BUILDING COMMISSIONING GUIDELINE

BY
APEGM PRACTICE STANDARDS COMMITTEE

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Table of Contents

Forward

A nation wide survey (3) on "Commissioning" carried out by the Canadian Standards Association (CSA) in 1991 indicated that the concept of building commissioning varied considerably from person to person depending on their individual point of view. There were clearly differences of opinion on the definition of commissioning. While many saw it as a special one-time checking out of safety and service systems carried out upon completion of a building, others saw it as a more comprehensive ongoing process that would ensure that a completed building would meet the design intent and operational needs of the Owner. It is this latter viewpoint that is now commonly accepted.

Building systems are becoming increasingly complex and sophisticated. This increase in complexity and sophistication, coupled with the fact that more building systems are interrelated, points to a need to clearly define the process of building commissioning and develop it as a managed coordinated activity that will ensure completed facilities meet the design intent and operational needs of the Owner. The Association of Professional Engineers and Geoscientists of Manitoba (APEGM) has prepared this document with the objective of providing guidance to practitioners involved in commissioning. The document is intended to assist those who are providing services in the commissioning process either as overall manager of the process, or as a team member.

Other associations, most notably the Association of Professional Engineers Geologists and Geophysicists of Alberta (APEGGA) and the Professional Engineers of Ontario (PEO) have both developed and published guidelines for professional engineers providing commissioning work in buildings. As well, Alberta Public Works, Supply and Services have published department requirements for commissioning of building projects under their jurisdiction (1). These documents provide much of the content of this guideline and the work of the committees and individuals involved in their development is gratefully acknowledged.

1 Overview

1.1 Objectives of the Guideline

The objectives of the Association of Professional Engineers and Geoscientists of Manitoba (APEGM) in publishing this guideline are to:

- encourage recognition of commissioning as a distinct and essential function in the development of a successful facility,

- encourage a degree of uniformity within the engineering profession in carrying out commissioning activities,

- educate professional engineers and clients on the scope, responsibilities, and procedural issues of commissioning, and

- provide a reference document that will assist the Profession in carrying out its mandate of protecting the public.

1.2 Definition of Commissioning

Commissioning is the process of testing the performance of equipment and systems to determine their capability to meet performance requirements as defined in the specifications prepared by the designer. It may also include the provision of training and documentation necessary for the Owners' personnel to competently operate and maintain the equipment or system.

1.3 Benefits of a Comprehensive Commissioning Program

In addition to confirming that a completed facility meets all of the performance requirements for which it was designed, the commissioning process can be viewed as an investment which can provide both long and short term returns. The magnitude of these returns is generally directly proportional to the effort devoted to the process, starting from project inception. Examples of short-term benefits obtained from a well-developed commissioning program are:

- Increased probability of early identification of any deficiencies prior to occupancy or start-up, or before warranty expiration, leaving Owners in a strong position to have defects corrected by the parties responsible for them, on a timely basis.

- Reduction in the potential for unnecessary and costly shutdowns resulting from inadequate review and testing prior to a system or component being put into service.

- The establishment of a well trained operations staff equipped with comprehensive manuals written by personnel responsible for the overall system design.

Examples of the longer-term benefits that can be provided by a thorough commissioning program are:

- Reduction in energy consumption and operating costs over the life of a facility as a result of operations staff understanding the capabilities of the systems which are part of the facility, and the conditions under which they function most efficiently.

- Extended service life of a facility resulting from the implementation of a well planned maintenance program.

- A comfortable working environment that meets the original design intent under all operating conditions, thereby minimizing the potential for complaints from staff, or turnover of tenants.

- Reduction in the potential for Owner liability in critical occupancies where the performance of building systems can have a negative impact on product quality, or on the health and safety of building occupants.

Although an extensive commissioning program can add significant costs to the front end of a project, it can lead to savings which over the life of the facility can be many times greater than the initial amount invested in the commissioning process. At the outset of a project, a decision should be made regarding the effort and resources that will be expended on commissioning. This decision must be made only after the potential benefits of a given level of effort are weighed against the risks associated with implementing a program based on a lower level of effort and fewer resources.

1.4 Scope of the Guideline

This guideline focuses primarily on practices and responsibilities of engineers who are involved in the commissioning process, either as the Commissioning Manager or as a member of the commissioning team, for a complex project. It is recognized that many projects will not warrant a thorough commissioning process. However, variations can be made to the application of this guideline to accommodate many different types of projects or situations without detracting from the intent of the document.

