

Commissioning

Objectives

The proper commissioning of new or renovated facilities is extremely important to the University of Toronto. As a 1995 Task Group assigned to produce guidelines for this process defined it,

Commissioning is a process of design, documentation, testing and training activities, extending from the design phase through a complete operational cycle, performed to assure that all building facility systems perform in accordance with the design intent and the Owner's and Occupants' operational needs.

Consistent with this definition, are the following objectives:

- (a) Ensure the design is consistent with the requirements of the University's building occupants and operational personnel;
- (b) Demonstrate the building systems thoroughly to familiarize operating divisions with them at pertinent stages of construction;
- (c) Move the completed facility from the as-constructed state to the operating state;
- (d) Smoothly transfer the operation and maintenance of the facility from the Contractor to the University's operating personnel;
- (e) Optimize Operations and Maintenance through delivery of comprehensive quality training and systems documentation;
- (f) Provide systems documentation through accurate and useful historical records;
- (g) Achieve the highest level of quality assurance that is economically possible;
- (h) Assure systems performance verification including systems that require verification over multiple seasons.
- (i) Publish the final Commissioning Report before the warranty expires;

Scope

Systems to be commissioned will be defined by the University during its process for selection of the Architect and/or Mechanical and Electrical Consultants. These systems may include all mechanical, electrical and controls equipment and their combination used for environmental, life safety, elevating devices or plumbing purposes. In addition, certain architectural aspects of the building envelope such as the roof, insulation, etc. may be included.

The Commissioning Process

The process described in *CSA Z320-11 Building Commissioning Standard* (or the most recent revision) will form the basis of the commissioning activities. The Standard applies in its entirety except for items indicated as amended in Schedule 2.

The Commissioning Team

Successful commissioning of a facility requires the efforts of all of the players on the project team – the owner, the commissioning authority, the contractor and the consultant. Each participant has a role to play. These roles and responsibilities are outlined in the Responsibility Matrix that forms part of the CSA Z320-11 Standard.

The **Commissioning Authority** will be selected by the University's project manager and contracted directly to the University.

Within the University, two main parties have a stake in the successful commissioning of a facility – the **Project Manager**, who wants a complete project, finished within schedule and budget, which satisfies his or her client, and the operating and maintenance divisions within Facilities and Services, who will be charged with smoothly running the facility in a cost-effective manner after completion. On sizeable projects Facilities and Services may assign a U of T **Commissioning Coordinator** to the job at the beginning of the design process. The roles and responsibilities of the Project Manager are as described for “Building Owner/Representative” in Table 1 of the CSA Z320-11, while those of the Commissioning Coordinator are as described for “Building Operations and Maintenance Staff”.

The Commissioning Coordinator is accountable to the University's operating divisions. Statistics of costs for problem corrections on past projects indicate that the most expensive and critical of these are related to equipment and systems falling under the jurisdiction of the Utilities Division. Therefore, the natural choice for this assignment would be an individual within that division.

In order to retain the established lines of communication and control on the project, the Commissioning Coordinator must issue his instructions to the contractor or others through the Project Manager. This becomes very important when instructions affect costs or overall project schedules.

For a stipulated sum contract or construction management arrangement, the University will have a contract with each of the designer, the contractor and the commissioning authority. The designer will have site supervision responsibility and authority; that is, the designer will instruct the contractor when decisions must be made. As agents of the University, they will administer the agreement with the contractor. Similarly, the commissioning authority is also an agent of the University and will advise the designer in matters relevant to the successful commissioning of the building systems.

For design/build contracts the University does not have a direct contract with the design team. The design team's responsibilities for commissioning must be carefully described in the main contract to avoid misunderstandings. An independent commissioning authority must be engaged by the University.

Handover of systems to the University for operation and maintenance

The University of Toronto Facilities and Services Handover and Acceptance Checklist must be completed and signed off by the U of T Project Manager, the U of T Director of Utilities and Building Operations, the Commissioning Authority and the designer before Facilities and Services assumes responsibility for the operation and maintenance of each mechanical and electrical system.

References

CSA Z320-11, Building Commissioning Standard

Schedules

- 1 Instructions to users of this U of T standard.
- 2 Supplemental instructions to the use of *CSA Z320-11, Building Commissioning Standard*.

Appendices

Three sections are appended here to be inserted in the construction contract specifications. The design consultant shall ensure that his specifications are consistent with the requirements of these sections.

