

## **1 General**

### **1.1 COMMISSIONING OBJECTIVE**

- .1 Perform commissioning activities in order to achieve the following objectives:
  - .1 Collect data on equipment and systems supplied; and to document their installation;
  - .2 Conduct checks and tests on fully installed building component, equipment, systems and integrated systems to:
    - .1 Verify whether they operate in accordance with requirements of Contract Documents;
    - .2 Verify performance against design criteria and user requirements and measure peak capacities;
  - .3 Prepare a Building Management Manual (BMM) which contains operations and maintenance data, as-built record documents, commissioning reports, training data and other critical information for future use by Facility operational staff;
  - .4 Ensure transfer of knowledge on the operations, maintenance and management of the Facility to Owner and Operational personnel by means of appropriate training.
- .2 Commissioning activities conducted by Owner and/or Departmental Representative does not replace checks, tests, adjustments, balancing and other performance verification responsibilities to be performed by Trade Contractor as part of the work and as specified in other sections of the Specifications.

### **1.2 DEFINITIONS**

- .1 For the purpose of this contract, the following terms, used in this section, as they relate directly or indirectly to the commissioning process, shall be deemed to have the meaning as defined hereafter.
  - .2 Commissioning Process: a planned program of tasks, activities and procedures carried out systematically during the Construction and Occupancy Stages in accordance with the commissioning objectives, specified in clause 1.2 above, to:
    - .1 Verify whether the fully installed equipment, systems and integrated systems operate in accordance with contract documents and design criteria and;
    - .2 Ensure that appropriate documentation is compiled to effectively train Operation and Maintenance staff and prepare a comprehensive Building Management Manual (BMM).
  - .3 Commission (ie: to commission a building component or system): tests and checks conducted on all systems and integrated systems of Facility; carried out only after they are fully installed, functional and Contractor's Performance Verification responsibilities have been completed and approved.
    - .1 Contractor provides assistance during this process by operating equipment and systems, by troubleshooting and making adjustments as may be required.
    - .2 Systems are run under their full operation and under various modes to determine if they function correctly, consistently, at peak efficiency and interactively with each other as intended in accordance with Contract Documents and design criteria.
    - .3 During these checks, adjustments may be made enhancing performance to meet environmental or user requirements.
  - .4 Contractor: means the Contractor, however it also refers to any personnel from Subcontractors, including the controls subcontractors, suppliers and manufacturer representatives with whom the Contractor contracts or obtains services for the performance of work and designated commissioning duties.
  - .5 Departmental Representative: persons from the civil, architectural, mechanical and
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- electrical design disciplines of the Departmental Representative firm(s) engaged by Owner to prepare the final design and contract documents.
- .6 Design Criteria: All those factors included in the design of a Facility prescribed by the tenant needs or as determined by Departmental Representative as necessary in order to meet all Facility functional and user operational requirements.
  - .7 Installation/Start-up Checks: (sometimes referred to as pre-functional checks). Checks and inspections to be performed by Contractor during the pre-start-up and start-up of a particular equipment or system component.
    - .1 Checklist sheets are produced which include the following data:
      - .1 Product manufacturer's installation instructions and recommended checks and;
      - .2 Special procedures as specified in relevant sections of Specifications;
      - .3 Other items considered good installation and engineering industry practices deemed appropriate for proper and efficient operation.
    - .2 Standard Installation/Start-up Checklist sheets prepared by equipment manufacturer are acceptable for use. Supplement with additional data representative of specific project conditions as deemed required by Departmental Representative.
    - .3 Use Checklist sheets for all equipment installation. Document in writing on checklist the various checks made, deficiencies noted and corrective action taken.
    - .4 Installing Sub-Contractor to sign Checklist sheets upon completion, certifying that stated checks and inspections have been performed.
  - .8 Performance Verification: (sometimes referred to Functional Testing) checks, running dynamic tests and adjustments carried out by Contractor on equipment and systems, upon their installation, to ensure they operate correctly, efficiently and function independently and interactively with other systems as intended in accordance with contract documents and manufacturer's recommendations.
    - .1 Performance Verification shall not be considered part of the commissioning process. It is however considered an essential and integral part of Contractor's responsibilities in the equipment installation process which must be stringently conducted, successfully completed and approved by Owner before a piece of equipment or system is considered fully installed and functional.
    - .2 Facility components and systems will not be commissioned until performance verification has been completed and approved.
  - .9 Product Information (PI Data): a compilation of data gathered on a particular piece of equipment, typically produced by manufacturer, which includes nameplate information, installation/startup instructions, parts list, operating instructions, maintenance guidelines and other pertinent technical data and recommended checks that is necessary to prepare for start-up and functional testing and used during operation and maintenance of such equipment. This documentation is included in the Building Management Manual (BMM) at completion of work.