The scope of commissioning activity related to a specific project will vary depending on the attributes of the project itself;

- the size and complexity (complex design and/or technology) of the project and the number of building components to be commissioned,
- the critical nature of the occupancy
- client requirements that are new or unique,
- client requirements that are vague or uncertain, or
- remote location.

Other factors that may affect the scope of the commissioning activity are;

- the organizational relationships established for the project,
- the amount of money and/or resources that the Owner allocates to undertake commissioning, and
- the stage of the project at which the Owner decides to undertake commissioning.

These factors are not necessarily independent of one another.

For projects which include complex equipment and systems, and for projects with occupancies of a critical nature, a thorough approach to commissioning is essential. All complex and/or critical mechanical and electrical systems and related architectural elements such as the building envelope and internal wall

systems subject to pressure differences should be included in the commissioning program. It is also essential that the mechanical and electrical design consultants are included as an integral part of the commissioning team, and that the Commissioning Manager, whether the Owner, one of the design consultants or an independent agency, be suitably qualified and experienced in the commissioning of projects of similar size and complexity

Appendix A of this document provides examples of the types of systems to be considered in building commissioning. As a number of these systems are highly specialized, procedures specific to each project should be developed by personnel with relevant design and operating experience. One system which historically has received little or no attention in the commissioning process is the building envelope. In recent years, problems associated with building envelopes have highlighted the importance of their inclusion in comprehensive commissioning programs.

While the intent of this document is not to prescribe specific procedures for commissioning building systems, readers should be aware that there are many sources of information readily available that can be used in preparing commissioning procedures. A sample listing of a number of internet websites providing information on the topic of commissioning is provided in Appendix C. Other sources are texts and guidelines published by a number of technical and trade associations, and government agencies.

2 Fundamentals of a Comprehensive Commissioning Program

2.1 Introduction

In the document "Project Commissioning – Scope and Process", the Commissioning Branch of the Alberta Public Works Supply and Services Department present a detailed framework for managing the building commissioning process. This framework is presented here as a model that may be followed by professional engineers who are participants in the commissioning process.

The Alberta Public Works document presents the commissioning management process as a series of actions and activities by the project participants at various times over the complete life cycle of the project. These actions and activities can be regarded as fundamental to a sound commissioning program and are included in the following phases of the commissioning process;