Appendix A: Training of O&M Personnel,

Appendix B: O&M Manuals

Appendix C: Systems Acceptance Documents Required by the University.

Schedule 1 – Instructions to users of this U of T standard

1. *The tender documents must state that CSA Z320-11 will govern the commissioning process.*
2. *CSA Z320-11 covers the following systems:*
 - (a) *Architectural;*
 - (b) *Vertical and horizontal transportation;*
 - (c) *Electrical;*
 - (d) *Mechanical; and*
 - (e) *Control and integration.*

If any of these categories of systems are intended to be excluded from the scope of the commissioning responsibilities of the contractor, designer, etc. it must be noted in tender documents.

3. *The tender documents must also refer to “ Schedule 2 – Supplemental instructions for the use of CSA Z320-11, Building Commissioning Standard”*
4. *Article 4.94 of CSA Z320-11 requires a re-commissioning manual. The tender documents must reflect whether this requirement is applicable or not.*
5. *If a building is to be designed/constructed to a certain LEED rating, any special enhancements of the commissioning levels must be noted in the tender documents.*

**Schedule 2 – Supplemental instructions for the use of CSA Z320-11, Building
Commissioning Standard**

4.9.2 The commissioning plan shall include specific sequence of operations to test each system at its expected operational extremes.

4.14.2 Systems operations manual shall be mandatory.

Table 1

Under “Participants”:

- “Building owner/representative” will be the U of T project manager.
- “Building operations and maintenance staff” contact will be the U of T Commissioning Coordinator.

Under “Concept (Pre-design) Design”:

- Change “Include commissioning responsibilities” to read “Define commissioning responsibilities of team members.”
- Add “Review Basis of Design” as a new responsibility. The Building owner/representative leads (“L”); The Building operations and maintenance staff participate (“P”).

Under “Design Phase”:

- Re: “Perform commissioning focused design reviews of drawings and specifications” – Change responsibilities of Commissioning Authority/commissioning provider to leads (“L”) and Design Consultants to participates (“P”).
- Re: “Plan/prepare verification checklist and test procedures”, add responsibility to participate (“P”) under Building operations and maintenance staff.
- Re: “Develop commissioning specifications”, add responsibility to participate (“P”) under Building operations and maintenance staff for select equipment. (List to be provided by the Commissioning Coordinator.)

Under “Construction Phase”:

- Re: “Review contractor submissions and shop drawings”, add responsibility to participate (“P”)

END OF SECTION

Appendix A

Training of O&M Personnel, University of Toronto

1.0 Training of O&M Personnel

1.1 Definition of O&M Personnel

The term "O&M personnel" as used here includes the property manager, building engineers, control technicians, trades and specialists from Facilities & Services.

1.2 Co-ordination

1.2.1 The Commissioning Authority (CxA) shall direct and monitor all training (engineering, trades, control technician, etc.).

1.2.2 The designer shall include in the Contract Documents all specifications for training material, training and classroom time, contractor personnel, and resources to be provided by equipment/systems manufacturers and installers for training purposes. Consideration should be given to the use of videos to train personnel and for future use in training replacement staff.

1.2.3 The general contractor shall be responsible for:

- implementation of all training activities
- Coordination of training
- Quality of training and training materials
- Acknowledgement of participation (i.e. participants' registry with their signatures).

1.2.4 The designer shall also conduct training sessions to explain the design intent. These sessions should be held prior to training sessions conducted by the contractor.

1.3 Level of Training

Level of training required for O&M personnel on a project depends on many factors, including:

1.3.1 *Project complexity and size* Training must address not only the individual systems but interaction among all systems during integrated operation. A simple HVAC installation with one Programmable Control Unit obviously has a far different training requirement than a complete Building Automation System containing integrated systems for fire alarm, smoke control,

security and intrusion monitoring, window blind operation, lighting, emergency power, clock, communications, etc. If deemed necessary by the commissioning team, in depth training for O&M personnel shall be provided as required.

1.3.2 *Trainee potential* All materials and training sessions shall be geared toward the skills and knowledge levels of U of T O&M personnel.

1.3.3 *Service Contracts* The nature and extent of Service Contract provisions can influence the level of training required for in-house O&M personnel. The work required, the proximity of the Service Contractor to the site, and accessibility to the site can all have a bearing on training needs.

