. Zoning or Planned Unit Development Restrictions on Materials of Design: Describe any special restrictions on the design of the building such as exterior materials, roof shapes, percent glazed area, etc.
9. Local, Neighborhood or Community Review Boards or Approvals: Describe any special approvals of the building design that may be required.

2. BUILDING CODE

A. Authority Having Jurisdiction and Codes in Affect:

1. [IBC, etc.]
2. [200X International Building Code with Amendments]
3. [20XX NFPA 101 Fire Prevention Code]
4. [Plumbing Code]
5. [Mechanical Code]

B. Construction Types Type:

1. Fully Sprinkled: [Yes.] [No.]
2. Structural Fire Ratings.

C. Allowable Areas:

1. Tabular Allowable Area per Floor (Table 503): [ ] SF.
2. Frontage Increase (506.2): [ ] percent.
3. Sprinkler Increase (506.3): [ ] percent.
4. Allowable Area per Floor (506.1): [ ]SF.
5. Allowable Total Building Area:

D. Allowable Height:

1. Tabular Allowable Height (Table 503): [ ] FT.
2. Increase (XXXX): [ ] percent.
3. Allowable Height (506.1): [ ]SF.

## OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS

4. [Special Conditions such as a Atrium]
3. SUSTAINABILITY
  - A. Describe the Owner's and Design Professional's criteria for sustainability for the project. Describe any specific programs or measuring tools that may be required to measure energy conservation issues such as LEED ratings or ASHRAE 90.1. Coordinate with section below for enclosure thermal performance criteria.
    1. Energy Conservation.
    2. Life Cycle Costing.
    3. Recycled Materials.
4. EXISTING FACILITIES
  - A. Identify special criteria for renovations, restorations, additions, alterations or any other work on an existing facility. Coordinate this overall section with the "Existing" paragraphs in the remainder of the OPR. Coordinate with the code analysis and life safety section.
  - B. Note that building code, energy conservation and accessibility requirements may affect areas of the building beyond the owners identified scope.
  - C. Note that any change of use or occupancy frequently triggers additional code requirements. Adding conference rooms or cafeterias to existing office buildings is a commonly missed change of use.
5. PROGRAM
  - A. Functional Criteria: Describe needs for building functions and arrangements of major areas. If separate Criteria or Program Report is included, give a basic list of program requirements here.
6. EXTERIOR ENCLOSURE THERMAL PERFORMANCE CRITERIA
  - A. Identify applicable code requirements for thermal performance of exterior enclosure. Many jurisdictions are adopting the IBC, which requires compliance with the International Energy Code and/or ASHRAE/IESNA Standard 90.1. If more than code is applicable, identify requirements of each and indicate most restrictive. Verify if required value is for insulation only or for the entire assembly.
  - B. Note that ASHRAE 90.1 and IEC allow alternative analysis methods to determine compliance in lieu of the prescriptive method. Identify if alternative methods may be utilized.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- C. Coordinate this section carefully with the appropriate Architectural Criteria Worksheets and with the Mechanical Engineers.
7. EXTERIOR ENCLOSURE STRUCTURAL CRITERIA
- A. Identify the structural criteria required for the project. Coordinate with the Structural OPR if provided separately as part of Whole Building OPR.
  - B. Loads & Serviceability Critical Standards.
  - C. Progressive Collapse.
  - D. Enclosed Loads (Soils, Foundation, Roof Live Loads, Roof Ponding Loads, Snow Loads, Wind Loads, Seismic Loads, Movement, Deflection and Drift.
8. ROOFING
- A. Roofing Standards.
  - B. Roofing Criteria
  - C. Roofing Selection Proposals with Life Cycle Costing for each proposal.
  - D. Existing Roofing.
9. EXTERIOR WALL SYSTEMS
- A. Exterior Wall Standards.
  - B. Exterior Wall Criteria.
  - C. Existing Exterior Wall Standards.
10. EXTERIOR WINDOWS, CURTAINWALL and STOREFRONT SYSTEMS
- A. Exterior Window, Curtainwall, and Storefront Standards.
  - B. Exterior Window, Curtainwall or Storefront Criteria.
  - C. Existing Exterior Window, Curtainwall or Storefront Criteria.
11. SKYLIGHT SYSTEMS
- A. Skylight Criteria.
  - B. Skylight Standards.
  - C. Existing Skylights.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

12. EXTERIOR DOORS
  - A. Exterior Door Standards.
  - B. Exterior Door Criteria.
  - C. Existing Exterior Doors.
  - D. Owner and Code Door Hardware Requirements (durability and type).
13. BELOW GRADE WALL and HORIZONTAL SYSTEMS
  - A. Standards.
  - B. Exterior Below Grade System Criteria.
14. SLABS-ON-GRADE
  - A. Identify Criteria Important for the Owner to Understand.
  - B. Criteria.
15. MISCELLANEOUS EXTERIOR CRITERIA
  - A. Identify the Criteria for Placement of Expansion Joints.
16. INTERIOR CONSTRUCTION CRITERIA
  - A. Describe Needed Partitions, Doors, Shafts and Ceilings.
  - B. Describe Required Finishes by Space Categories.
  - C. Stress Durability and Maintenance.
  - D. Window Treatment.
17. ACCESSIBILITY
  - A. Describe need for accessibility within the building for compliance with American with Disabilities Act Accessibility Guidelines (ADAAG), ANSI A 117.1, appropriate portions of the building code, and any other applicable regulations. Clearly identify strict code requirements versus ADA Guidelines.
  - B. Extent.
  - C. Egress.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

D. Remodeling/ Renovation of Existing Facilities

18. ACOUSTICAL CRITERIA

A. Off-site Noise Sources

1. Describe noise generated off the site that needs to be controlled, I.E. facility next to airports or busy highways.

B. Control of Noise Generated by the Facility

1. Describe requirements for control of noise generated on the site and attenuation of the noise at property lines.
2. Check zoning codes and regulations.

C. Background Noise Levels

1. Describe Owner's requirements for acceptable background noise.

19. OTHER CRITERIA

A. Radio Frequency

1. Identify requirements for shielding from radio frequency interference and/or electromagnetic interference. Describe specific areas where shielding is required if not required for entire building.

B. Interference or Electromagnetic Interference (RFI/EMI) Shielding

1. Computer Rooms

- a. Note that it is not uncommon for some users to request RFI/EMI

2. Teledata/Closets

- a. Shielding of major teledata or computer rooms. If shielding is required cross-reference to all affected sections of the OPR. At a minimum, desktop computers may need to be kept a certain small distance (3 - 5 feet) from rooms with electrical transformers and other electrical equipment.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

3. Lightning Protection

- a. Describe needed rooftop lightning protection system. Coordinate with electrical.

4. Odors

- a. Describe any special requirements for control of noxious odors.

5. Offsite Odors

- a. Describe criteria for control of noxious odors that are generated off site that affect the project.

6. Control of Odors

- a. Describe criteria for control of any noxious odors generated on the site. Consider mechanical exhaust, and odor that may be generated by trash areas. In some areas it may be necessary to provide a refrigerated room to store garbage.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**APPENDIX B**

**PRE-FUNCTIONAL PERFORMANCE TEST CHECKLISTS**

Designation Function:

- A Commissioning Specialist
- M Contractor's Mechanical Representative
- E Contractor's Electrical Representative
- T Contractor's Testing, Adjusting, and Balancing (TAB) Specialist
- C Contractor's Controls Representative
- D Design Professional Representative
- O OSU Architecture Services Representative
- U Using Agency's Representative (Client Physical Plant)

**Pre-Functional Performance Test Checklist - Multizone Air Handling Unit**

Checklist Item	A	M	E	T	C	O
<b>Installation</b>						
a. Inspection and access doors are operable and sealed.	___	___	X	___	X	___
b. Condensate drainage is unobstructed. (Visually verify pan drains completely by pouring a cup of water into drain pan.)	___	___	X	X	X	___
c. Fan belt adjusted.	___	___	X	___	X	___
<b>Electrical</b>						
a. Power available to unit disconnect.	___	X	___	X	X	___
b. Power available to unit control panel.	___	X	___	X	X	___
c. Proper motor rotation verified.	___	X	___	___	X	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
d. Verify that power disconnect is located within sight of the unit it controls.	___	X	___	X	X	___
e. Power available to electric heating coil.	___	X	___	X	X	___
Coils						
a. Chilled water piping properly connected.	___	___	X	X	X	___
b. Refrigerant piping properly connected.	___	___	X	X	X	___
c. Hot water piping properly connected.	___	___	X	X	X	___
d. Steam and condensate piping properly connected.	___	___	X	X	X	___
Controls						
a. Control valves/actuators properly installed.	___	X	X	X	___	___
b. Control valves/actuators operable.	___	X	X	X	___	___
c. O/A dampers/actuators properly installed.	___	X	X	X	___	___
d. O/A dampers/actuators operable.	___	X	X	X	___	___
e. Zone dampers/actuators properly installed and dampers leak checked.	___	X	X	X	___	___
f. Zone dampers/actuators operable.	___	X	X	X	___	___
Testing, Adjusting, and Balancing (TAB)						
a. Construction filters removed and replaced.	___	___	X	___	X	___
b. TAB report approved.	___	X	X	___	X	___
Installation						
a. Inspection and access doors are operable and sealed.	___	___	X	___	X	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
b. Condensate drainage is unobstructed. (Visually verify drainage by pouring a cup of water into drain pan.)	___	___	X	X	X	___

c. Fan belt adjusted.	___	___	X	___	X	___
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Electrical

a. Power available to unit disconnect.	___	X	___	X	X	___
b. Power available to unit control panel.	___	X	___	X	X	___
c. Proper motor rotation verified.	___	X	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	X	___	X	X	___
e. Power available to electric heating coil.	___	X	___	X	X	___

Coils

a. Chilled water piping properly connected.	___	___	X	X	X	___
b. Refrigerant piping properly connected.	___	___	X	X	X	___
c. Hot water piping properly connected.	___	___	X	X	X	___
d. Steam and condensate piping properly connected.	___	___	X	X	X	___

**Pre-Functional Performance Test Checklist - Variable Volume Air Handling Unit**

Controls

a. Control valves/actuators properly installed.	___	X	X	X	___	___
b. Control valves/actuators operable.	___	X	X	X	___	___
c. Dampers/actuators properly installed.	___	X	X	X	___	___
d. Dampers/actuators operable.	___	X	X	X	___	___
e. Verify proper location, installation and calibration of duct static pressure sensor.	___	X	X	X	___	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
f. Fan air volume controller operable.	___	X	X	X	___	___
g. Air handler controls system operational.	___	X	X	X	___	___