### 1.3 CONTRACTOR'S COMMISSIONING RESPONSIBILITIES

- .1 General:
  - .1 Coordinate the participation of the various subcontractors, their specialists and manufacturer's representatives in providing the commissioning activities described below.
  - .2 Ensure that workers and manufacturer's personnel are knowledgeable and qualified to interpret system functions and intended design criteria.
  - .3 Develop a commissioning schedule.
  - .4 Notify Departmental Representative in writing when Facility is ready to be commissioned. Give 14 calendar day notice.

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- .5 Commissioning of Facility and designated systems will only commence once that required documentation has been received and all installed equipment and systems have undergone successful performance verification.
  - .6 Be aware that inspection certificate will only be issued by Departmental Representative when:
    - .1 All commissioning documentation has been received, reviewed for suitability and approved by Departmental Representative;
    - .2 Designated facility components and systems have been commissioned and;
    - .3 Training has been completed.
  - .7 Non-Conformance of Performance Verification Requirements:
    - .1 Should incorrectly installed or malfunctioning equipment, system components or associated controls be found while Facility is being commissioned, Contractor shall be required to re-verify 100% of all equipment and components within the non functional system, including other related system as deemed required by Departmental Representative, to correct deficiencies and ensure effective performance.
    - .2 Costs to correct work and any additional tests or inspections, as deemed required by Departmental Representative, to determine acceptability and proper performance of such items to be paid for by Contractor.
      - .1 Above costs held against Contractor will be as financial penalties in the form of progress payment reductions or holdback assessments.
  - .2 Prior to Facility being Commissioned:
    - .1 Submit commissioning documentation as specified in clause 1.8 for use during commissioning.
    - .2 Carryout pre-start-up and start-up of equipment.
    - .3 Conduct performance verification on all installed equipment and systems. Ensure they are fully functional.
    - .4 Address deficiencies in Work identified during performance verification of equipment and systems. Conduct additional performance verification checks and tests to ensure acceptability of Work.
    - .5 Arrange for special tools and devices, identified at commissioning meeting(s), as deemed required to assist with commissioning.
    - .6 Provide access ladders, two way radios and other equipment required by Team when facility will be commissioned.
  - .3 When Facility is being Commissioned:
    - .1 Provide qualified tradespersons to be present at site to assist commissioning activity.
    - .2 Assist in commissioning architectural and structural building component, and mechanical, electrical and civil systems specified and as follows:
      - .1 Operate designated building component, mechanical/electrical equipment and system under all modes of operation and conduct checks and tests as directed by Departmental Representative.
      - .2 Check and verify that building component, equipment, systems and integrated systems, including their controls, are functioning and responding correctly and interactively with each other.
      - .3 Test systems independently and then in unison with other related systems.
      - .4 Conduct all Commissioning checks and tests in presence of and witnessed by Departmental Representative.
    - .3 Specific procedures used to commission Facility may be provided by
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Departmental Representative which includes:

- .1 Sequential order of building component and system to be tested.
  - .2 Running systems under various anticipated modes and demands (example: high and low cooling or heating loads, duplicating outside temperature conditions, fire alarm and power failure conditions etc...).
  - .3 Running building controls through all sequences of operation to verify and confirm that equipment and systems are responding as designed and intended.
  - .4 Operating designated equipment at peak capacities, recording output data against design criteria.
- .4 Run component or systems as long as necessary to effectively commission all items as deemed required by Departmental Representative.
  - .5 Monitor equipment and system responses.
  - .6 Record test results, measurements and other data.
  - .7 Assist in analyzing results. Identify system deficiencies and components not responding as intended.
  - .8 Correct deficiencies and system non-conformance issues. Adjust, calibrate or fine tune system components as required. Debug system software as may be required.
  - .9 Retest systems when directed to confirm compliance.
- .4 Upon completion of Facility Commissioning:
    - .1 Provide training to Maintenance & Operational personnel as specified in clause 1.7 below.
    - .2 Turn over any filled-in checks sheets or reports resulting from commissioning.
- .5 During Warranty period at Occupancy Stage:
    - .1 Fine tune components, systems and integrated systems and continue system debugging to optimize Facility performance.
    - .2 Rectify warranty issues.
    - .3 Submit written report to Departmental Representative.
      - .1 Indicate results noted and corrective action taken.
      - .2 Note improvements made to operating parameters and control settings.
      - .3 Recommend modifications deemed advisable to improve performance, environmental conditions, energy consumptions and other issues.
    - .4 Departmental Representative to be present during such work.