1.4 Instructors

Instructors shall include:

The designer: To provide written and classroom instruction on the design philosophy, design intents, design criteria and brief description of all systems.

The contractor and maintenance specialist, factory-trained and certified personnel and/or equipment manufacturers as appropriate: to provide manuals, classroom and on-site instruction, maintenance and operation of systems.

1.5 Training Requirements

1.5.1 Organization

Training of O&M personnel shall consist of three main parts:

A) Familiarization: Familiarization sessions shall be organized for all systems during Implementation (construction and installation stage) and during Commissioning (activation and performance verification activities).

B) Hands-on: Hands-on training shall be provided on all systems, components and equipment, explanations of all commissioning procedures shall be given during the commissioning phase.

C) Classroom: Classroom sessions shall be provided during Commissioning, with instruction regarding use of the O&M manuals and all other commissioning documentation.

Copies of the training material shall be made available to O&M

personnel prior to the familiarization sessions for retention throughout the training period.

1.5.2 Content

Instructions shall include:

1.5.2.1 Review of the facility. A general review of the building's construction (including fire zoning), function and what it is used for.

1.5.2.2 System philosophy - design criteria, design intents, why the system was designed in this way, why certain settings are important and should not be changed without proper authority, limitations of each system, including emergency procedures.

1.5.2.3 Review of system layout and equipment, components and controls.

1.5.2.4 System operating sequence, including, a list of automated systems/components, step-by-step directions for starting up and shutting down all systems, closing and opening valves, dampers, and switches, adjusting control settings, turning motors on and off, and so on.

1.5.2.5 Maintenance and servicing of systems, equipment and components.

1.5.2.6 Trouble-shooting diagnosis - symptoms, signs, causes and corrective measures.

1.5.2.7 Review of O&M documentation.

1.5.2.8 Review of 'As Built' drawings and documentation.

1.5.3 Delivery

Training shall normally be provided during regular working hours prior to handover of the project and after commissioning if

necessary.

1.5.4 Instructional Materials

Instructors shall be responsible for the content and quality of training materials for all training sessions under their jurisdiction.

1.5.4.1 All instructional manuals and material shall be produced in a form that will permit future training for new U of T personnel to the same degree of detail and depth as supplied by the initial training.

1.5.4.2 Instructional manuals and material shall be supplemented as necessary by PowerPoint presentation etc:

1.6 Training Activities

SYNOPSIS OF TRAINING ACTIVITIES

| STAGE | TRAINING ACTIVITY | RESPONSIBLE PARTY |
|-----------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1. Planning | No training activities | |
| 2. Definition | Training requirements of the O&M divisions are collected and defined. This would include the extent, nature and location of training; the standards that must be achieved; and an estimate of the number of O & M personnel who will need to be trained. | CxA & F & S Commissioning Coordinator |
| 3. Implementation | The designer defines the proposed levels of training and submits O & M personnel requirements. | Designer |
| a) Design | | |
| b) Tender/Working documents | In the commissioning section of the specification: 1. Identify systems and equipment requiring specially trained or licensed operating personnel. For example, some equipment may require Stationary Engineers and Shift Engineers, or round-the-clock supervision. 2. Identify the operator classification requirements, scope, and level of O & M training. | Designer Designer |
| c) Tender call / contract | No training activities | |
| d) construction and installation | Confirm the availability and presence of assigned O & M personnel for observation as system installations proceed. 2. Provide site familiarization sessions. 3. Ensure that the assigned O & M personnel have free to all areas of the construction site so as to observe the installation of all systems (subject to the jurisdiction of the Contractor). | O&M Divisions & F&S Commissioning Coordinator Contractor Contractor |
| 4. Commissioning | 1. Verify the quality of materials to be used in training sessions, instructions, demonstrations, provided to the O & M personnel. 2. Monitor quality of all formal training sessions and assess the depth of understanding of training received by the O & M personnel to adjust quality or focus of training. 3. Organize, supervise and conduct all on-site and classroom training. 4. Demonstrate to the Owner/User and the Project Manager all start-up, shut-down and all other normal and emergency procedures of all systems under all conditions, involving the trained O & M personnel. | CxA & F&S Commissioning Coordinator CxA & F&S Commissioning Coordinator Contractor Contractor |
| 5. Operation | 1. Observations and assessment of training. 2. Recommendations to the University regarding any additional training deemed necessary | Operations and Maintenance Divisions Operations & Maintenance Divisions |
| 6. Evaluation | No training activities. | |

Appendix B

O&M Manual Requirements, University of Toronto

1. Introduction

Production of O&M Manuals must be a co-operative effort by the designer, the contractor, and the Commissioning Authority (CxA), however it is the ultimate responsibility of the Contractor to provide the completed document to the owner which must be 90 per cent complete before static completion. The manuals should begin to be assembled as soon as possible after equipment has begun to be selected. The manuals are amended during the Commissioning Phase to reflect the working, commissioned system(s).

