

Washington State

Building

Commissioning

Guidelines

APPENDIX VII

Commissioning Guidelines

1.0 PURPOSE

additional service.

The purpose of the commissioning guidelines is to establish the project commissioning requirements, including those requirements to be specified in the construction documents. The commissioning process is to ensure that the facility's mechanical, electrical and designated systems' performance meets the design intent and the owner's functional criteria and operational needs.

2.0 GOAL

The goal of commissioning is to deliver a facility that operates as it was intended, meets the needs of the building owner and occupants, and provides training of facility operators. To reach this goal it is necessary for the commissioning process to provide documentation and verification of the performance of all building equipment and systems. For the process to work successfully it is equally important to have good communications between all participants (building designers, owners, operators and the commissioning agent) and to keep all parties involved and informed of all pertinent decisions.

3.0 APPLICABILTIY

Building Commissioning is strongly recommended for all major facilities. The need for building commissioning on other facilities will be determined by the owner's representative and the project manager based on the complexity of the systems installed.

4.0 BASIC FEE OR ADDITIONAL SERVICE

Building Commissioning is considered an additional service. A separate commissioning firm will be contracted with to perform the commissioning agent's functions. The time spent by the A/E in preparing for the commissioning activities are considered an

5.0 DESCRIPTION

The process of commissioning a facility is a team effort involving the project manager, building owners, designers, contractors, operators and the commissioning agent. The parties responsible for the various tasks involved in the commissioning process differ with each project and depend on the size of the facility and the complexity of systems and controls. Smaller projects may have overlapping or interchangeable roles for the team members. Flexibility is essential when defining responsibilities of the team members so that the needs of each individual project can be met. The following description of roles and responsibilities of team members would be typical for larger projects.

Project Manager (PM): the Department of General Administration, through the Division of Engineering and Architectural Services (E&AS), is the contracting authority for design and construction of public works projects for state owned facilities for numerous state agencies. E&AS assigns a PM to manage projects. The PM is the owner's representative.

Building Owner: defines the functional and operational use of the facility, setting the operating requirements, such as the occupancy schedules, ventilation requirements for the various areas of the facility, and control and lighting requirements for the facility.

Architect/Engineer (A/E): typically the architect or engineer who is the primary consultant. The designer documents the design intent of all systems and controls, monitors construction activities, and reviews and approves shop drawings, mock-ups of operation and maintenance manuals, as-built drawings and documentation.

Building Contractors: assist with the development and execution of the functional performance test procedures for all systems. The contractor also helps facilitate the commissioning schedule to keep the project proceeding smoothly.

Building Operators: assist the contractor with the functional performance tests and are responsible for attending the contractor and vendor training.

<u>Commissioning Agent (CA):</u> an independent agent, who acts as representative to the facility Owner, and is typically not associated with the Architect/Engineer (A/E) team members or Contractor. The CA contracts with E&AS and reports directly to the E&AS PM.

5.1 **DEFINITIONS**

Building Commissioning - the process of achieving, verifying and documenting the performance of building systems to meet the design intent and the client's functional and operational needs. It is the advancement of systems from static completion to full dynamic working order according to the specified requirements. Building Commissioning is a team effort to ensure that all equipment and systems have been completely and properly installed and put into service. The team is made up of the Commissioning Agent, Owner, A/E, and Contractor. Commissioning is primarily part of the acceptance process. However, some commissioning activities occur during both design phase and warranty period as described under section 5.2 RESPONSIBILITIES.

<u>Commissioning process</u> - a complete and thorough investigation of mechanical, electrical, safety, control, and communication systems to ensure proper installation and operation of all components and systems. ATTACHMENT 2, SYSTEMS TO BE COMMISSIONED provides a potential list of systems that could require commissioning. The following provides the systems that could be evaluated and tested when those systems are selected to be included in the commissioning process:

HVAC Systems

- Automated energy management and temperature controls,
- Instrumentation (gauges, thermometers, etc.)
- Air handlers
- Ductwork
- Packaged units (air conditioners and heat pumps)
- Terminal units (air)
- Unit heaters
- Heat exchangers
- Computer room units
- Fume hoods
- Lab pressures
- Specialty fans
- Testing, adjusting and balancing
- Variable frequency drives
- Indoor air quality
- Equipment sound control
- Equipment vibration control
- Egress pressurization
- Fire and smoke dampers
- Pumps
- Boilers
- Chillers
- Cooling towers
- Hydronic and steam distribution systems