#### 1.4 COMMISSIONING MEETINGS

- .1 Convene commissioning meetings following project meetings: as required through the project to coordinate commissioning requirements.
- .2 Purpose: to resolve issues, monitor progress, identify deficiencies, relating to commissioning.
- .3 Continue commissioning meetings on regular basis until commissioning deliverables have been addressed.
- .4 At 60% construction completion stage. Contractor to call a separate commissioning scope meeting to review progress including Departmental Representative, discuss schedule of equipment start-up activities and prepare for commissioning. Issues at meeting to include:
  - .1 Review duties and responsibilities of Contractor and subcontractors, addressing delays and potential problems.
  - .2 Determine the degree of involvement of trades and manufacturer's representatives in the commissioning process.
- .5 Thereafter commissioning meetings to be held until project completion and as required

- during equipment start-up and functional testing period.
- .6 Meeting will be chaired by Contractor, who will record and distribute minutes within 3 business days.
- .7 Ensure Subcontractors and relevant manufacturer representatives are present at subsequent commissioning meetings and as required.

### **1.5 COMMISSIONING SCHEDULE**

- .1 Address commissioning activities within the construction work schedule. Clearly identify allocated time period for commissioning and training activities.
- .2 Provide a commissioning schedule at the 60% construction stage in order that specific issues and individual details of commissioning can be reviewed, discussed and dealt with from that period onward to project completion. Submit updates thereafter.
- .3 Indicate allocated time period and anticipated dates for:
  - .1 Submission of commissioning documentation, including O&M Manuals.
  - .2 Equipment and system start-up and performance verification, making them ready to be commissioned.
  - .3 Allocated period to commission designated building components and systems.
  - .4 Training period.
  - .5 Work during Warranty period.
- .4 Submit schedule to Departmental Representative for review.

### **1.6 INSTRUCTORS**

- .1 Contractor and certified factory-trained manufacturers' personnel to provide instruction on the following:
  - .1 Start-Up, operation, shut-down of equipment, components and systems.
  - .2 Control features, reasons for, results of, implications on associated systems of, and adjustment of set points of control and safety devices.
  - .3 Instructions on servicing, maintenance and adjustment of systems, equipment and components.
- .2 Contractor and equipment manufacturer to provide instruction on:
  - .1 Start-up, operation, maintenance and shut-down of equipment they have certified installation, started up and carried out PV tests.

### **1.7 TRAINING OBJECTIVES**

- .1 Training to be detailed and duration to ensure:
  - .1 Safe, reliable, cost-effective, energy-efficient operation of systems in normal and emergency modes under all conditions.
  - .2 Effective on-going inspection, measurements of system performance.
  - .3 Proper preventive maintenance, diagnosis and trouble-shooting.
  - .4 Ability to update documentation.
- .2 Ability to operate equipment and systems under emergency conditions until appropriate qualified assistance arrives.

### **1.8 TRAINING MATERIALS**

- .1 Contractor to be responsible for content and quality.
  - .2 Training materials to include:
    - .1 "As-Built" Contract Documents.
    - .2 Operating Manual.
    - .3 Maintenance Manual.
    - .4 Management Manual.
    - .5 Testing, Adjusting and Balancing and Performance Verification Reports.
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- .3 Training materials to be in a format that permits future training procedures to same degree of detail.
- .4 Supplement training materials:
  - .1 Multimedia presentations.
  - .2 Manufacturer's training videos.
- .5 Equipment models.

#### **1.9 RESPONSIBILITIES**

- .1 Be responsible for:
  - .1 Implementation of training activities,
  - .2 Coordination among instructors,
  - .3 Quality of training, training materials,
- .2 Departmental Representative will evaluate training and materials.
- .3 Upon completion of training, provide written report, signed by Instructors, witnessed by Departmental Representative.
  - .1 Report to include a list of all attendees.

#### **1.10 TRAINING CONTENT**

- .1 Training to include demonstrations by Instructors using the installed equipment and systems.
- .2 Content includes:
  - .1 Review of facility and occupancy profile.
  - .2 Functional requirements.
  - .3 System philosophy, limitations of systems and emergency procedures.
  - .4 Review of system layout, equipment, components and controls.
  - .5 Equipment and system start-up, operation, monitoring, servicing, maintenance and shut-down procedures.
  - .6 System operating sequences, including step-by-step directions for starting up, shut-down, operation of valves, dampers, switches, adjustment of control settings and emergency procedures.
  - .7 Maintenance and servicing.
  - .8 Trouble-shooting diagnosis.
  - .9 Inter-Action among systems during integrated operation.
  - .10 Review of O&M documentation.
- .3 Provide specialized training as specified in relevant Technical Sections of the construction specifications.

#### **1.11 VIDEO-BASED TRAINING**

- .1 Manufacturer's videotapes to be used as training tool with Departmental Representative's review and written approval 3 months prior to commencement of scheduled training.
- .2 On-Site training videos:
  - .1 Videotape training sessions for use during future training.
  - .2 To be performed after systems are fully commissioned.
  - .3 Organize into several short modules to permit incorporation of changes.
- .3 Production methods to be professional quality.