Testing, Adjusting and Balancing (TAB)

a. Construction filters removed and replaced.	___	___	X	___	___	___
b. TAB report approved.	___	X	X	___	X	___

**Pre-Functional Performance Test Checklist - VAV Terminal**

Installation

a. Reheat coil connected to hot water pipe.	___	___	X	___	X	___
b. Electric reheat coil connected to local disconnect.	___	X	___	___	X	___

Controls

a. Cooling only VAV terminal controls set.	___	X	X	X	___	___
b. Cooling only VAV controls verified.	___	X	X	X	___	___
c. Reheat VAV terminal controls set.	___	X	X	X	___	___
d. Reheat terminal/coil controls verified.	___	X	X	X	___	___

Testing, Adjusting, and Balancing (TAB)

a. TAB report approved.	___	___	X	___	X	___
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**Pre-Functional Performance Test Checklist - VAV Terminal**

Installation

a. Reheat coil connected to hot water pipe.	___	___	X	___	X	___
b. Electric reheat coil connected to local disconnect.	___	X	___	___	X	___

Controls

a. Cooling only VAV terminal controls set.	___	X	X	X	___	___
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**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
b. Cooling only VAV controls verified.	___	X	X	X	___	___
c. Reheat VAV terminal controls set.	___	X	X	X	___	___
d. Reheat terminal/coil controls verified.	___	X	X	X	___	___

Testing, Adjusting, and Balancing (TAB)

a. TAB report approved.	___	___	X	___	X	___
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**Pre-Functional Performance Test Checklist - DX Air Cooled Condensing Unit**

Installation

a. Check condenser fans for proper rotation.	___	___	X	___	X	___
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Electrical

a. Power available to unit disconnect.	___	X	___	X	X	___
b. Power available to unit control panel.	___	X	___	X	___	___
c. Verify that power disconnect is located within sight of the unit it controls	___	X	___	X	___	___

Controls

a. Unit safety/protection devices tested.	___	___	X	X	___	___
b. Control system and interlocks installed.	___	___	X	X	___	___
c. Control system and interlocks operational.	___	___	X	X	___	___

**Pre-Functional Performance Test Checklist - Pumps**

Installation

a. Piping system installed.	___	___	X	X	X	___
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Electrical

a. Power available to pump disconnect.	___	X	___	X	X	___
b. Pump rotation verified.	___	X	___	X	X	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
c. Control system interlocks functional.	___	X	___	X	___	___

Testing, Adjusting, and Balancing (TAB)

a. Pressure/temperature gauges installed.	___	___	X	___	X	___
b. TAB Report approved.	___	___	X	___	X	___

**Pre-Functional Performance Test Checklist - Packaged Air Cooled Chiller**

Installation

a. Chiller properly piped.	___	___	X	___	___	___
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Electrical

a. Power available to unit disconnect.	___	X	___	X	___	___
b. Power available to unit control panel.	___	X	___	X	___	___
c. Separate power is supplied to electric heating tape.	___	X	___	X	___	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	X	___	X	___	___

Controls

a. Factory startup and checkout complete.	___	___	X	X	___	___
b. Chiller safety/protection devices tested.	___	___	X	X	___	___
c. Chilled water flow switch installed.	___	___	X	X	___	___
d. Chilled water flow switch tested.	___	___	X	X	___	___
e. Chilled water pump interlock installed.	___	___	X	X	X	___
f. Chilled water pump interlock tested.	___	___	___	X	___	___

Installation

a. Chilled water connections properly piped.	___	___	X	___	___	___
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**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
b. Condenser water connections properly piped.	___	___	X	___	___	___
c. Refrigerant leak detector installed.	___	___	___	___	___	___
d. Oxygen sensor installed and tested.	___	___	___	___	___	___
e. Mechanical room ventilation installed as specified.	___	___	___	___	___	___

Electrical

a. Power available to unit starter.	___	X	___	X	___	___
b. Power available to unit control panel.	___	X	___	X	___	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	X	___	X	___	___

**Pre-Functional Performance Test Checklist - Packaged Air Cooled Chiller**

Controls

a. Factory startup and checkout complete.	___	___	X	X	___	___
b. Chiller safety/protection devices tested.	___	___	___	X	___	___
c. Chilled water flow switch installed and tested.	___	___	X	X	___	___
d. Chilled water pump interlock installed and tested.	___	___	___	X	___	___
e. Condenser water flow switch installed and tested.	___	___	___	X	___	___
f. Condenser water pump interlock installed and tested.	___	___	___	X	___	___

**Pre-Functional Performance Test Checklist - Cooling Tower**

Installation

a. Cooling tower properly piped.	___	___	X	X	___	___
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**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
b. Cooling tower fan drive adjusted.	___	___	___	___	X	___
c. Cooling tower makeup water supply piped.	___	___	X	X	___	___
d. Verify makeup control valve shutoff.	___	___	X	___	X	___
e. Fan lubricated and blade pitch adjusted.	___	___	X	___	X	___

Electrical

a. Power available to tower disconnect.	___	X	___	X	___	___
b. Power available to electric sump heater.	___	X	___	X	___	___
c. Control system interlocks functional.	___	___	___	X	___	___
d. Motor and fan rotation checked.	___	X	___	X	___	___
e. Verify that power disconnect is located within sight of the unit controls.	___	X	___	X	___	___

Piping

a. Condenser water treatment functional.	___	___	X	X	X	___
b. All required temperature sensing wells, pressure ports and flow sensors have been installed for performance tests.	___	___	___	___	___	___
c. Testing, Adjusting, and Balancing (TAB)	___	___	X	___	X	___
d. TAB report approved.	___	___	X	___	X	___

**Pre-Functional Performance Test Checklist - Steam Boiler**

Installation

a. Boiler steam piping installed.	___	___	X	X	X	___
b. Boiler makeup water piping installed.	___	___	X	___	X	___
c. Boiler fuel oil piping installed.	___	___	X	X	X	___
d. Boiler gas piping installed.	___	___	X	X	X	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
<b>Startup</b>						
a. Boiler safety/protection devices, including high temperature burner shutoff, low water cutoff, flame failure, pre and post purge, have been tested.	___	___	___	X	___	___
b. Verify that PRV rating conforms to boiler rating.	___	___	___	X	___	___
c. Boiler feed water system operational.	___	___	___	X	___	___
d. Boiler water treatment system functional.	___	___	X	X	X	___
e. Boiler startup and checkout complete.	___	___	___	X	___	___
f. All steam traps operational.	___	___	X	X	X	___
g. All condensate return pumps operational.	___	___	___	___	X	___
h. Combustion efficiency demonstrated.	___	___	X	___	X	___
<b>Electrical</b>						
a. Verify that power disconnect is located within sight of the unit served.	___	X	___	X	___	___
<b>Testing, Adjusting, and Balancing (TAB)</b>						
a. TAB report approved.	___	___	X	___	X	___
<b>Pre-Functional Performance Test Checklist - Steam/Hot Water Converter</b>						
<b>Installation</b>						
a. Converter steam piping installed.	___	___	X	___	X	___
b. Hot water piping installed.	___	___	X	___	___	___
c. Makeup water piping installed.	___	___	X	X	X	___
d. Vacuum breaker installed on shell of shell and tube unit.	___	___	X	X	X	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
<b>Startup</b>						
a. All steam traps operational.	___	___	X	X	X	___
b. All condensate return pumps operational.	___	___	___	X	___	___
c. Converter safety/protection devices tested.	___	___	X	X	X	___
d. Converter startup and checkout complete.	___	___	X	X	X	___
<b>Controls</b>						
a. Control valves/actuators properly installed.	___	___	X	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___
<b>Pre-Functional Performance Test Checklist - Fan Coil Unit</b>						
<b>Installation</b>						
a. Access doors/removable panels are operable and sealed.	___	___	X	___	X	___
b. Condensate drainage is unobstructed.	___	___	X	X	X	___
c. Fan belt adjusted.	___	___	X	___	X	___
<b>Electrical</b>						
a. Power available to unit disconnect.	___	___	___	X	___	___
b. Power available to unit control panel.	___	___	___	X	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
e. Power available to electric heating coil.	___	___	___	X	X	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
<b>Coils</b>						
a. Dual temperature piping properly connected.	___	___	X	___	___	___
b. Chilled water piping properly connected.	___	___	X	X	X	___
c. Hot water piping properly connected.	___	___	X	___	___	___
<b>Controls</b>						
a. Control valves/actuators properly installed.	___	___	X	___	___	___
b. Control valves/actuators operable.	___	___	X	X	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___
<b>Testing, Adjusting and Balancing (TAB)</b>						
a. TAB Report approved.	___	___	X	___	X	___
<b>Pre-Functional Performance Test Checklist - Unit Heater</b>						
<b>Installation</b>						
a. Hot water piping properly connected.	___	___	X	___	___	___
b. Steam and condensate piping properly connected.	___	___	X	X	X	___
<b>Electrical</b>						
a. Power available to unit disconnect.	___	___	___	X	___	___
b. Proper motor rotation verified.	___	___	___	X	X	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
d. Power available to electric heating coil.	___	___	___	X	___	___
<b>Controls</b>						
a. Control valves properly installed.	___	___	X	___	___	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
b. Control valves operable.	___	___	X	X	___	___
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)						
a. TAB Report approved.	___	___	X	___	X	___
<b>Pre-Functional Performance Test Checklist - Exhaust Fan</b>						
Installation						
a. Fan belt adjusted.	___	___	X	___	X	___
Electrical						
a. Power available to fan disconnect.	___	___	___	X	___	___
b. Proper motor rotation verified.	___	___	___	___	X	___
c. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
Controls						
a. Control interlocks properly installed.	___	___	___	X	___	___
b. Control interlocks operable.	___	___	___	X	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___
Testing, Adjusting, and Balancing (TAB)						
a. TAB Report approved.	___	___	X	___	X	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

A M E T C O

**Pre-Functional Performance Test Checklist - Computer Room Unit**

Installation

a. Access doors are operable and sealed.	___	___	X	___	X	___
b. Condensate drainage is unobstructed and routed to floor drain.	___	___	X	X	X	___
c. Fan belt adjusted.	___	___	X	___	X	___

Electrical

a. Power available to unit disconnect.	___	X	___	X	X	___
b. Proper motor rotation verified.	___	X	___	___	X	___
c. Proper motor rotation verified.	___	X	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	X	___	X	___	___
e. Power available to reheat coils.	___	X	___	___	X	___

Coils/Humidifier

a. Chilled water piping properly connected.	___	___	X	___	___	___
b. Refrigerant piping properly connected.	___	___	X	X	X	___
c. Hot water piping properly connected.	___	___	X	___	___	___
d. Steam piping properly connected.	___	___	X	X	X	___
e. Humidifier makeup water connected.	___	___	X	X	X	___