O&M Manuals shall not merely be collections of catalogue pages, cuts and manufacturer's brochures. They must include, where possible, ONLY information that is applicable to this project and the information included must be complete in every respect.

Operational aspects of the O&M manuals shall contain all information necessary to:

- a. Operate each system under all normal and emergency modes
- b. Permit operating personnel to make operational decisions which are in agreement with the University's requirements within the limits of the installed systems

Maintenance aspects of the O&M manuals shall contain:

- a. All information necessary for preventive and corrective maintenance, diagnosis, troubleshooting, servicing and repairs of all systems, equipment and components.
- b. Inventory of maintenance materials, special tools, and spare parts

2. Contents

This project shall include at least the following. Additional material may also be necessary to suit project requirements:

- a. Table of Contents
- b. Cover sheet, containing:
 - i. Date of completion of project
 - ii. Names and addresses of:
 - .1 All Consultants
 - .2 All Contractors and Trades

3. Preparation

- 3.1. Specific procedures/sequence of events etc. shall be prepared in Microsoft Word format and submitted on CD disc to permit updating as necessary.
- 3.2. Each page shall be 8½ x 11, punched for 3-ring binders and identified with date of issue and revision number.
- 3.3. All text shall be arranged in logical sequence, clear, concise, using vocabulary and expressions that are clearly understood by O&M personnel.
- 3.4. Text shall be 1½ spacing with margin on each side.
- 3.5. Drawings, diagrams, schematics, etc. shall be sketched using AutoCad format.
- 3.6. All submitted material shall be of the highest quality reproduction.

4. Binders

- 4.1. Each Manual shall be single or multiple volume as appropriate and contained in 3-ring D-ring binders having clear vinyl pockets on front and spine. Each binder shall be identified with the name of the facility, manual name and volume number (1 of 3, 2 of 3, 3 of 3) etc.
- 4.2. Each binder shall be prefaced with a complete Table of Contents.
- 4.3. Binders **shall not be more than 2/3 full.**

5. Indexing

- 5.1. All data in each Manual shall be sub-divided and indexed using hard paper separators having large, strong indexing tabs protected by clear plastic covers with alpha-numeric descriptors.

6. Approvals

- 6.1. The preliminary draft (90% complete) of each Manual must be approved by the Commissioning Authority at the start of Commissioning phase. Submission of individual data will not be accepted unless so directed by the Commissioning Authority.
- 6.2. Upon approval, the Commissioning Authority shall be provided with a copy of each manual.

7. Use of Current Technology

The use of current technology for information storage, retrieval and presentation shall be considered in addition to the required hard copy and MS Word or AutoCad files on CD.

Whichever methods are adopted, the main emphasis shall be ease of accessibility to all information at all times and to maintaining all data in an up-to-date state.

8. Operation sections of the manuals

8.1. Shall be used to instruct University O&M personnel.

8.2. The Operation Manual shall be organized system by system and contain at least the following:

8.2.1. A description of the design philosophy, design intent and design criteria for each system from the Consultant.

8.2.2. Schematics of the controls for each system from the Contractor.

8.2.3. Manufacturers detailed operating instructions and all other data relating to the installed systems/subsystems, equipment and components from the Contractor.

8.2.4. Start-up and shut-down procedures by the Consultant.

8.2.5. Contents of Building Automation & CCMS alarms and appropriate response to alarms.

8.2.6. Description by the Consultant of actions to be taken in event of outage of critical equipment in areas such as animal colonies, hazardous research facilities or where damage to materials will be sustained.

8.2.7. Copies of all posted instructions (folded or miniaturized, if necessary) by Contractor.

8.2.8. Approved final commissioning report from the Commissioning Agent.

8.2.9. Any variances granted by authority having jurisdiction to not comply with any Codes, by Consultant.

9. Maintenance sections of the manuals

9.1. Shall serve three main purposes:

9.1.1. Service guide:

It shall provide basic information about all systems and highlight any special maintenance features.