#### **1.12 TRAINING**

- .1 Commence process of familiarizing O&M personnel in the early stages of work on purpose and operation of various equipment and systems. Continue process throughout the entire construction duration.
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- .1 Provide informal briefings during occasional site visits, at planned commissioning meetings and during the final commissioning site activities.
- .2 Conduct formal demonstration and training sessions only after all identified systems have been commissioned and Departmental Representative has given approval to proceed with the training process.
- .3 Provide training and demonstration on equipment, sub-systems, systems and integrated systems.
- .4 Carryout training in accordance with requirements of Section 01 91 13 - General Commissioning Requirements.
- .5 Submit written agenda of training session(s) 4 weeks before hand for review by Departmental Representative.
- .6 Submit training manuals for review 2 weeks prior to actual training.
- .7 Ensure required tools and O&M Manuals are on site for training and system demonstration.
- .8 As a minimum, the training sessions to cover the following information:
  - .1 Introduction.
  - .2 Description of the system with factory personnel being involved at appropriate times.
  - .3 Instructions on start-up procedures including seasonal procedures, system check-lists and emergency procedures.
  - .4 Operational procedures, including occupancy considerations, seasonal change-over, manual and automatic operations and emergency modes.
  - .5 Instruction on system shutdowns, including checklists.
  - .6 Instructions on all aspects of system maintenance, including routine servicing, lubrication, overhaul and factory servicing.
  - .7 Information concerning the scope of warranties and their use.
  - .8 A description of spare parts in stock and their service.
  - .9 A description of normal tools required for servicing the systems/equipment.
- .9 Submit typewritten record of training sessions given and list of attendees. Use forms of format approved by Departmental Representative.

#### **1.13 DESCRIPTION**

- .1 Demonstrate scheduled operation and maintenance of equipment and systems to Owner's personnel two weeks prior to date of final inspection.
- .2 Owner will provide list of personnel to receive instructions, and will co-ordinate their attendance at agreed-upon times.

#### **1.14 QUALITY CONTROL**

- .1 When specified in individual Sections require manufacturer to provide authorized representative to demonstrate operation of equipment and systems, instruct Owner's personnel, and provide written report that demonstration and instructions have been completed.
- .2 Obtain signature from attendees and provide a copy in the Building Maintenance Manual.

#### **1.15 SUBMITTALS**

- .1 Submittals: in accordance with Section 01 33 00 - Submittal Procedures.
  - .2 Submit schedule of time and date for demonstration of each item of equipment and each system two weeks prior to designated dates, for Departmental Representative's approval.
  - .3 Submit reports within one week after completion of demonstration, that demonstration and instructions have been satisfactorily completed.
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- .4 Record signatures of all attendees.
- .5 Give time and date of each demonstration, with list of persons present.

**1.16 CONDITIONS FOR DEMONSTRATIONS**

- .1 Equipment has been inspected and put into operation in accordance with respective applicable Sections.
- .2 Testing, adjusting, and balancing has been performed and equipment and systems are fully operational.
- .3 Provide copies of completed operation and maintenance manuals for use in demonstrations and instructions.

**1.17 PREPARATIONS**

- .1 Verify that conditions for demonstration and instructions comply with requirements.
- .2 Verify that designated personnel are present.

**1.18 DEMONSTRATION AND INSTRUCTIONS**

- .1 Demonstrate start-up, operation, control, adjustment, trouble-shooting, sequencing, winter/summer operating, servicing, and maintenance of each item of equipment at scheduled times, at the equipment location.
- .2 Instruct personnel in phases of operation and maintenance using operation and maintenance manuals as basis of instruction.
- .3 Review contents of manual in detail to explain aspects of operation and maintenance.
- .4 Prepare and insert additional data in operations and maintenance manuals when need for additional data becomes apparent during instructions.

**1.19 COMMISSIONING DOCUMENTATION**

- .1 Submit the following documentation for use during commissioning and for incorporation thereafter into a Building Management Manual (BMM).
- .2 Operations and Maintenance Manuals, Project Record Documents and other data as specified in Section 01 78 00 - Closeout Submittals. Data to include:
  - .1 Equipment Product Information (PI Data) complete with:
    - .1 Nameplate info,
    - .2 Installation instructions,
    - .3 Operating procedures and
    - .4 Maintenance guidelines.
    - .5 Reviewed shop drawings,
    - .6 As-built record drawings and Specifications.
  - .2 Completed Installation/Start-up Checklist sheets used.
  - .3 Copy of any static and dynamic test and reports conducted.
  - .4 Reports as specified in various trade sections.
- .3 Documentation to include detailed information and number of copies as specified for maintenance manuals of Section 01 78 00 - Closeout Submittals.

**END OF SECTION**

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