Controls

a. Control valves operable.	___	___	X	X	___	___
b. Unit control system operable and verified.	___	___	___	X	___	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
c. Verify proper location and installation of thermostat.	___	___	X	___	___	___

Testing, Adjusting, and Balancing (TAB)

a. TAB Report submitted.	___	___	X	___	X	___
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**Pre-Functional Performance Test Checklist - HVAC System Controls**

Installation

a. Layout of control panel matches drawings.	___	___	X	X	___	___
b. Framed instructions mounted in or near control panel.	___	___	X	X	___	___
c. Components properly labeled (on inside and outside of panel).	___	___	X	X	___	___
d. Control components piped and/or wired to each labeled terminal strip.	___	___	X	X	___	___
e. EMCS connection made to each labeled terminal strip as shown.	___	___	X	X	___	___
f. Control wiring and tubing labeled at all terminations, splices, and junctions.	___	___	X	X	___	___

Main Power and Control Air

i. 120 volt AC power available to panel.	___	___	___	X	___	___
ii. 20 psig compressed air available to panel.	___	___	X	X	___	___

Testing, Adjusting, and Balancing (TAB)

a. TAB Report submitted.	___	___	X	___	X	___
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**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

A M E T C O

**Pre-Functional Performance Test Checklist - Single Zone Air Handling Unit**

Installation

a. Inspection and access doors are operable and sealed.	___	___	X	___	X	___
b. Condensate drainage is unobstructed.	___	___	X	X	X	___
c. Fan belt adjusted.	___	___	X	___	X	___

Electrical

a. Power available to unit disconnect.	___	___	___	X	X	___
b. Power available to unit control panel.	___	___	___	X	___	___
c. Proper motor rotation verified.	___	___	___	___	X	___
d. Verify that power disconnect is located within sight of the unit it controls.	___	___	___	X	___	___
e. Power available to electric heating coil.	___	___	___	X	___	___

Coils

a. Chilled water piping properly connected.	___	___	X	___	___	___
b. Refrigerant piping properly connected.	___	___	X	X	X	___
c. Hot water piping properly connected.	___	___	X	___	___	___
d. Steam and condensate piping properly connected.	___	___	X	X	X	___

Controls

a. Control valves/actuators properly installed.	___	___	X	___	___	___
b. Control valves/actuators operable.	___	___	X	___	___	___
c. Dampers/actuators properly installed.	___	___	X	___	___	___
d. Dampers/actuators operable.	___	___	X	___	___	___

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

	A	M	E	T	C	O
e. Verify proper location and installation of thermostat.	___	___	X	___	___	___

Testing, Adjusting, and Balancing (TAB)

a. TAB Report approved.	___	___	X	___	X	___
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**Pre-Functional Performance Test Checklist - Energy Recovery System**

Installation

a. Recovery system piping installed.	___	___	X	___	X	___
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Startup

a. Startup and checkout complete.	___	___	X	X	X	___
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Controls

a. Control valves/actuators properly installed.	___	___	X	___	___	___
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b. Control valves/actuators operable.	___	___	X	___	___	___
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**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Battery**

Specification Sections: \_\_\_\_\_ Page: 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage.						
2	Compare equipment with specifications.						
3	Inspect for proper connections.						
4	Test for proper voltage.						
5	Verify system operation.						
6	Verify operation of emergency lights.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Bus Duct**

Specification Sections: \_\_\_\_\_ Page: 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect bus for physical damage and proper connection in accordance with single-line diagram.						
2	Inspect for proper bracing, suspension alignment and enclosure ground						
3	Check tightness of bolted joints by using calibrated torque wrench.						
4	Check for proper physical orientation per manufacturer's labels to ensure proper cooling. Perform continuity tests on each conductor to verify that proper phase relationships exist.						
5	Check outdoor busway for removal of "weep-hole" plugs, if applicable, and the proper installation of joint shield.						
6	Measure insulation resistance of each bus run phase-to-phase and phase-to-ground.						
7	Perform AC or DC overpotential tests on each bus run phase-to-phase and phase-to-ground.						
8	Perform contact-resistance test on each connection point of uninsulated bus. On insulated bus, measure resistance of bus section and compare values with adjacent phases.						
9	Perform phasing test on each bus tie section energized by separate sources.						
10	Check fire stops at rated penetrations.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist - Elec Receptacles & Other Devices**  
**Pre-Functional Performance Test Checklist - Fire Alarm System**  
Specification Sections: \_\_\_\_\_ Page: 1 of 1 \_\_\_\_\_

ITEM NO.	DESCRIPTION	TYPE	SIGN	DATE	YES	NO	DATE
1	Test ground fault on GF CI receptacles						
2	Test polarity on standard receptacles.						
3	Check wiring on several selected receptacles.						
4	Remove sample receptacles to verify manufacturer.						
5	Verify that device ratings meet approved shop drawings and specifications.						
6	Verify color of all devices and plates meet specifications.						

ITEM NO.	DESCRIPTION	RESP.CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Installation complete						
	<b>WIRING COMPLETE</b>						
2	Opens						
3	Shorts						
4	Ground faults						
5	Improper branching						
6	Alarm certification & description form filled in and signed						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Emergency Generator**

Specification Sections: \_\_\_\_\_ Page: 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage.						
2	Compare nameplate information and connection with drawings and specs.						
3	Inspect for proper anchorage and grounding.						
4	Perform an insulation-resistance test on generator winding with respect to ground. Determine polarization index.						
5	Test protective relay devices in accordance with specifications.						
6	Perform phase rotation test to determine compatibility with load requirements.						
7	Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other features as applicable.						
8	Perform vibration base-line test. Vibration levels shall not exceed manufacturer's recommendations.						
9	Perform load bank test in accordance with the following schedule: 25% rated for 30 minutes 50% rated for 30 minutes 75% rated for 30 minutes 100% rated for 3 hours Record voltage, frequency, load current, oil pressure, and coolant temperature at periodic intervals during test.						
10	Perform an insulation-resistance test.						
11	Provide factory test report.						
12	Test power failure start.						
13	Perform battery charger system test.						
14	Adjust time delay relay settings.						
15	Verify rotation.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Grounding System**

Specification Section: \_\_\_\_\_ Page: 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Check terminations at devices.						
2	Apply biddle ground tester. Perform ground-impedance measurements utilizing the fall-of-potential method.						
3	Verify transformer secondary bonded to ground.						
4	Test resistance to earth of grounding connections.						
5	Check for bonding jumper across water meter.						
6	Check grounding electrode conductor to water service pipe.						
7	Check ground rods and building steel ground.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Isolated Grounding System**

**Specification Section:** \_\_\_\_\_ **Page:** 1 of 1

ITEM NO.	DESCRIPTION	RESP.CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage.						
2	Verify full size grounding conductor terminated at nearest grounding electrode and panel.						
3	Verify that grounding conductor is copper, not spliced, and that all connectors are U.L. listed and comply with specifications.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – KWH Meter**

Specification Section: \_\_\_\_\_ Page: 1 of 1

ITEM NO.	DESCRIPTION	RESP.CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Check polarity and ratio of C.T.'s.						
2	Check ratio of P.T.'s.						
3	Check for correct rotation.						
4	Verify test block for proper shorting and test jack operation. Use the test block to calibrate the meter and for phase angle checks.						
5	Determine accuracy of meters at 25/50/75/100% of full scale.						
6	Calibrate watt hour meters to one half percent (0.5%).						
7	Perform current injection tests on each C.T.						
8	Perform phase angle checks.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – KWH Meter**

**Specification Section:** \_\_\_\_\_ **Page:** 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage.						
2	Compare installed fixtures with schedule on the drawings.						
3	Verify installed ballasts (selected samples).						
4	Verify installed lamp types.						
5	Verify load shed operation if present.						
6	Set and verify dimming controls. Verify control equipment with drawings and specifications.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Medium Voltage Cables (15KV)**

**Specification Section:** \_\_\_\_\_ **Page:** 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect exposed sections for physical damage.						
2	Verify cable is supplied and connected in accordance with single-line diagram.						
3	Inspect for shield grounding, cable support and termination.						
4	Check for visible cable bends against ICEA or manufacturer's minimum allowable bending radius.						
5	Inspect for proper fireproofing in common cable areas.						
6	If cables are terminated through window-type CT's make an inspection to verify that neutrals and grounds are properly terminated for proper operation of protective devices.						
7	Visually inspect jacket and insulation condition.						
8	Inspect for proper phase identification and arrangement.						
9	Perform a shield continuity test on each power cable by ohmmeter method.						
10	Perform an insulation-resistance test utilizing a megohmmeter with a voltage output of at least 2500 volts.						
11	Perform a DC high-potential test on all cables.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Medium Voltage Switch Gear**

**Specification Section:** \_\_\_\_\_ **Page:** 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage.						
2	Compare equipment nameplate with specifications.						
3	Compare installed equipment with drawings.						
4	Test bus connections for high resistance.						
5	Use torque wrench to check bolted bus joints.						
6	Verify correct CT and PT ratios.						
7	Test interlock system.						
8	Test ground fault system as per NETA ATS-1995 Grounding systems.						
9	Perform an overpotential test on each bus section and each phase to ground.						
10	Perform contact-resistance duct test.						
11	Check relay settings.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Medium Voltage Switches/Breakers**  
 Specification Section: \_\_\_\_\_ Page: 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage and compare nameplate information with plans and specs.						
2	Inspect anchorage, alignment and grounding.						
3	Perform all mechanical operator and contact alignment tests on both the breaker and its operating mechanism.						
4	Check tightness of bolted bus joints by using calibrated torque wrench.						
5	Check cell fit and element alignment.						
6	Check racking mechanism.						
7	Verify that primary and secondary contact wipe and other dimensions vital to satisfactory operation of the breaker are correct.						
8	Ensure that all maintenance devices are available for servicing and operating the breaker.						
9	Lubricate all moving current carrying parts.						
10	Check for proper operation of the cubicle shutter.						
11	Measure contact resistance.						
12	Measure insulation resistance pole-to-pole, pole-to-ground, and across open poles.						
13	Perform insulation-resistance at 1000 volts DC on all control wiring.						
14	Perform an overpotential test with breaker in closed position.						
15	Perform minimum pickup voltage tests on trip and close coils.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Medium Voltage Transformers**  
**Specification Section:** \_\_\_\_\_ **Page:** 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Compare equipment nameplate information with single-line diagram.						
2	Inspect for physical damage, cracked insulators, leaks, tightness of connections, and general mechanical and electrical conditions.						
3	Inspect impact recorder prior to unloading transformer if applicable.						
4	Verify removal of any shipping bracing after final placement.						
5	Verify proper auxiliary device operation.						
6	Check tightness of accessible bolted electrical connections in accordance with torque wrench.						
7	Verify proper liquid level in all tanks and bushings.						
8	Perform specific inspections and mechanical tests as recommended by manufacturer.						
9	Verify proper equipment grounding.						
10	Perform insulation-resistance tests, winding-to-winding, and windings-to-ground, utilizing a megohmmeter.						
11	Perform a turns-ratio test between windings at all tap positions.						
12	Sample insulating liquid. Sample shall be laboratory tested for:						
	(a) Dielectric breakdown voltage.						
	(b) Acid neutralization number.						
	(c) Specific gravity.						
	(d) Interfacial tension.						
	(e) Color.						
	(f) Visual condition.						
13	Perform insulation power-factor tests or dissipation-factor tests on all windings and bushings.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Motor Control Center**