9.1.2. Checklist for periodic maintenance:

It shall assist maintenance personnel to service each system and its components promptly, effectively and completely. For this purpose, it shall list such things as:

- All items requiring service, preventive maintenance steps and frequency at which they should be performed.
- Diagnostic checks referencing the relevant portion of the troubleshooting guide.
- Special maintenance items that may be, or are often known to be, overlooked.

9.1.3. Troubleshooting guide:

It shall provide direction for diagnosing causes of malfunctions and listing steps to pinpoint such causes.

9.2 The following information must be supplied for each system, all components, equipment and related control systems:

9.2.1 Names, addresses and telephone numbers of manufacturers, suppliers and/or service depots as applicable plus dates warranty is in effect.

9.2.2 Nameplate information including equipment number, make, capacity, serial number

9.2.3 Installation details

9.2.4 Manufacturers maintenance, servicing data and instructions

9.2.5 Trouble-shooting charts and/or tables

9.2.6 Equipment and system wiring diagrams

- 9.2.7 Inventories of maintenance materials, special tools and spare parts prepared by the contractor, including:
 - 9.2.7.1 Maintenance materials:
 - 9.2.7.1.1 Room, area and/or system number (as applicable) where material is used, to match the identification on the cartons or packages.
 - 9.2.7.2 Maintenance instructions.
 - 9.2.7.3 Special tools:
 - 9.2.7.3.1 Identify the component of the equipment of system for which they are applicable.
 - 9.2.7.3.2 Instructions for using the tool.
 - 9.2.7.4 Spare parts:
 - 9.2.7.4.1 Recommended spare parts list should be furnished by the installer (supplier) particularly referencing long delivery components which could cost excess down time.
 - 9.2.7.4.2 Part number and manufacturer.
 - 9.2.7.4.3 Identification for the component, equipment or system for which they are applicable.
 - 9.2.7.4.4 Installation instructions.
 - 9.2.7.4.5 Name and address of the nearest supplier.
- 9.2.8 Comprehensive Parts lists
- 9.2.9 Copies of approvals and certificates
 - 9.2.9.1 Approvals, inspection certificates and test certificates
- 9.2.10 Lubrication charts and schedules
- 9.2.11 Extended Warranties
- 9.2.12 Equipment performance data sheets showing the point of operation as left after commissioning is completed
- 9.2.13 Detailed service requirements for each device including information relating to removal of major sub-components for replacement.
- 9.2.14 Any other relevant engineering data to be included.

Appendix C

Systems Acceptance Documents Required by the University

**UofT Facilities & Services Handover Acceptance Checklist
(to be used for Mechanical and Electrical Disciplines)**

Equipment/System Description:

The construction/installation of the noted equipment/facility is now complete.
The following handover procedures/documentation have been received by UofT Facilities & Services Dept:

| | Date Received by UT |
|--------------------------------------------------------------------|---------------------|
| 1. Operating and Maintenance Manuals, (Including all certificates) | _____ |
| 2. As-built Drawings | _____ |
| 3. Balancing | _____ |
| 4. Systems/Equipment Commissioning completed, reports received | _____ |
| 5. Deficiencies corrected | _____ |
| 6. Tagging/Identification of Equipment, Valves, etc. | _____ |
| 7. Training/Demonstration of System/Equipment completed | _____ |

PLEASE NOTE THAT STEP #7 (TRAINING/DEMONSTRATION) SHALL BE CONDUCTED ONLY AFTER ITEMS #1 TO #6 INCLUSIVE HAVE BEEN COMPLETED TO THE UNIVERSITY'S AND THE CONSULTANTS SATISFACTION. TRANSFER OF ANY KEYS WILL ALSO BE MADE AT STEP #7 ABOVE.

The warranty period for this equipment/facility is _____ year(s), starting on _____.

For service within the warranty period, please call _____

Telephone: _____ Fax: _____

Please sign below confirming UofT Facilities & Services Dept. acceptance of operating and maintenance responsibility for this equipment/facility, subject to the comments below (or attach a deficiency list) and return the original of this form.

Comments:

_____ Date _____

UofT Project Manager

_____ Date _____
University of Toronto – Director of Utilities

_____ Date _____

Commissioning Authority

_____ Date _____
Design company name – Design Engineer