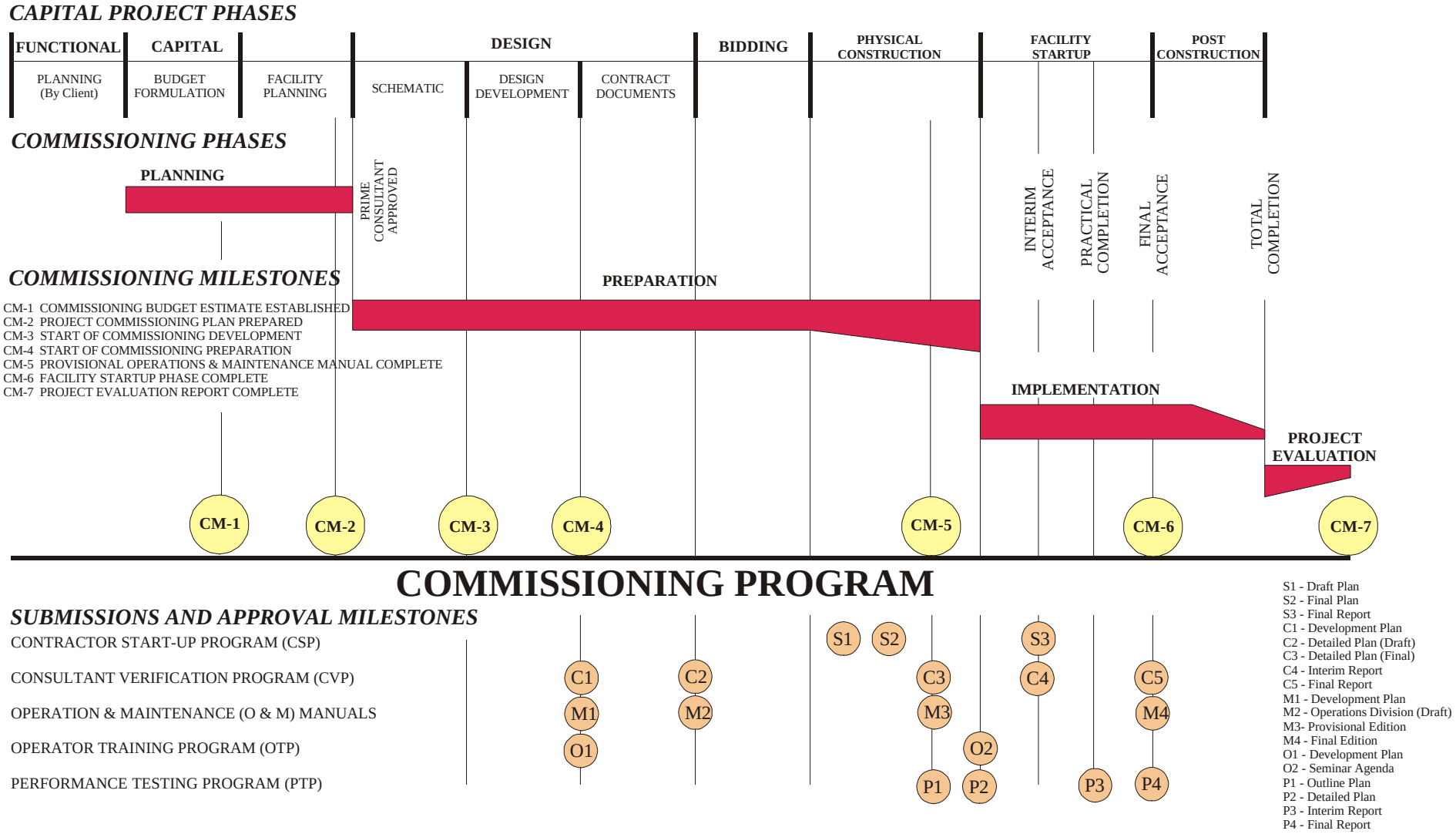
(a) Planning,
(b) Preparation,
(c) Implementation, and
(d) Project Evaluation.

Within each of these phases are major milestones that should be achieved. The four phases, and seven major "Commissioning Milestones" (CM) to be achieved are illustrated in Figure 1 and are described in the following sub-sections.

2.2 Planning

This phase of the commissioning process parallels the Functional Planning, Budget Formulation and Facility Planning activities of the project. Planning related to the start-up of a facility, documentation of appropriate information, and training of system operators must commence in the very early stages of a project, and evolve on a continuous more detailed basis throughout all phases of the work. However, prior to the appointment of the Prime Consultant for any particular project, there are basic decisions to be made that could have a major impact on the success or failure of the project from a commissioning point-of-view. This period

GENERAL FRAMEWORK FOR PROJECT COMMISSIONING



COMMISSIONING PROGRAM

S1 - Draft Plan
S2 - Final Plan
S3 - Final Report
C1 - Development Plan
C2 - Detailed Plan (Draft)
C3 - Detailed Plan (Final)
C4 - Interim Report
C5 - Final Report
M1 - Development Plan
M2 - Operations Division (Draft)
M3- Provisional Edition
M4 - Final Edition
O1 - Development Plan
O2 - Seminar Agenda
P1 - Outline Plan
P2 - Detailed Plan
P3 - Interim Report
P4 - Final Report

Figure 1

of the project is characterized by planning activities and related decisions that will establish the project commissioning plan and related budget. Two commissioning milestones should be achieved during the Commissioning Planning Phase:

CM-1 Commissioning Budget Estimate Established
An assessment of commissioning risks associated with a new project is made and a separate budget provision should be established to cover costs expected during the Preparation and Implementation phases of commissioning. This includes the costs associated with the preparation of operation and maintenance manuals and familiarization and training of operations personnel.

CM-2 Preparation of Project Commissioning Plan
Once the scope of the project has been defined, and prior to the selection of a Prime Consultant for the project, a Project Commissioning Plan should be prepared to define the commissioning requirements for the project in terms of:

- The equipment and/or systems that are targeted for commissioning.
- A general assessment of risks, uncertainties and/or vulnerabilities expected during the facility start-up phase of the work.
- Special resources required to support the commissioning effort and the timing of their involvement.
- Any special or additional services that may be required from the design consultants to support the commissioning effort.
- The general staging and timing for the facility start-up and the timing for key commissioning activities through to the completion of the project.