**Specification Section:** \_\_\_\_\_ **Page:** 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage.						
2	Compare nameplate with specifications.						
3	Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for one (1) minute.						
4	Perform an overpotential test on each bus section and each phase-to-ground.						
5	Check the ground connection.						
6	Use torque wrench to check bolted bus connections.						
7	Verify control sequence and time delays as specified.						
8	Verify sizes and quantities of devices.						
9	Verify space capacity.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Panel Boards**

**Specification Section:** \_\_\_\_\_ **Page:** 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage.						
2	Compare equipment nameplate with specifications.						
3	Verify copper bus.						
4	Megger test feeders and conductors and verify size. Perform insulation resistance test on each conductor with respect to ground and adjacent conductors.						
5	Check ground connection.						
6	Use torque wrench to check conductor connections per Table A.						
7	Verify size and quantity of devices.						
8	Verify space capacity.						
9	Keys turned over to Owner.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Primary Grounding**

Specification Section: \_\_\_\_\_ Page: 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect ground system for compliance with drawings and specifications						
2	Perform ground-impedance test utilizing the fall-of-potential method.						
3	Test resistance to earth of grounding connections.						
4	Measure resistance between main system and neutral.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – Secondary Transformers (Dry Type)**

**Specification Section:** \_\_\_\_\_ **Page:** 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Compare equipment nameplate information with single-line diagram.						
2	Inspect for physical damage, cracked insulators, leaks, tightness of connections, and general mechanical and electrical conditions.						
3	Verify proper operation of auxiliary devices such as fans and indicators.						
4	Check tightness of accessible bolted electrical connections with torque wrench.						
5	Perform specific inspections and mechanical tests as recommended by manufacturer.						
6	Verify removal of any shipping racking after final placement. Ensure that resilient mounts are free.						
7	Verify proper core grounding.						
8	Verify proper equipment grounding.						
9	Perform insulation-resistance tests, winding-to-winding, and windings						
10	Verify setting of taps.						
11	Perform audible sound pressure test for compliance with NEMA standards.						
12	Check temperature rating.						
13	Measure temperature rise.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Pre-Functional Performance Test Checklist – 480/240 Volt Switchboards**

Specification Section: \_\_\_\_\_ Page: 1 of 1

ITEM NO.	DESCRIPTION	RESP. CONTRACTOR			COMMISSIONER		
		TYPE	SIGN	DATE	YES	NO	DATE
1	Inspect for physical damage.						
2	Compare equipment nameplate with specifications.						
3	Verify spare capacity.						
4	Check ratio of CT's with one-line diagram and specifications.						
5	Perform insulation-resistance tests on each bus section, phase-to-phase and phase-to-ground for one (1) minute.						
6	Perform an over potential test on each bus section and each phase-to-ground.						
7	Use torque wrench to check bolted bus connections. See Table A for values.						
8	Test ground fault.						
9	Check the ground connection.						
10	Check quantity and sizes of devices.						
11	Check breaker settings and fuse size and type with electrical one-line and specifications.						

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Appendix C**

**FUNCTIONAL PERFORMANCE TESTS CHECKLIST**

**Functional Performance Test - Pump**

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

1. Activate pump start using control system commands.

a. Verify correct operation in:

HAND \_\_\_\_\_ OFF \_\_\_\_\_ AUTO \_\_\_\_\_

b. Verify pressure drop across strainer:

Strainer inlet pressure \_\_\_\_\_ psig

Strainer outlet pressure \_\_\_\_\_ psig

c. Verify pump inlet/outlet pressure reading, compare to Testing,

Adjusting, and Balancing (TAB) Report and pump design conditions.

DESIGN TAB ACTUAL

Pump inlet pressure psig \_\_\_\_\_

Pump outlet pressure psig \_\_\_\_\_

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

Pump inlet pressure psig \_\_\_\_\_

Pump outlet pressure psig \_\_\_\_\_

Pump flow rate gpm \_\_\_\_\_

SETPOINT

Differential Pressure Transmitter \_\_\_\_\_

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- e. For variable speed pumps, operate pump at shutoff (shutoff to be done in manual on variable speed drive at the minimum rpm that the system is being controlled at) and at minimum flow or when all components are in full by-pass. Plot test readings on pump curve and compare results against readings taken from flow measuring devices.

SHUTOFF 100 percent

Pump inlet pressure psig \_\_\_\_\_

Pump outlet pressure psig \_\_\_\_\_

Pump flow rate gpm \_\_\_\_\_

SETPOINT

Differential Pressure Transmitter \_\_\_\_\_

- 2. Measure motor amperage each phase and voltage phase to phase and phase to ground for both the full flow and the minimum flow conditions. Compare amperage to nameplate FLA

- a. Full flow:

Nameplate FLA \_\_\_\_\_

Amperage Phase 1 \_\_\_\_\_ Phase 2 \_\_\_\_\_ Phase 3 \_\_\_\_\_

Voltage Ph1-Ph2 \_\_\_\_\_ Ph1-Ph3 \_\_\_\_\_ Ph2-Ph3 \_\_\_\_\_

Voltage Ph1-gnd \_\_\_\_\_ Ph2-gnd \_\_\_\_\_ Ph3-gnd \_\_\_\_\_

- b. Minimum flow:

Amperage Phase 1 \_\_\_\_\_ Phase 2 \_\_\_\_\_ Phase 3 \_\_\_\_\_

Voltage Ph1-Ph2 \_\_\_\_\_ Ph1-Ph3 \_\_\_\_\_ Ph2-Ph3 \_\_\_\_\_

Voltage Ph1-gnd \_\_\_\_\_ Ph2-gnd \_\_\_\_\_ Ph3-gnd \_\_\_\_\_

- 3. Note unusual vibration, noise, etc.

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

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

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Contracting Officer's Representative	_____
Design Agency Representative	_____
Using Agency's Representative	_____

**Functional Performance Test - Centrifugal Chiller**

Note: If water-cooled chiller perform in conjunction with Cooling Tower test.

1. Demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows:
  - a. Time of day startup program initiates chiller start: \_\_\_\_\_
  - b. Start condenser water pump and establish condenser water flow. Verify chiller condenser water proof-of-flow switch operation. \_\_\_\_\_
  - c. Start chilled water pump and establish chilled water flow. Verify chiller chilled water proof-of-flow switch operation. \_\_\_\_\_
  - d. Verify control system energizes chiller start sequence. \_\_\_\_\_
  - e. Verify chiller senses chilled water temperature above set point and control system activates chiller start. \_\_\_\_\_
  - f. Verify functioning of "soft start" sequence. \_\_\_\_\_
  - g. Record data in 2, 3 and 4 below on fully load chiller.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- h. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed. \_\_\_\_\_
- i. Restart air-handling equipment one minute after chiller shut down. Verify condenser water pump, cooling tower and chiller restart sequence. \_\_\_\_\_
- j. Verify chiller inlet/outlet pressure and flow reading, compare to Testing, Adjusting, and Balancing (TAB) Report, chiller design conditions and chiller manufacturer's performance data.

DESIGN TAB REPORT ACTUAL

Chiller inlet pressure psig \_\_\_\_\_

Chiller outlet pressure psig \_\_\_\_\_

Chiller flow GPM \_\_\_\_\_

- 3. Measure chiller amperage each phase and voltage phase-to-phase and phase-to-ground for both the fully loaded condition.

Motor F/L AMPS

Amperage Phase 1 \_\_\_\_\_ Phase 2 \_\_\_\_\_ Phase 3 \_\_\_\_\_

Voltage Ph1-Ph2 \_\_\_\_\_ Ph1-Ph3 \_\_\_\_\_ Ph2-Ph3 \_\_\_\_\_

Voltage Ph1-gnd \_\_\_\_\_ Ph2-gnd \_\_\_\_\_ Ph3-gnd \_\_\_\_\_

- 4. Record the following information: Design

Ambient dry bulb temperature \_\_\_\_\_ deg F

Entering chilled water temperature \_\_\_\_\_ deg F

Leaving chilled water temperature \_\_\_\_\_ deg F

Calculate chiller load at ambient conditions and compare to chiller rated capacity from manufacturer's literature.

Calculated: \_\_\_\_\_ Ton

Rated: \_\_\_\_\_ Ton

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

5. Unusual vibration, noise, etc.

\_\_\_\_\_

\_\_\_\_\_

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

	Signature and Date
Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Contracting Officer's Representative	_____
Design Agency Representative	_____
Using Agency's Representative	_____

**Functional Performance Test - Cooling Tower**

1. Demonstrate operation of the cooling tower as per specification and the following:

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

Verify fan start after timed delay.

b. After chiller startup, control system should modulate bypass valve and two-speed fan motor to maintain condenser water set point.

Verify function of bypass valve under varying loads.

c. Verify cooling tower interlock with chiller.

d. Verify makeup water float valve is functioning.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

e. Activate chemical treatment feed valve, verify make-up of chemical treatment system, pump and controls.

f. Record the following:

Entering water temperature: \_\_\_\_\_ deg F

Leaving water temperature: \_\_\_\_\_ deg F

Measured water flow: \_\_\_\_\_ gpm

Entering air wet bulb temperature: \_\_\_\_\_ deg F

2. Compare results with test results from cooling tower specification test.

a. Stop all building cooling equipment so that cooling tower pumps stop. Observe tower for at least 15 minutes and verify no overflow occurs.

b. Start cooling tower pumps in hand and observe pumps for air binding/cavitation, none allowed.

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

Signature and Date

Contractor's Commissioning Specialist \_\_\_\_\_

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

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

Contractor's TAB Representative \_\_\_\_\_

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

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

Design Agency Representative \_\_\_\_\_

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

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Functional Performance Test Checklist - VAV Terminals**

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

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

a. Cooling only VAV boxes:

- i. Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F below ambient and measure maximum airflow. Turn thermostat to 5 degrees F above ambient and measure minimum airflow.