Electrical System

- Lighting controls (sweep or scheduled, daylighting dimming, lighting occupancy sensors)
- Motor starters and controls
- Elevators, escalators, automatic doors, dock levelers, etc.
- Emergency power systems
- UPS system
- Power quality
- Communication systems (voice and data systems usually purchased separately)
- Security systems
- Fire and smoke alarms
- Fire protection system

Other

- Drainage systems
- Water wells
- Refrigeration systems
- Water treatment
- Plumbing systems
- Service water heaters
- Service water booster pumps

Medical gas system

Systems Concept and Operations Manual -

describes the design intent and expected operation of the systems. This document lays the groundwork for system acceptance as well as commissioning. Included in this document will be the basis for design, detailed sequence of operations and narrative description of system operation in lay terms. The System Concept and Operation Manual is not the same as the Operation and Maintenance Manual. A suggested outline for the Systems Concept and Operations Manual follows:

Indoor and Outdoor Design Conditions Dry bulb and wet bulb temperatures Relative humidity Thermostat setpoints

Building Function Occupancy Usage Schedules

Building Zoning Rationale

Load Calculations Internal loads assumptions Building envelope assumptions

Air Distribution Criteria and Calculation Air quality design criteria Ventilation requirement calculations Equipment sizing criteria

Sequence of Operation All seasons Occupied and unoccupied modes

Narrative Description of System Operation for Each System

Energy Conservation Measures

Fire and Life Safety Design Intent

Noise Criteria

Maintenance Schedules

Operation and Maintenance Manual -

describes the operation of systems and system components including manufacturer's technical data; including maintenance, operating, start up, shut down and trouble shooting information. A suggested outline for the maintenance manual is provided in ATTACHMENT 1, OPERATION AND MAINTENANCE MANUAL OUTLINE:

5.2 **RESPONSIBILITIES**

This section describes the responsibilities of all parties for the commissioning process.

5.2.1 COMMISSIONING AGENT (CA)

The purpose of a CA review of any phase of the project is to facilitate the commissioning process. The CA is not responsible for design concept, design criteria, compliance with codes, design or construction scheduling, cost estimating, or construction management. If any action by the CA causes a conflict between parties of the commissioning effort, the CA must be a participant in the conflict resolution.

DESIGN PHASE: The CA should be included in the Schematic Design phase of the project, and will assist the A/E in preparing the Systems Concept and Operations Manual. The CA will prepare a commissioning plan, provide the A/E with a complete description of the commissioning requirements, and review design documents for coordination of requirements.

CONSTRUCTION PHASE: The CA will review Contractor's submittals for compliance with commissioning needs concurrently with the A/E team review.

ACCEPTANCE PHASE: The CA will assist the Contractor to schedule the field commissioning at least 30 days prior to beginning field commissioning. CA will coordinate commissioning efforts as required until functions of all systems have been fully demonstrated and are accepted by the Owner, upon the recommendation of PM, A/E and CA. The CA will review the Operation and Maintenance Manuals for compliance with commissioning requirements. The CA will review equipment warranty responsibilities to ensure that all Owner's responsibilities are explicitly listed including time schedule and procedures for routine maintenance. CA will report to the Owner the results of all commissioning activities in each phase of the work and, when appropriate, make recommendation of actions required. The CA will prepare written progress reports of results of performance testing for the Owner. The testing, adjusting and balancing firm will be contracted by the CA. The CA will attend and review the material used to train the Owner's personnel.

WARRANTY PERIOD: The CA will perform recommissioning of appropriate systems during

warranty period at change of seasons. At completion of commissioning, the CA will prepare a final written report describing results of all performance testing and corrective actions recommended.

5.2.2 ARCHITECT/ENGINEER

DESIGN PHASE: The A/E team members will prepare the Systems Concept and Operations Manual with the assistance of the CA, and provide the PM with four copies.

The A/E team will include in the project specifications instructions to the contractor describing the contractor's responsibilities in the commissioning process. No part of these instructions shall be construed to relieve the A/E of any responsibility assigned under the contractual agreement. The A/E is responsible for providing a complete and working design, construction documents, compliance with codes, permits, scheduling, cost estimating, review of the contractor's shop drawings and submittals, construction observation and preparation of asbuilt drawings as described in the A/E agreement.