2.3 Preparation

This phase of the commissioning process spans the design, bidding and physical construction activities of the project. Depending on the size and complexity of the project, this phase can involve any number of activities, by any or all project participants, that are specifically aimed at preparing for the successful implementation of facility start-up including the preparation of operation and maintenance manuals and familiarization of operations staff. The focus of commissioning activities in this period is generally:

- Definition of explicit general contract requirements by the design consultants to ensure that the Contractor’s start-up activities are properly planned, prepared and implemented. Specifications prepared for the project must be thorough and clear.

- Consultant verification of contract work, through shop drawing reviews, field inspections, and witnessing of equipment and system tests, to ensure that the work is being installed as specified and to confirm the completeness of construction and acceptable system operation.
- Progressive development of the detailed plans to ensure that all aspects of the facility start-up are carried out in a well coordinated, timely and effective manner.
- Testing of systems individually and collectively to determine the level of performance.

Commissioning milestones achieved during the Preparation Phase include:

CM-3 Start of Commissioning Preparation

This commissioning milestone typically occurs at the end of the schematic design and at the beginning of design development. For the routine facility, this milestone simply confirms that any special requirements to properly commission the facility are known and arrangements are being made. For more complex facilities, this milestone signals the start of intensive development activities, aimed at the successful execution of the facility start-up activities, the documentation of essential information, and the planning of the future training of the operator/user group.

CM-4 Start of Commissioning Development

This commissioning milestone typically begins at the same time that final design and contract documentation (drawings and specifications) start. Based on prior planning, a consultant verification program is prepared, on a system-by-system basis, including preparation of report forms. Also, an operations division of the operations and maintenance manual is prepared based on the final design.

CM-5 Provisional Operations and Maintenance Manual Complete

This milestone results in the provision of manuals, except for information obtained during facility start-up, for use by all project team members and the permanent system operators. Based on the information contained in the Operations Division, a performance test program is prepared on a system-by-system basis including the preparation of report forms. Guidelines pertaining to the Operation and Maintenance Manual are presented in Appendix B.

2.4 Implementation

The implementation phase of the commissioning process covers the Facility Start-Up and the Post Construction activities associated with the project. Prior planning and preparation activities should reduce the implementation phase to fieldwork, analysis of results, necessary corrective action and the training and familiarization of system Operators. The milestone met during this commissioning phase is the most significant of the commissioning process and occurs with the final acceptance of the project.

CM-6 Facility Start-Up Activities Complete – Final Acceptance
This is clearly the most important commissioning milestone and should have the most significant impact on scope and intensity of commissioning related activities throughout the project. This milestone marks the point in time where all contract, design and facility performance requirements have been met and where a stable and acceptable level of facility operation has been achieved. It is a date that should be fixed for planning purposes as part of the detailed facility start-up planning activities and should be achieved within six months of interim acceptance of the contract work for even the largest and most complex facilities. For smaller and simpler facilities this time frame should be substantially reduced.

The implementation activities leading up to, and following CM-6 are described in the sections below.

2.4.1 Facility Start-Up Activities

Facility start-up is regarded as the most important step of the entire commissioning process. It is when the commissioning plan is put into action. Facility start-up concludes with final acceptance of the facility by the Owner. Activities and milestones associated with facility start-up are illustrated in Figure 2.

Facility start-up activities fall under 3 categories, or sub-phases

(a) completion
(b) testing
(c) tuning

(a) Completion Activities

The Alberta Public Works document describes completion as the period in which a series of preplanned and coordinated activities are carried out by the Contractor (Contractor Start-Up Program) to transform the facility from a state of static completion to a state of dynamic operation in compliance with the contract documents. It is also the period in which a series of preplanned and coordinated activities are carried out by the design consultants (Consultant Verification Program) to verify that the installed work is complete and in accordance with the contract documents and the design intent.

These two programs may be carried out in two separate steps. The first step would be a prerequisite to interim acceptance and operator occupancy of the facility. The second step would include the start-up of those facilities that cannot be operated until some later period in the first year of operation, due to outdoor conditions.

Successful completion of the Consultant Verification Program should be sufficient for the design consultants to issue "certification letters" as may be required by the regulatory authorities prior to occupancy or interim occupancy of the building.