Setting Measured Design

Maximum flow [ ] [ ] [ ] cfm

Minimum flow [ ] [ ] [ ] cfm

b. Cooling with reheat VAV boxes:

- i. Verify VAV box response to room temperature set point adjustment. Turn thermostat to 5 degrees F above ambient and measure maximum airflow. Turn thermostat to 5 degrees F below ambient and measure minimum airflow.

Setting Measured Design

Maximum flow [ ] [ ] [ ] cfm

Minimum flow [ ] [ ] [ ] cfm

- ii. Verify reheat coil operation range (full closed to full open) by turning room thermostat 5 degrees F above ambient.

With heating water system and boiler in operation providing design supply hot water temperature records the following:

Design HW supply temperature: \_\_\_\_\_ deg F

Actual HW supply temperature: \_\_\_\_\_ deg F

AHU supply air temperature: \_\_\_\_\_ deg F

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

VAV supply air temperature: \_\_\_\_\_ deg F

Calculate coil capacity and compare to design:

Design: \_\_\_\_\_ BTU/hr

Actual: \_\_\_\_\_ BTU/hr

c. Parallel Fan powered VAV boxes:

- i. Verify VAV box responses to call for heating via set point adjustment. Change from cooling set point to heating set point. Verify cooling damper closes to minimum position, blower fan energizes according to sequence of operation, and upon further drop in space temperature, heating coil activation.

With heating water system in operation providing design supply hot water temperature records the following:

Design HW supply temperature: \_\_\_\_\_ deg F

Actual HW supply temperature: \_\_\_\_\_ deg F

AHU supply air temperature: \_\_\_\_\_ deg F

VAV supply air temperature: \_\_\_\_\_ deg F

Calculate coil capacity and compare to design:

Design: \_\_\_\_\_ BTU/hr

Actual: \_\_\_\_\_ BTU/hr

- ii. Check primary air damper maximum/minimum flow settings and compare to actual measured flows.

Setting Measured Design

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

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

- iii. Check blower fan flow. [\_\_\_\_\_] cfm

- iv. Verify free operation of fan backdraft damper (insure no primary air is being discharged into plenum space).

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

d. Series Fan Powered VAV boxes

- i. Ensure VAV fan starts prior to AHU fan
- ii. Verify VAV box response to sensor call for heating via set point adjustment. Change from cooling set point to heating set point. Verify cooling damper closes to minimum position and upon further drop in space temperature, heating coil activation. With heating water system and boiler in operation providing design supply hot water temperature record the following:

Design HW supply temperature: \_\_\_\_\_ deg F

Actual HW supply temperature: \_\_\_\_\_ deg F

AHU supply air temperature: \_\_\_\_\_ deg F

VAV supply air temperature: \_\_\_\_\_ deg F

Calculate coil capacity and compare to design:

Design: \_\_\_\_\_ BTU/hr

Actual: \_\_\_\_\_ BTU/hr

- iii. Check primary air damper maximum/minimum flow settings and compare to actual measured flows.

Setting Measured Design

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

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

- iv. Verify that minimal primary air is discharging into the plenum space when in full cooling mode.
- v. Verify that no plenum air is being induced from the plenum space into the supply air during full cooling by measuring supply air temperature and comparing to primary air temperature

Primary air temp: \_\_\_\_\_ deg F

Supply air temp: \_\_\_\_\_ deg F

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

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

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Contracting Officer's Representative	_____
Design Agency Representative	_____
Using Agency's Representative	_____

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

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:
  - a. Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.
  - b. The following shall be verified [supply fan operating][supply and return fans operating] mode is initiated:
    - i. All dampers in normal position prior to fan start.
    - ii. All valves in normal position prior to fan start.
    - iii. System safeties allow start if safety conditions are met.
    - iv. VAV fan controller shall "soft-start" fan.
    - v. Modulate all VAV boxes to minimum air flow and verify that the static pressure does not exceed the high static pressure shutdown setpoint.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- vi. Return all VAV boxes to auto.
- c. Occupied mode of operation - economizer de-energized.
  - i. Outside air damper at minimum position.
  - ii. Return air damper open.
  - iii. Relief air damper [at minimum position] [closed].
  - iv. Chilled water control valve modulating to maintain leaving air temperature set point.
    - Setpoint: \_\_\_\_\_ deg F
    - Actual: \_\_\_\_\_ deg F
  - v. Fan VAV controller receiving signal from duct static pressure sensor and modulating fan to maintain supply duct static pressure set point.
    - Setpoint: \_\_\_\_\_ inches-wg
    - Actual: \_\_\_\_\_ inches-wg
- d. Occupied mode of operation - economizer energized.
  - i. Outside air damper modulated to maintain mixed air temperature setpoint.
    - Setpoint: \_\_\_\_\_ deg F
    - Actual: \_\_\_\_\_ deg F
    - Outside air damper position. \_\_\_\_\_ %
  - ii. Relief air damper modulates with outside air damper according to sequence of operation.
    - Relief air damper position. \_\_\_\_\_ %
  - iii. Chilled water control valve modulating to maintain leaving air temperature set point.
    - Setpoint: \_\_\_\_\_ deg F
    - Actual: \_\_\_\_\_ deg F

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- iv. Hot water control valve modulating to maintain leaving air temperature set point.

Setpoint: \_\_\_\_\_ deg F

Actual: \_\_\_\_\_ deg F

- v. Fan VAV controller receives signal from duct static pressure sensor and modulates fan to maintain supply duct static pressure set point.

Setpoint: \_\_\_\_\_ inches-wg

Actual: \_\_\_\_\_ inches-wg

- e. Unoccupied mode of operation

- i. Observe fan starts when space temperature calls for heating and/or cooling. Note: This does not apply to series boxes.
- ii. All dampers in normal position.
- iii. Verify space temperature is maintained as specified in sequence of operation.

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

- i. All dampers in normal position.
- ii. All valves in normal position.
- iii. Fan de-energizes.

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

Max Cooling

Supply air temp: \_\_\_\_\_ deg F

Verify cooling valve operation.

Min cooling

Supply air temp: \_\_\_\_\_ deg F

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

Verify cooling valve operation.

- h. Verify safety shut down initiated by low temperature protection thermostat.
  - i. Verify occupancy schedule is programmed into time clock/UMCS.
2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Contracting Officer's Representative	_____
Using Agency's Representative	_____

**Functional Performance Test Checklist - Single Zone Air Handling Unit**

- 1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:
  - a. Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.
  - b. The following shall be verified when the [supply fan operating] supply and return fans operating] mode is initiated:
    - i. All dampers in normal position prior to fan start.
    - ii. All valves in normal position prior to fan start.
    - iii. System safeties allow start if safety conditions are met.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- iv. Occupied mode of operation - economizer de-energized.
- v. Outside air damper at minimum position.
- vi. Return air damper open.
- vii. Relief air damper [at minimum position][closed].
- viii. Chilled water control valve modulating to maintain space cooling temperature set point.

Setpoint: \_\_\_\_\_ deg F

Actual: \_\_\_\_\_ deg F

- ix. Hot water control valve modulating to maintain space heating temperature set point input from outside air temperature controller.

c. Occupied mode of operation - economizer energized.

- i. Outside air damper modulated to maintain mixed air temperature set point.

Setpoint: \_\_\_\_\_ deg F

Actual: \_\_\_\_\_ deg F

O/A Damper Position: \_\_\_\_\_ %

Return Air Temperature: \_\_\_\_\_ deg F

Outside Air Temperature: \_\_\_\_\_ deg F

- ii. Relief air damper modulates with outside air damper according to sequence of operation.

Relief air damper position: \_\_\_\_\_ %

- iii. Chilled water control valve modulating to maintain space cooling temperature set point.

Setpoint: \_\_\_\_\_ deg F

Actual: \_\_\_\_\_ deg F

Return sensor overrides to normal operation.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- d. Unoccupied mode of operation.
    - i. Observe fan starts when space temperature calls for heating/cooling.
    - ii. All dampers in normal position.
    - iii. Verify low limit space temperature is maintained as specified in sequence of operation.
  - e. The following shall be verified when the [supply fan off][supply and return fans off] mode is initiated:
    - i. All dampers in normal position.
    - ii. All valves in normal position.
    - iii. Fan de-energizes.
  - f. Verify cooling coil and heating coil operation by varying thermostat set point from cooling set point to heating set point and returning to cooling set point.
  - g. Verify safety shut down initiated by low temperature protection thermostat.
  - h. Verify occupancy schedule is programmed into time clock/UMCS.
2. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

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

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

**Functional Performance Test Checklist - Multi-zone Air Handling Unit**

1. Functional Performance Test: Contractor shall verify operation of air handling unit as per specification including the following:
  - a. Ensure that a slight negative pressure exists on inboard side of the outside air dampers throughout the operation of the dampers. Modulate OA, RA, and EA dampers from fully open to fully closed positions.
  - b. The following shall be verified when the supply and return fans operating mode is initiated:
    - i. All dampers in normal position.
    - ii. All valves in normal position.
    - iii. System safeties allow start if safety conditions are met.
  - c. Occupied mode of operation - economizer de-energized.
    - i. Outside air damper at minimum position.
    - ii. Return air damper open.
    - iii. Relief air damper [at minimum position] [closed].
    - iv. Chilled water control valve modulating to maintain cold deck supply air temperature set point.

Setpoint: \_\_\_\_\_ deg F

Actual: \_\_\_\_\_ deg F

- v. Hot water control valve modulating to maintain hot deck supply air temperature set point input from outside air temperature controller.

Setpoint: \_\_\_\_\_ deg F

Actual: \_\_\_\_\_ deg F

O/A: \_\_\_\_\_ deg F

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- d. Occupied mode of operation - economizer energized. Note outside air and return air temperature sensors may need to be simulated.
- i. Outside air damper modulates to maintain mixed air temperature set point.  
  
Setpoint: \_\_\_\_\_ deg F  
  
Actual: \_\_\_\_\_ deg F  
  
Return Air Temperature: \_\_\_\_\_ deg F  
  
Outside Air Temperature: \_\_\_\_\_ deg F
  - ii. Relief air damper modulates with outside air damper according to sequence of operation.
  - iii. Chilled water control valve modulating to maintain cold deck supply air temperature set point.  
  
Setpoint: \_\_\_\_\_ deg F  
  
Actual: \_\_\_\_\_ deg F
  - iv. Hot water control valve modulating to maintain hot deck supply air temperature set point input from outside air temperature controller.  
  