The traditional and contractual duties of the A/E are not altered by this document. If a conflict arises between this document and the A/E agreement, the A/E agreement takes precedence.

The A/E will work cooperatively with the CA and the Owner to provide a properly commissioned project.

5.2.3 OWNER

DESIGN PHASE: The Owner will provide comprehensive information as to functional and programmatic requirements for the building. The Owner must authorize work performed by the A/E or CA and approve the costs.

ACCEPTANCE PHASE: The Owner will make final decisions regarding results of commissioning activities. The Owner will arrange for facility maintenance personnel to attend field commissioning and training sessions and will designate the lead person.

WARRANTY PERIOD: The Owner will notify the A/E of any deficiencies before or during warranty period. During the warranty period, the Owner and building operators should not make any system adjustments, alterations or repairs without first contacting the A/E. Adjustment of room thermostats may be made at building occupant's discretion. In the event that adjustments, alterations or repairs are necessary, the PM should be contacted as soon as possible so that the Contractor can carry out a permanent repair.

Emergency repairs and adjustments may be made to prevent damage to system or building components without first contacting the A/E if followed up in writing to the A/E, PM, and Contractor. Emergency procedures would include items such as repairing leaks, adjusting controls to prevent building freeze-up or other similar adjustments to prevent the building from becoming uninhabitable or unsafe.

Maintenance procedures that are the responsibility of the building Owner during the warranty period may include, but may not be limited to, the following unless specified differently in the construction contract:

- Replacement of air filters
- Replacement of fuel filters
- Replacement or repair of any items which are broken or damaged by building users
- Replacement of water softener salt
- Filling boiler with water and fuel
- Replacement (if required) of acid neutralization marble
- Cleaning of oil separators or grease traps, and liquid filters
- Replacement of belts
- Lubrication of motors and pumps

5.2.4 CONTRACTOR

CONSTRUCTION PHASE: The Contractor will prepare the Operation and Maintenance Manuals.

ACCEPTANCE PHASE: A representative of the sub-contractor for each applicable trade will carry out performance testing under the observation of the CA and others as described in the commissioning schedule. Contractor will correct discrepancies between the Construction Documents and the commissioning results. The Contractor will provide training for Owner's personnel. WARRANTY PERIOD: The Contractor will identify Owner's warranty responsibilities required to maintain validity of warranty, explicitly listing time schedules and procedures for any routine maintenance. The Contractor will coordinate with warrantors to determine specific requirements to maintain the validity of the warranty.

No part of these instructions shall be construed to relieve the Contractor of any responsibility assigned under the construction contract. The Contractor is responsible for submission of shop drawings and submittals, construction according to the drawings and specifications, start up procedures, and as-built drawings as described in the Construction Documents.

The traditional and contractual duties of the Contractor are not altered by this document. If a conflict arises between this document and the contract, the contract takes precedence.

The Contractor will work cooperatively with the CA, A/E, and the Owner to provide a properly commissioned project.

5.2.5 PROJECT MANAGER

The PM manages the A/E agreement, the construction contract, and the commissioning contract.

6.0 TRAINING:

Contractor will explain any special features or intricacies of system operation to the building operating personnel during training sessions. Items covered should include safety features, hazards to be aware of, precautions to be observed to avoid damage to equipment and any necessary seasonal adjustments. Generally discuss service frequency for devices such as bearings, belt drives, filters, strainers, etc. This information should be clearly stated in the O&M Manuals for reference. Training sessions may be video taped. and that all systems are installed according to the contract documents and manufacturer's installation instructions. The Contractors further certify that all adjustment, lubrication, alignment and startup procedures have been carried out.

7.0 CERTIFICATION:

ATTACHMENT 3, COMMISSIONING

CERTIFICATE OF COMPLETION will need to be signed by each trade listed, indicating that all commissioning work has been completed