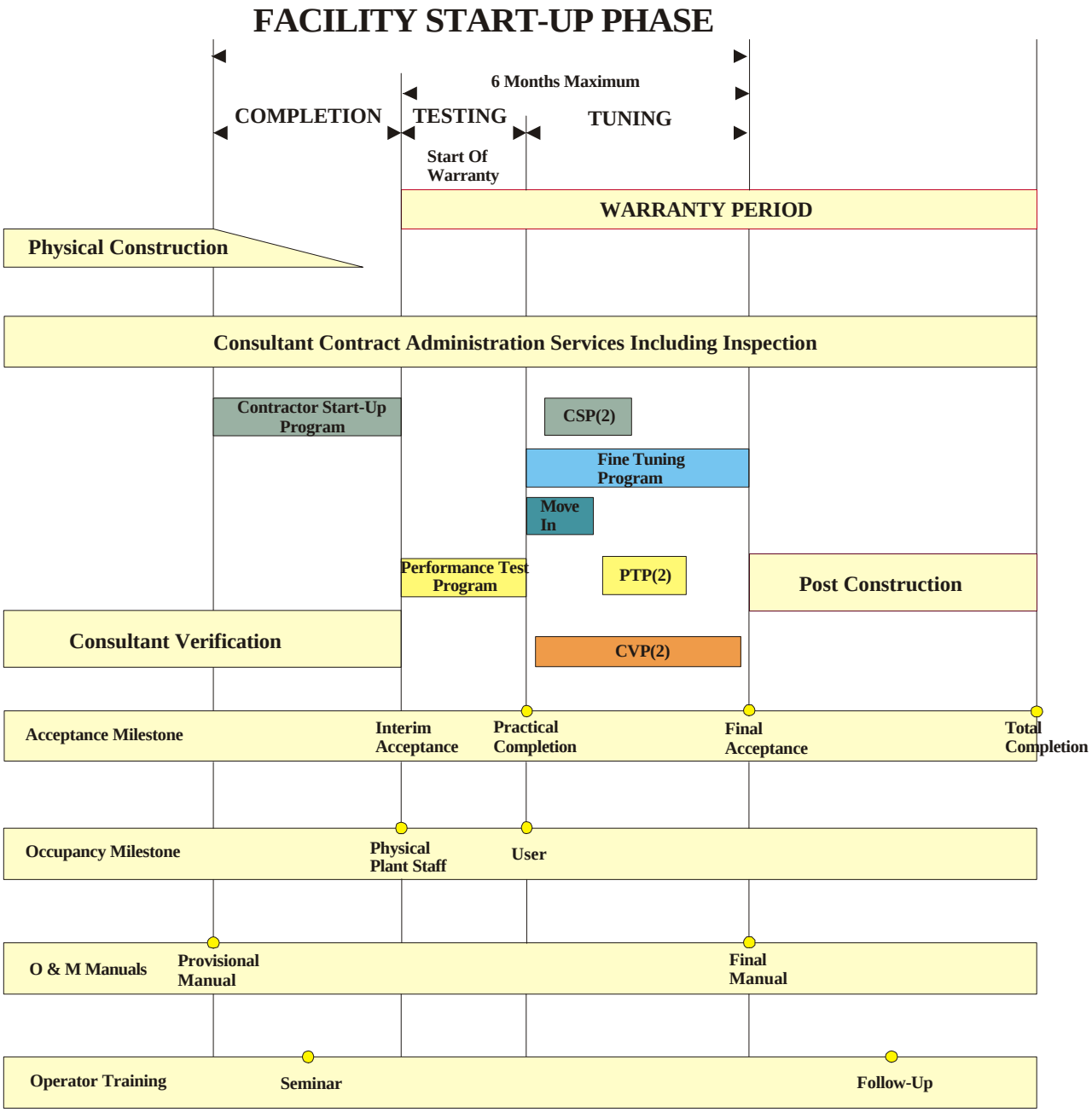
During the completion sub-phase the provisional edition of the system operation and maintenance manuals should be made available to system operators and everyone involved in the start-up for their review and familiarization with the various systems. A formal training seminar, led by the design consultants with support from the contractors and equipment suppliers should be held to familiarize the operators with each system.

(b) Testing Activities

Testing is the period that takes place following the contractor start-up program and the Consultant Verification Program and after a formal training seminar for the system operators has been held.

Testing is a series of operating tests carried out by the Owner (Performance Testing Program). These tests are carried out independent of the project team and should be performed under simulated operating conditions.