Setpoint: \_\_\_\_\_ deg F  
  
Actual: \_\_\_\_\_ deg F  
  
O/A: \_\_\_\_\_ deg F  
  
Return temperature sensors to normal operation.
- e. Unoccupied mode of operation note time clock and space temperature sensor may require simulation.
- i. Observe fan starts when space temperature calls for heating/cooling.
  - ii. All dampers in normal position.
  - iii. Verify low limit space temperature is maintained as specified in sequence of operation.
- f. The following shall be verified when the supply and return fans off mode is initiated:

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- i. All dampers in normal position.
- ii. All valves in normal position.
- iii. Fan de-energizes.

Note: return time clock and space temperature sensors to normal operation.

- g. Verify zone damper operation by varying zone thermostat set points from cooling set point to heating set point and returning to cooling set point.
- h. Verify safety shut down initiated by low temperature protection thermostat.
- i. Index room thermostats to full cooling then to full heating. Measure and record cold deck, hot deck, and supply air temperatures and determine damper leakage for a minimum of 2 zones.

Cold deck temperature: \_\_\_\_\_ deg F

Hot deck temperature: \_\_\_\_\_ deg F

Zone \_\_\_\_ Supply Air Temperature at Max Cooling \_\_\_\_\_ deg F

Zone \_\_\_\_ Supply Air Temperature at Max Heating \_\_\_\_\_ deg F

Zone \_\_\_\_ Hot Deck Damper leakage at Max cooling \_\_\_\_\_ CFM

Zone \_\_\_\_ Cold Deck Damper leakage at Max heating \_\_\_\_\_ CFM

Zone \_\_\_\_ Supply Air Temperature at Max Cooling \_\_\_\_\_ deg F

Zone \_\_\_\_ Supply Air Temperature at Max Heating \_\_\_\_\_ deg F

Zone \_\_\_\_ Hot Deck Damper leakage at Max cooling \_\_\_\_\_ CFM

Zone \_\_\_\_ Cold Deck Damper leakage at Max heating \_\_\_\_\_ CFM

- j. Verify occupancy schedule is programmed into time clock/UMCS.

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

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Contracting Officer's Representative	_____
Using Agency's Representative	_____

**Functional Performance Test Checklist - Packaged Air Cooled Chiller**

1. Functional Performance Test: Contractor shall demonstrate operation of chilled water system as per specifications including the following: Start building air handler to provide load for chiller. Activate controls system chiller start sequence as follows.
  - a. Start chilled water pump and establish chilled water flow. Verify chiller-chilled water proof-of-flow switch operation.
  - b. Verify control system energizes chiller start sequence.
  - c. Verify chiller senses chilled water temperature above set point and control system activates chiller start.  
  
Setpoint: \_\_\_\_\_ deg F  
Actual: \_\_\_\_\_ deg F
  - d. Verify functioning of "soft start" sequence.
  - e. Verify and record chiller data per 2, 3 and 4 below on fully loaded chiller.
  - f. Shut off air handling equipment to remove load on chilled water system. Verify chiller shutdown sequence is initiated and accomplished after load is removed.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- g. Restart air handling equipment one minute after chiller shut down. Verify chiller restart sequence.
- 2. Verify chiller inlet/outlet pressure reading, compare to Testing, Adjusting, and Balancing (TAB) Report, chiller design conditions, and chiller manufacturer's performance data.

DESIGN TAB TEST ACTUAL

Chiller inlet pressure (psig) \_\_\_\_\_

Chiller outlet pressure (psig) \_\_\_\_\_

Chiller flow GPM \_\_\_\_\_

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

Motor F/L AMPS

Amperage Phase 1 \_\_\_\_\_ Phase 2 \_\_\_\_\_ Phase 3 \_\_\_\_\_

Voltage Ph1-Ph2 \_\_\_\_\_ Ph1-Ph3 \_\_\_\_\_ Ph2-Ph3 \_\_\_\_\_

Voltage Ph1-gnd \_\_\_\_\_ Ph2-gnd \_\_\_\_\_ Ph3-gnd \_\_\_\_\_

- a. Record the following information:

Design

Ambient dry bulb temperature \_\_\_\_\_ deg F

Entering chilled water temperature \_\_\_\_\_ deg F

Leaving chilled water temperature \_\_\_\_\_ deg F

- b. Calculate chiller load at ambient conditions and compare to chiller rated capacity from manufacturer's literature.

Calculated: \_\_\_\_\_ Ton

Rated: \_\_\_\_\_ Ton

- 4. Unusual vibration, noise, etc.

\_\_\_\_\_

\_\_\_\_\_

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

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

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Contracting Officer's Representative	_____
Using Agency's Representative	_____

**Functional Performance Test Checklist - Air Cooled Condensing Unit**

1. Functional Performance Test: Contractor shall demonstrate operation of refrigeration system as per specifications including the following:

Start building air handler to provide load for condensing unit. Activate controls system start sequence as follows.

- a. Start air handling unit. Verify control system energizes condensing unit start sequence.
- b. Verify and record data in 2 and 3 below.
- c. Shut off air handling equipment to verify condensing unit de-energizes.
- d. Restart air handling equipment one minute after condensing unit shut down. Verify condensing unit restart sequence.

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

Motor Full-Load Amps: \_\_\_\_\_

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

Amperage Phase 1 \_\_\_\_\_ Phase 2 \_\_\_\_\_ Phase 3 \_\_\_\_\_

Voltage Ph1-Ph2 \_\_\_\_\_ Ph1-Ph3 \_\_\_\_\_ Ph2-Ph3 \_\_\_\_\_

Voltage Ph1-gnd \_\_\_\_\_ Ph2-gnd \_\_\_\_\_ Ph3-gnd \_\_\_\_\_

3. Record the following information:

Ambient dry bulb temperature: \_\_\_\_\_ deg F

Suction pressure: \_\_\_\_\_ psig

Discharge pressure: \_\_\_\_\_ psig

4. Unusual vibration, noise, etc.

\_\_\_\_\_

\_\_\_\_\_

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

Signature and Date

Contractor's Commissioning Specialist \_\_\_\_\_

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

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

Contractor's TAB Representative \_\_\_\_\_

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

Design Agency Representative \_\_\_\_\_

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

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

**Functional Performance Test Checklist - Hot Water Boiler**

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

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- a. Start hot water pump and establish hot water flow.
- b. Verify boiler hot water proof-of-flow switch operation.
- c. Verify control system energizes boiler start sequence.
- d. Verify boiler senses hot water temperature below set point and control system activates boiler start.

Setpoint: \_\_\_\_\_ deg F

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

DESIGN SYSTEM TEST ACTUAL

Boiler inlet water temperature deg F	_____
Boiler outlet water temperature deg F	_____
Boiler outlet pressure psig	_____
Boiler flow rate gpm	_____
Flue-gas temperature at boiler outlet deg F	_____
Percent carbon dioxide in flue-gas	_____
Draft at boiler flue-gas exit inches-wg	_____
Stack emission pollutants concentration	_____
Fuel type	_____
Combustion efficiency	_____

- 3. Record the following information:

Ambient dry bulb temperature to determine reset schedule: \_\_\_\_\_ deg F

Building Entering hot water temperature: \_\_\_\_\_ deg F

Building Leaving hot water temperature: \_\_\_\_\_ deg F

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- 4. Verify temperatures in item 3 are in accordance with the reset schedule.
  
- 5. Verify proper operation of boiler safeties.
  - a. Low water \_\_\_\_\_
  - b. Water flow \_\_\_\_\_
  - c. Flame failure \_\_\_\_\_
  - d. Pilot failure \_\_\_\_\_
  - e. Pre and Post Purge failure \_\_\_\_\_
  - f. Pressure relief \_\_\_\_\_
  - g. High temperature \_\_\_\_\_
  
- 6. Shut off building heating equipment to remove load on hot water system. Verify boiler shutdown sequence is initiated and accomplished after load is removed.
  
- 7. Unusual vibration, noise, etc.  
\_\_\_\_\_  
\_\_\_\_\_
  
- 8. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Contracting Officer's Representative	_____

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

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

**Functional Performance Test Checklist - Steam Boiler**

1. Functional Performance Test: Contractor shall demonstrate operation of steam heating system as per specifications including the following: Start building heating equipment to provide load for boiler. Activate controls system boiler start sequence as follows.
  - a. Start steam heating system. Verify control system energizes boiler start sequence.
  - b. Verify boiler senses steam pressure below set point and control system activates boiler start.
  - c. Shut off building heating equipment to remove load on steam heating system. Verify boiler shutdown sequence is initiated and accomplished after load is removed.
  - d. Verify that water level and makeup water system are operational.
2. Verify boiler inlet/outlet pressure reading, compare to boiler design conditions and manufacturer's performance data.

DESIGN SYSTEM TEST ACTUAL

Boiler inlet feedwater temp deg F. \_\_\_\_\_

Boiler outlet pressure psig. \_\_\_\_\_

Flue-gas temperature at boiler outlet deg F. \_\_\_\_\_

Percent carbon dioxide in flue-gas. \_\_\_\_\_

Draft at boiler flue-gas exit inches-wg. \_\_\_\_\_

Stack emission pollutants concentration. \_\_\_\_\_

Fuel type. \_\_\_\_\_

Combustion efficiency. \_\_\_\_\_

3. Record the following information:

Ambient temperature: \_\_\_\_\_ deg F

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

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

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

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

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

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Contracting Officer's Representative	_____
Using Agency's Representative	_____

**Functional Performance Test Checklist - Fan Coil Units**

The Contracting Officer will select fan coil units to be spot-checked during the functional performance test. The number of terminals shall not exceed 10 percent. Hot water and chilled water systems must be in operation providing design water temperatures.

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

a. Cooling only fan coils:

i. Verify fan coil unit response to room temp set point adjustment.

ii. Check blower fan airflow. \_\_\_\_\_ cfm

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

iii. Check cooling coil water flow. \_\_\_\_\_ gpm

iv. Verify proper operation of cooling water control valve.

v. Cooling mode inlet air temperature. \_\_\_\_\_ def F

vi. Cooling mode outlet air temperature. \_\_\_\_\_ def F

vii. Calculate coil sensible capacity and compare to design:

Calculated: \_\_\_\_\_ BTU/hr

Design: \_\_\_\_\_ BTU/hr

b. Cooling/heating fan coils:

i. Verify fan coil unit response to room temp set point adjustment.

ii. Check blower fan airflow. \_\_\_\_\_ cfm

iii. Check cooling coil water flow. \_\_\_\_\_ cfm

iv. Verify proper operation of cooling water control valve.

v. Check cooling mode inlet air temperature. \_\_\_\_\_ def F

vi. Check cooling mode outlet air temperature. \_\_\_\_\_ def F

vii. Calculate cooling coil sensible capacity and compare to design:

Calculated: \_\_\_\_\_ BTU/hr

Design: \_\_\_\_\_ BTU/hr

viii. Check heating coil water flow. \_\_\_\_\_ gpm

ix. Verify proper operation of heating water control valve.

x. Check heating mode inlet air temperature. \_\_\_\_\_ def F

xi. Check heating mode outlet air temperature. \_\_\_\_\_ def F

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

xii. Calculate heating coil capacity and compare to design:

Calculated: \_\_\_\_\_ BTU/hr

Design: \_\_\_\_\_ BTU/hr

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

Signature and Date

Contractor's Commissioning Specialist \_\_\_\_\_

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

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

Contractor's TAB Representative \_\_\_\_\_

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

Design Agency Representative \_\_\_\_\_

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

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

**Functional Performance Test Checklist - Unit Heaters**

The Contracting Officer will select unit heaters to be spot-checked during the functional performance test. The number of terminals shall not exceed 10 percent. Hot water systems {for hot water unit heaters} must be in operation and supplying design hot water supply temperature water.