ATTACMENT 1

OPERATION AND MAINTENANCE MANUAL OUTLINE

1. The system division will be organized into sections by system and major sub-system. For example, each major fan system will be completely documented in its own section. For each section include the following sub-sections as appropriate:

a. Descriptive Information

- (1) Function or service area served
- (2) Classification
- (3) Design capacity
- (4) Performance characteristics
- (5) Principal components
- (6) Distribution arrangement
- (7) Schematic diagram
- (8) Control diagram
- (9) Commissioning plan
- (10) Results from system functional performance tests
- (11) Equipment list referenced to Equipment Division

b. Operating Instructions

- (1) Starting and stopping procedures
- (2) Adjustment and regulation
- (3) Seasonal changeover
- (4) Seasonal start-up
- (5) Seasonal shutdown
- (6) Logs and records
- (7) Part load performance

c. Control System

- (1) Panel layout sheets
- (2) Point checkout sheets
- (3) As-built control diagrams
- (4) As-built ladder diagrams with hardware interlocks
- (5) Reduced floor plans showing sensor, terminal and panel locations

d. Inspection and Maintenance

- (1) Inspection schedule and checklist
- (2) Schedules and procedures for lubrication, replacements, adjustment, calibration, cleaning, painting, protection, and testing.
- *(3) Inspection and maintenance records*
- 2. Reference documents should include the

following:

- a. Construction drawings list
- b. Construction specifications
- c. As-built record drawings
- d. Test and balance records
- e. Commissioning Reports
- f. Copies of certificates and reports, for example:

Plumbing sanitization, boiler start up, include stack gas test, accumulation test, safety valve test, hydronic system water analysis, steam boiler water analysis, electric inspection, fire marshal inspection, and elevator inspection.

- g. List of A/E, sub-consultants, contractors, and sub-contractors with addresses and telephone numbers
- 3. The equipment division is composed of manufacturers' and fabricators' data on equipment and materials organized into sections by generic classifications of equipment. Within each section organize sub-sections of specific types of equipment.

Each section includes the following information for each equipment item as appropriate:

a. Descriptive Literature

- (1) Catalog cuts, brochures, or shop drawings
- (2) Dimensional drawings
- (3) Materials of construction
- (4) Parts designations

b. Operating Characteristics

- (1) Performance tables and charts
- (2) Performance curves
- (3) Pressure, temperature, and speed limitations
- (4) Safety devices

c. Operating Instructions

- (1) Pre-start checklist
- (2) Start-up procedures
- (3) Inspection during operation
- (4) Adjustment and regulation
- (5) Testing
- (6) Detection of malfunction
- (7) *Precautions*

d. Inspection Instructions and Procedures

(1) Normal and abnormal operating

temperatures, pressures, and speed limits

- (2) Schedule and manner of operation
- (3) Detection signals

e. Maintenance Instructions and

Procedures

- (1) Schedule of routine maintenance, schedule of preventive maintenance
- (2) Procedures
- (3) Troubleshooting
- (4) Overhaul specifications for major equipment

f. Parts List

- g. Spare Parts
 - (1) Essential inventory
 - (2) Distributor directory

h. Service and Dealer Directory

- i. Warranty
- *j.* Service Contracts

ATTACHMENT 2

SYSTEMS TO BE COMMISSIONED

The following list provides potential systems that could require commissioning.

4.0 AIR DISTRIBUTION:

The CA will verify and report on the operation and accessibility of the following items.

4.1 EQUIPMENT:

- **4.1.1** Air filtration, dampers, diffusers, grilles, fire dampers and access doors.
- **4.1.2** Hoods and exhaust systems.
- **4.1.3** Heat buildup or noise in motor or shaft bearings.
- **4.1.4** Humidification equipment.
- **4.2 BALANCING**: Perform balancing for the following devices:
- **4.2.1** Motor current draw. Compare running current to nameplate full load amps rating.
- **4.2.2** Motor starter contactor size and overload heater size.
- **4.2.3** Voltage and rotation of each motor driven fan or air handling device.
- **4.2.4** Belt tension and drive alignment.
- **4.2.5** Airflow at outlets with the thermostat adjusted to simulate full cooling, full heating, hood operation, etc. where appropriate.
- **4.2.6** Airflow at each air handler at simulated full cooling and/or maximum fresh air.
- **4.2.7** Airflow at each fume hood based on sash positions.
- **4.2.8** Air flow at each range, dishwasher and process hood.
- **4.2.9** Room static pressure with respect to adjacent spaces and outdoors.
- **4.2.10** Outside air rate into system.
- 4.2.11 Drafts or noise from air distribution devices.

5.0 PLUMBING AND PIPING SYSTEMS:

The CA will verify and report on the operation and accessibility of the following items.

5.1 EQUIPMENT

- **5.1.1** Sewage lift pump.
- **5.1.2** Sump pumps.
- **5.1.3** Chemical feed equipment.
- **5.1.4** Air compressor, deionized water equipment and other process equipment.
- **5.1.5** Pump motor current draw. Compare running current to nameplate full load amps rating. Overload heater size.