COMMISSIONING OF BUILDINGS



CSP - Contractor Start-Up Program
CVP - Consultant Verification Program
PTP - Performance Test Program
FTP - Fine Tuning Program

Reference: Adapted From Project Commissioning Alberta Public Works

Figure 2

Testing is normally carried out by the Owner's personnel if they are available, or by private testing agents directly contracted by the Owner. If testing is carried out by private testing agents, the Owner's key operation and maintenance staff should still be present during the testing to increase their familiarity with the systems.

Testing results should confirm that the systems operate according to the contract documents and the design intent. Testing should also confirm that the Owner's operators are ready to operate the facility under actual operating conditions.

If there are any contract or design deficiencies identified as a result of the testing program, they are turned over to the project team for resolution. If additional operator training is required, a supplemental training seminar should be arranged.

(c) Tuning Activities

Tuning is the period during initial occupancy of the facility by the user in which all systems are fine-tuned by the Owner under actual operating conditions. All outstanding deficiencies are eliminated or otherwise resolved. Also, deferred seasonal systems are usually completed during this period.

Once all activities associated with completion, testing and tuning are completed, milestone CM-6 associated with final acceptance can be achieved.

2.4.2 Post Construction Phase

This is the period of the project which follows final acceptance. During this period any remaining minor deficiencies are corrected. Once all outstanding deficiencies are corrected, the project is considered to be totally complete.

A follow-up operator training seminar may be held at this time.

2.5 Project Evaluation

This is the period following the completion of a project during which an evaluation is carried out to assess both the good features and the problems encountered in delivering the new facility to the point of stable and acceptable level of operations, that is in accordance with predefined client and operator requirements.

The milestone achieved at this stage of the project is important for the benefit of future projects.

CM-7 Project Evaluation Report Complete

This milestone identifies the completion of the commissioning management process for any individual project. The Project Evaluation Report is an important mechanism to ensure that commissioning related problems are minimized on future projects. This report will also provide information, which will serve as a datum for future facility operation and evaluation.

3 Organizational Considerations

3.1 Typical Organizational Relationships

Three organizational arrangements that can be applied to the commissioning process are illustrated in Figure 3.

Option 1: Prime Consultant coordinates and manages all specialist subconsultants in the development and implementation of a commissioning program.

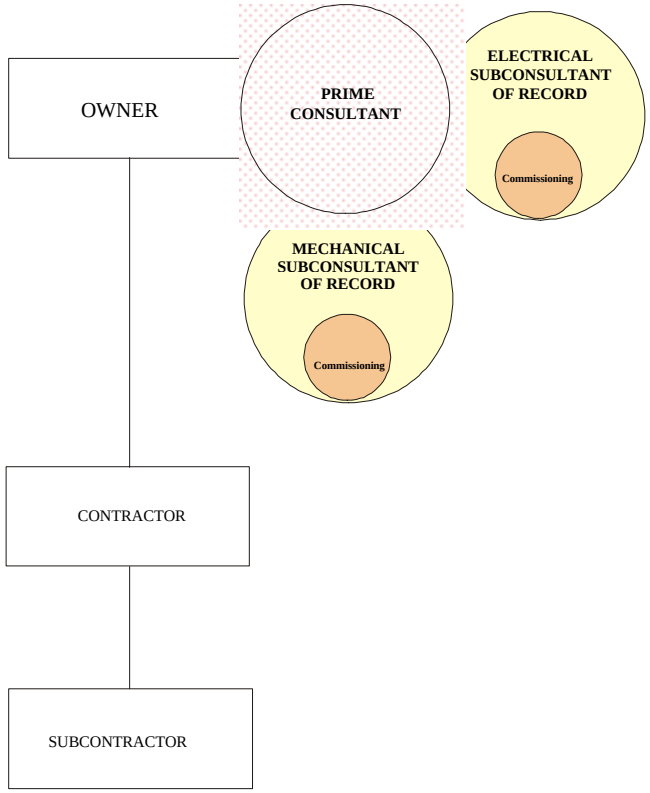
Option 2: Prime Consultant coordinates and manages all specialist subconsultants, one of which is a commissioning consultant, or "Commissioning Manager", having the responsibility for development and implementation of the commissioning program.

Option 3: Owner arranges for a commissioning consultant, or "Commissioning Manager", who is directly responsible for the development and implementation of the commissioning program, and who reports directly to the Owner and the Owner's staff.