1. Functional Performance Test: Contractor shall demonstrate operation of selected unit heaters:

a. Verify unit heater response to room temperature set point adjustment.

b. Check heating mode inlet air temperature: \_\_\_\_\_ def F

c. Check heating mode outlet air temperature. \_\_\_\_\_ def F

d. Record manufacturer's submitted fan capacity \_\_\_\_\_ cfm

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

- e. Calculate unit heater capacity using manufacturer's fan capacity and recorded temperatures and compare to design.

Calculated: \_\_\_\_\_ BTU/hr

Design: \_\_\_\_\_ BTU/hr

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

Signature and Date

Contractor's Commissioning Specialist \_\_\_\_\_

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

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

Contractor's TAB Representative \_\_\_\_\_

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

Design Agency Representative \_\_\_\_\_

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

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

**Functional Performance Test Checklist - Steam/Hot Water Converter**

- 1. Functional Performance Test: Contractor shall demonstrate operation of heating system as per specifications including the following: Start building heating equipment to provide load for converter.
  - a. Verify control system energizes. \_\_\_\_\_
  - b. Verify converter senses hot water temperature below set point and control system modulates steam valve. \_\_\_\_\_
  - c. Shut off building heating equipment to remove load on heating system. Verify converter steam valve closes after load is removed.
- 2. Verify converter inlet/outlet pressure reading, compare to converter design conditions and manufacturer's performance data.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

DESIGN ACTUAL

- Converter inlet water temp deg F \_\_\_\_\_
- Converter outlet water temp deg F \_\_\_\_\_
- Converter inlet steam pressure psig \_\_\_\_\_
- Determine water flow rate based on pressure drop through converter (GPM). \_\_\_\_\_
- Determine water flow rate with flow measuring device GPM. \_\_\_\_\_
- Verify that temperature of water Current Actual is in accordance with outdoor air Setpoint Temperature reset schedule. \_\_\_\_\_
- 3. Verify proper operation of converter safeties. \_\_\_\_\_
- 4. Check and report unusual vibration, noise, etc.  
\_\_\_\_\_  
\_\_\_\_\_
- 5. Certification: We the undersigned have witnessed the above functional performance tests and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

- Contractor's Commissioning Specialist \_\_\_\_\_
- Contractor's Mechanical Representative \_\_\_\_\_
- Contractor's Electrical Representative \_\_\_\_\_
- Contractor's TAB Representative \_\_\_\_\_
- Contractor's Controls Representative \_\_\_\_\_
- Design Agency Representative \_\_\_\_\_
- Contracting Officer's Representative \_\_\_\_\_
- Using Agency's Representative \_\_\_\_\_

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Functional Performance Test Checklist - Computer Room Unit**

1. Functional Performance Test: Contractor shall verify operation of computer room unit as per specification including the following:
  - a. System safeties allow start if safety conditions are met.
  - b. Verify cooling and heating operation by varying thermostat set point from space set point to space set point plus 10 degrees, space set point minus 10 degrees, and returning to space set point.
  - c. Verify humidifier operation by varying humidistat set point from space set point to space set point plus 20 percent RH, and returning to space set point.
  - d. Verify that airflow is within tolerance specified in Section

**TESTING, ADJUSTING, AND BALANCING OF HVAC SYSTEMS.**

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

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Contracting Officer's Representative	_____
Using Agency's Representative	_____

**Functional Performance Test Checklist - HVAC Controls**

The Contracting Officer will select HVAC control systems to undergo functional performance testing. The number of systems shall not exceed 10 percent. Perform this test simultaneously with FPT for AHU or other controlled equipment.

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

1. Functional Performance Test: Contractor shall verify operation of HVAC controls by performing the Performance Verification Test (PVT) test for that system. Contractor to provide blank PVT test procedures previously done by the controls Contractor.
2. Verify interlock with UMCS system.
3. Verify all required I/O points function from the UMCS system.
4. Certification: We the undersigned have witnessed the Performance Verification Test and certify that the item tested has met the performance requirements in this section of the specifications.

Signature and Date

Contractor's Commissioning Specialist	_____
Contractor's Mechanical Representative	_____
Contractor's Electrical Representative	_____
Contractor's TAB Representative	_____
Contractor's Controls Representative	_____
Design Agency Representative	_____
Contractor's Officer's Representative	_____
Using Agency's Representative	_____

**Functional Performance Test Checklist - Energy Recovery System**

1. Functional Performance Test: Contractor shall demonstrate operation of energy recovery system as per specifications including the following:
  - Start equipment to provide energy source for recovery system.
  - a. Verify energy source is providing recoverable energy.
  - b. Verify recovery system senses available energy and activates.
2. Verify recovery system inlet/outlet readings, compare to design conditions and manufacturer's performance data.

Design Actual

Primary loop inlet temp (degrees F)	_____
-------------------------------------	-------

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

Primary loop outlet temp (degrees F) \_\_\_\_\_

Primary loop flow rate [gpm][cfm] \_\_\_\_\_

Secondary loop inlet temp (degrees F) \_\_\_\_\_

Secondary loop outlet temp (degrees F) \_\_\_\_\_

Secondary loop flow rate [gpm][cfm] \_\_\_\_\_

Primary loop energy BTU/hr \_\_\_\_\_

Secondary loop energy BTU/hr \_\_\_\_\_

3. Verify that recovery system deactivates when recoverable energy is no longer available.

\_\_\_\_\_

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

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

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

Signature and Date

Contractor's Commissioning Specialist \_\_\_\_\_

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

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

Contractor's TAB Representative \_\_\_\_\_

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

Design Agency Representative \_\_\_\_\_

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

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

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Functional Performance Test Checklist – Fire Alarm System**

**Design Engineer:** \_\_\_\_\_ **Contractor:** \_\_\_\_\_

DESCRIPTION				WITNESS			
Elevator Recall Operation	CONTR		U.C.B.	MFGR REP	DESIGN ENGR	ELEVATOR SUPPLIER	–
			Fire Alarm	Elev.	–		
Fan Shutdown/Smoke Evacuation Operation			U.C.B.	MFGR REP	DESIGN ENGR	CONTROL CONTR	–
			Fire Alarm	Control	–		
Pre-action System Operation	CONTR		U.C.B.	MFGR REP	DESIGN ENGR	SUPL'R CONT'R	FIRE PROT CONSLT
			Fire Alarm	Spe'l Tech	EH&S		
Initiation of Smoke Detectors	CONTR		U.C.B.	MFGR REP	DESIGN ENGR	–	–
			Fire Alarm	–	–		
Initiation of Duct Detectors	CONTR		U.C.B.	MFGR REP	DESIGN ENGR	–	–
			Fire Alarm	–	–		
Initiation of Pull Stations	CONTR		U.C.B.	MFGR REP	DESIGN ENGR	–	–
			Fire Alarm				



**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Appendix D**

**BUILDING ENVELOPE PERFORMANCE TESTING CHECKLISTS**

**Components included:** \_\_\_ unit masonry, \_\_\_ limestone veneer, \_\_\_ cast stone, \_\_\_ sheet metal flashing & trim, \_\_\_ roof, \_\_\_ joint sealants, \_\_\_ wood windows/doors

**1. Submittal / Approvals**

**Submittal:** The above components and systems integral to them are complete and ready for testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This construction checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed. \_\_\_ List attached.

Sealant Contractor	Date	Glazing Contractor	Date
Ext. Limestone Veneer Contractor	Date	Sheet Metal Contractor	Date
Masonry/Cast Stone Contractor	Date	Steel Fabricator	Date
General Contractor	Date	Roof Contractor	Date

Construction checklist items are to be completed as part of installation & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer’s recommended checkout and installation procedures or reporting requirements.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- Contractors’ assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.
- “Contr.” column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, CxA = commissioning agent, GC = general contractor, LVC = limestone veneer/sheet metal contractor, SC = sealant contractor, GLC = glazing contractor, UMC = masonry/cast stone/sheet metal contractor, RC = roof contractor, SMC = sheet metal contractor

**Approvals:** This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

Commissioning Agent	Date	Owner’s Representative	Date
---------------------	------	------------------------	------

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

Building Envelope Components	Masonry	Limestone Veneer/ Cast Stone	Sheet Metal	Sealants	Glazing	Steel	Roof	Contr.
Manufacturer's cut sheets.								
Installation details.								
Manufacturer's requirements.								
Shop drawings showing attachment and details grills and louver.								
Architect of Record has reviewed installation to see that placement is consistent with original design.								
Building envelop Structural Engineer of Record has reviewed concentric connections between limestone and embeds and issued a letter of authorization to proceed.								

**2. Requested documentation submitted (filled out by CxA)**

\* Documentation complete per contract documents for given trade.  YES  NO

**3. Installation Checks (filled out by Contractor)**

Location: \_\_\_\_\_ Elevation \_\_\_\_\_ Floor; \_\_\_\_\_ From grid line \_\_\_\_\_ to grid line \_\_\_\_\_

Location: \_\_\_\_\_ Elevation \_\_\_\_\_ Floor; \_\_\_\_\_ From grid line \_\_\_\_\_ to grid line \_\_\_\_\_

Location: \_\_\_\_\_ Elevation \_\_\_\_\_ Floor; \_\_\_\_\_ From grid line \_\_\_\_\_ to grid line \_\_\_\_\_

Location: \_\_\_\_\_ Elevation \_\_\_\_\_ Floor; \_\_\_\_\_ From grid line \_\_\_\_\_ to grid line \_\_\_\_\_





















**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

<b>Building Envelope Components - Grills &amp; Louvers</b>	<b>Masonry</b>	<b>Limestone Veneer/ Cast Stone</b>	<b>Sheet Metal</b>	<b>Sealants</b>	<b>Glazing</b>	<b>Steel</b>	<b>Roof</b>	<b>Contr.</b>
Sill members and other members have been set in a bed of sealant or with joint fillers or gaskets to provide weather tight construction.								
<b>Final</b>								
Report completed with this checklist attached								
Finished surfaces are clean and not discolored.								
Exterior wall has been cleaned in accordance with Contract Documents within 48 hours of substantial completion date								
All seals and joints are tight.								
System is waterproof as specified.								
Brick, limestone, cast stone are clean.								
Cavity drains remove moisture effectively preventing water build-up in the cavity.								