5.2 PIPING

- **5.2.1** Strainers, valves, fixtures, steam traps, air purge, and blow down systems, and instrumentation and flow measuring or control. Bypass and shut off valves for maintenance.
- **5.2.2** Cleaning, degreasing and flushing of piping systems.
- **5.2.3** Fluid temperatures and pressures.
- **5.2.4** Fuel supply system. Check for water in fuel.
- **5.2.5** Test ports for temperature, pressure and chemical treatment measurements.

5.3 WATER AND STEAM TREATMENT

- **5.3.1** Filling of hydronic and chilled water systems.
- **5.3.2** Glycol concentration and pH.
- **5.3.3** Specific conductance.
- **5.3.4** Total alkalinity.
- **5.3.5** Suspended solids.
- 5.3.6 Silica.
- **5.3.7** Additives for steam system and protection of the condensate piping.
- **5.3.8** Chemical or additive injection systems.

6.0 HEATING AND COOLING PLANT EQUIPMENT:

The CA will verify and report on the operation and accessibility of the following items.

- 6.1 Service access.
- 6.2 Compressors.
- 6.3 Chillers.
- 6.4 Boilers.
- 6.5 Cooling towers.
- 6.6 Combustion air and exhaust systems.
- **6.7** Safety devices and controls.

7.0 CONTROL SYSTEMS:

The CA will verify and report on the operation and accessibility of the following

items.

- 7.1 Functioning of each control program.
- 7.2 Functioning of each hardware control point.
- **7.3** Instruction and training for Owner's operating personnel in the proper operation of the systems. The balancing contractor will correct flows and assist in fine tuning system.
- **7.4** Functioning of following devices:
 - Thermostats and temperature sensors,
 - Automatic dampers and valves,
 - Fresh air and return air dampers,
 - Economizer operation,
 - Air handler, boiler, chiller and pump starting and stopping from program control,
 - Exhaust fan and air handler start and stop,
 - Variable air volume control of VAV air handlers, and tracking of associated return fan,
 - Surge and transient protection,
 - Freeze prevention control,
 - Labeling of each control device.
- **7.5** Function of control loops
 - Time schedules,
 - Optimum start/stop,
 - Reset type schedules,
 - Demand limiting,
 - Alarm sequences,
 - Maintenance alarms,
 - Remote communication (modem),
 - Low (or high) limits, and
 - Other system programming features.
- 7.6 Safety devices.
- 7.7 Instrumentation, gauges, thermometers, flow measuring devices.
- **7.8** Shutdown of air handling systems in the event of presence of smoke or products of combustion.

applicable.

- 8.1 Circuit breakers, and protective relays.
- **8.2** Low voltage circuit breakers, motor starters, motor controls,
- **8.3** Setpoints, sensitivity and location of lighting controls.
- **8.4** Equipment ground fault interruption devices.
- **8.5** Emergency power systems.
- **8.6** Fire alarm system.
- **8.7** Communication systems including, but not limited to, telephones, television, intercoms, local area networks (when included in the project).

8.0 ELECTRICAL:

The CA will verify and report on the operation and accessibility of the following items. Use NETA testing procedures where

ATTACHMENT 3

Commissioni	ng Certificate of Completion		
Project No.		Date_	
Project Title			
Building			
Address			
Contractors pro	oviding the following services for this proj	ect:	
Mechanical	firm name		
Electrical	signature	title	date
Eleculcal	firm name		
Dhumbing	signature	title	date
Fluinoing	firm name		
	signature	title	date
Sheet Metal	firm name		
Dalaasias	signature	title	date
Balancing	firm name		
	signature	title	date

Commissioning Certificate of Completion

Controls			
	firm name		
	signature	title	date
Fire Protection			
	firm name		
	signature	title	date
Elevator			
	firm name		
	signature	title	date
other			
	firm name		
	signature	title	date
The Commission carried out acco	oning Agent has observed the con ording to the contract documents.	nmissioning process and acknowl	edges that it was
Commissioning	I		
e	firm name		
	signature	title	date
The Client Age 1. Op 2. As- 3. All 4. Op	ncy acknowledges receipt of the erating and Maintenance Manual Built Drawings certificates erator instruction	following documents and service s	s:
Client Agency			
	firm name		
	signature	title	date