The checklist items of Part 3 are all successfully completed for given trade. \_\_\_ YES \_\_\_ NO

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Construction Checklist**

**WINDOWS & DOORS**

**Components included:** \_\_\_unit masonry, \_\_\_sheet metal flashing & trim, \_\_\_joint sealants, \_\_\_wood windows/doors, \_\_\_glazing, \_\_\_limestone veneer, \_\_\_brick/cast stone

**1. Submittal / Approvals**

**Submittal:** The above components and systems integral to them are complete and ready for functional testing. The checklist items are complete and have been checked off only by parties having direct knowledge of the event, as marked below, respective to each responsible contractor. This prefunction checklist is submitted for approval, subject to an attached list of outstanding items yet to be completed. A Statement of Correction will be submitted upon completion of any outstanding areas. None of the outstanding items preclude safe and reliable functional tests being performed. \_\_\_ List attached.

Masonry Contractor	Date	Glazing Contractor	Date
Interior Contractor	Date	Limestone Contractor	Date
Security Contractor	Date	Sealant Contractor	Date
General Contractor	Date		

Construction checklist items are to be completed as part of installation & initial checkout, preparatory to functional testing.

- This checklist does not take the place of the manufacturer’s recommended checkout and installation procedures or reporting requirements.
- Items that do not apply shall be noted with the reasons on this form (N/A = not applicable, BO = by others).
- Contractors’ assigned responsibility for sections of the checklist shall be responsible to see that checklist items by their subcontractors are completed and checked off.
- “Contr.” column or abbreviations in brackets to the right of an item refer to the contractor responsible to verify completion of this item. A/E = architect/engineer, All = all contractors, GC = general contractor, LVC = limestone veneer/sheet metal contractor, UMC = masonry /sheet metal contractor, SC = sealant contractor, GLC = glazing contractor, contractor CxA = commissioning agent, SCC = Security contractor

**Approvals.** This filled-out checklist has been reviewed. Its completion is approved with the exceptions noted below.

Commissioning Agent	Date	Owner’s Representative	Date
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**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**2. Requested documentation submitted (filled out by CxA)**

Windows and Doors	Hardware	Sheet Metal	Sealants	Glazing	Framing	Jambs & Thresholds	Contr.
Manufacturer's cut sheets.							
Installation details.							
AAMA 101 -97 test report by an independent laboratory for each window model and door configuration.							
ASTM E 330 test report by an independent laboratory for each window model.							
Shop drawings showing Attachment and details.							

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

<b>Windows and Doors</b>	<b>Hardware</b>	<b>Sheet Metal</b>	<b>Sealants</b>	<b>Glazing</b>	<b>Framing</b>	<b>Jams &amp; Thresholds</b>	<b>Contr.</b>
Window units are plumb, level, and true to line, without warp or rack of frames or sash. Proper support is provided and units are anchored securely in place.							
Masonry surfaces are dry and free of excess mortar, sand and other construction debris.							
Rough or masonry opening is correct with required clearance for proper installation of window.							
Metal surfaces are dry, clean, free of grease, oil, dirt, and corrosion, and without sharp edges or offsets at joints.							
Sill members and other members have been set in a bed of sealant or with joint fillers or gaskets to provide weather tight construction.							
Weeps are installed per Contract Documents.							
Weep holes are open and free of debris or blockages.							
Opening mechanism is installed correct within required clearance.							
Security contacts are installed and function correctly.							
<b>Joint Sealants</b>							
Windows are placed so that backer rod and sealant have sufficient bearing surface for proper adhesion and sealant reinforcement.							
Backing material has been installed in accordance with sealant manufacturer's requirements.							

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

<b>Joint Sealants</b>	<b>Hardware</b>	<b>Sheet Metal</b>	<b>Sealants</b>	<b>Glazing</b>	<b>Framing</b>	<b>Jambs &amp; Thresholds</b>	<b>Contr.</b>
Materials delivered in original containers or bundles with labels showing manufacturer, product name or designation, color, shelf life, and installation instructions.							
Surfaces are clean and dry prior to application of sealant.							
Joints are completely filled.							
Nonsag sealants have been tooled to smooth surface.							
Surfaces adjacent to joints are clean.							
Sealant has cured according to manufacturer's recommendations and is ready for testing.							
<b>Window Glazing</b>							
Each unit is permanently labeled on spacer or on one pane.							

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**3. Requested documentation submitted (filled out by CxA)**

<b>General Installation</b>	<b>Hardware</b>	<b>Sheet Metal</b>	<b>Sealants</b>	<b>Glazing</b>	<b>Framing</b>	<b>Jambs &amp; Thresholds</b>	<b>Contr.</b>
Exterior windows & door components completed and cleaned per Contract Documents.							
<b>Sheet Metal Flashing</b>							
Substrates and conditions under which sheet metal flashing and trim are to be installed are satisfactory.							
Sheet metal complies with at least minimum specified thickness, weight and grade.							
Lap joints are sealed in accordance with Contract Documents.							
Surfaces were cleaned with no oils or foreign matter prior to sealing or joining together.							
Joints have been filled with sealant per Contract Documents.							
<b>Windows</b>							
Color, quality and finish are with acceptable color range.							

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

<b>Check Windows &amp; Door Components</b>	<b>Hardware</b>	<b>Sheet Metal</b>	<b>Sealants</b>	<b>Glazing</b>	<b>Framing</b>	<b>Jambs &amp; Thresholds</b>	<b>Contr.</b>
Visual characteristics, such as pattern, bow, and roll wave distortion are uniform.							
Temporary labels have been Removed. No tape or labels have been applied to glazing.							
Installed glazing is clean.							
<b>Doors</b>							
Color quality and finish are within acceptable color range							
Door units are square, plumb, Level and true to line, without warp or rack of frame or sash. Proper support is provided and units are anchored securely in place.							
Masonry surfaces are dry and free of excess mortar, sand and other construction debris.							
Rough or masonry opening is correct within required clearance for proper installation of exterior doors.							
Metal surfaces are dry, clean, free of grease, oil, dirt, rust and corrosion, and welding slag, without sharp edges or offsets at joints.							
Doors are plumb, level and true to line, without warp or rack of frames or sash. Proper support is provided and units are anchored securely in place.							

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

<b>Doors</b>	<b>Hardware</b>	<b>Sheet Metal</b>	<b>Sealants</b>	<b>Glazing</b>	<b>Framing</b>	<b>Jams &amp; Thresholds</b>	<b>Contr.</b>
Jamb members and threshold members have been set in a bead of sealant or with joints fillers or gaskets to provide weathertight construction.							
Interior drains adjacent to ADA thresholds are plumbed to drainage plane per contract documents. Weep holes are open and free of debris or blockages.							
<b>Door Glazing</b>							
Each unit is permanently labeled on spacer or on one pane.							
Visual characteristics, such as pattern, bow, and roll wave distortion are uniform.							
Temporary labels have been removed. No take or labels have been applied to glazing.							
Installed glazing is clean.							

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

Final	Hardware	Sheet Metal	Sealants	Glazing	Framing	Jambs & Thresholds	Contr.
Report completed with this checklist attached.							
Finished surfaces are clean and not discolored.							

The checklist items of Part 3 are all successfully completed for given trade. \_\_\_ YES \_\_\_ NO

a. **Operational Checks** (These augment mfr’s list. This is not the functional performance testing.)

Check Windows & Doors Components	Hardware	Sheet Metal	Sealants	Glazing	Framing	Jambs & Thresholds	Contr.
All seals and joints are tight.							
System is waterproof as specified.							
Windows/doors and wood surfaces are clean. Hardware and other moving parts are lubricated.							
Windows/doors and hardware have been adjusted to operate smoothly and close tightly.							

The checklist items of Part 4 are all successfully completed for given trade. \_\_\_ YES \_\_\_ NO

**END OF SECTION 15995**

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

**Appendix**

**Index**

Commissioning Description & General Requirements	<b>1</b>
Typical Systems/Equipment to be Commissioned	<b>5</b>
Qualifications	<b>7</b>
Sequencing and Scheduling	<b>8</b>
Commissioning Flow Chart	<b>9</b>
Appendix A: Owner's Project Requirements for the Building's Exterior Enclosure	<b>11</b>
Appendix B: Pre-Functional Performance Test Checklists	<b>18</b>
Pre-Functional Performance Test Checklist - Battery	<b>34</b>
Pre-Functional Performance Test Checklist - Bus Duct	<b>35</b>
Pre-Functional Performance Test Checklist - Elec(tric) Receptacles & Other Devices	<b>36</b>
Pre-Functional Performance Test Checklist - Fire Alarm System	<b>36</b>
Pre-Functional Performance Test Checklist - Emergency Generator	<b>37</b>
Pre-Functional Performance Test Checklist - Grounding System	<b>38</b>
Pre-Functional Performance Test Checklist - Isolated Grounding System	<b>39</b>

**OKLAHOMA STATE UNIVERSITY - BUILDING DESIGN STANDARDS**

Pre-Functional Performance Test Checklist - KWH Meter	<b>40</b>
Pre-Functional Performance Test Checklist - KWH Meter	<b>41</b>
Pre-Functional Performance Test Checklist - Medium Voltage Cables (15KV)	<b>42</b>
Pre-Functional Performance Test Checklist - Medium Voltage Switch Gear	<b>43</b>
Pre-Functional Performance Test Checklist - Medium Voltage Switches/Breakers	<b>44</b>
Pre-Functional Performance Test Checklist - Medium Voltage Transformers	<b>45</b>
Pre-Functional Performance Test Checklist - Motor Control Center	<b>46</b>
Pre-Functional Performance Test Checklist - Panel Boards	<b>47</b>
Pre-Functional Performance Test Checklist - Primary Grounding	<b>48</b>
Pre-Functional Performance Test Checklist - Secondary Transformers (Dry Type)	<b>49</b>
Pre-Functional Performance Test Checklist - 480/240 Volt Switchboards	<b>50</b>
Appendix C: Functional Performance Test Checklist	<b>51</b>
Functional Performance Test Checklist - Fire Alarm System	<b>84</b>
Functional Performance Test Checklist - Room Thermostats	<b>85</b>
Appendix D: Building Envelope Performance Testing Checklists	<b>86</b>
Construction Checklist Windows & Doors	<b>99</b>