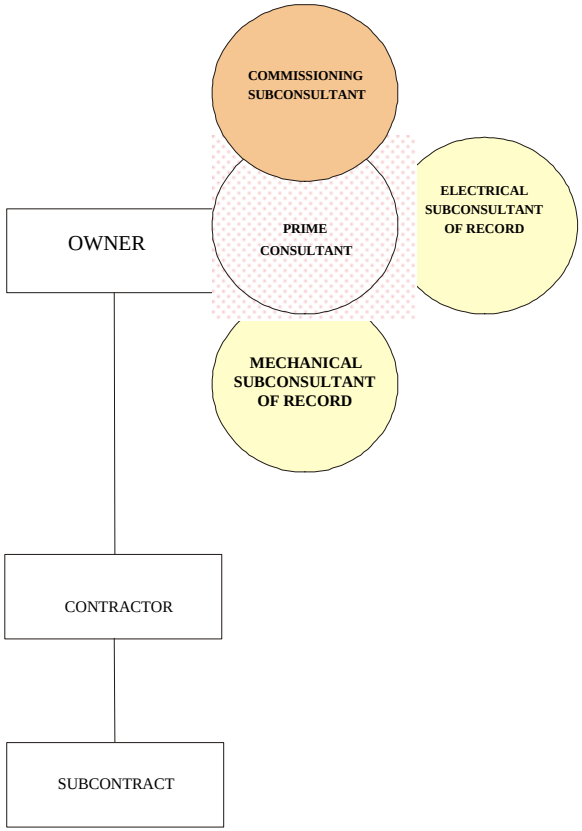
The concepts illustrated in Figure 3 are applicable to other types of organizations, as well. For example, the commissioning function may be performed by in-house engineering staff in the Owner's organization.

Under Option 1 described above, the Owner engages a Prime Consultant to coordinate and manage all specialist subconsultants. In this arrangement, the commissioning function is performed by the in-house staff of the electrical and mechanical subconsultants respectively. Its success is dependent upon the in-house capability of the subconsultants to provide commissioning services and their ability to deal objectively with conflicts that may arise with the design. It also requires ability by the Prime Consultant to coordinate the commissioning function.

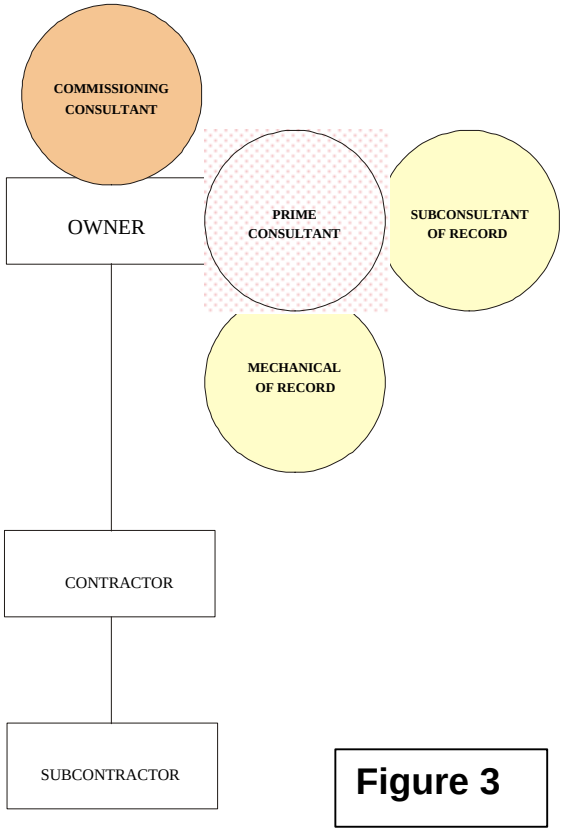
Option 2 also describes an organizational arrangement in which the Owner engages a Prime Consultant to coordinate and manage all specialist subconsultants. In this arrangement, the commissioning function is performed by a subconsultant who specializes in commissioning. It has the advantages of specialization and direct communication between the members of the design/ commissioning team. It also permits effective control of potential conflicts between the design and commissioning functions.



Option 1



Option 2



Option 3

Figure 3

Organizational Considerations

Option 3 describes an organizational relationship in which the Owner engages the Commissioning Manager directly. In this option, the commissioning function may be performed entirely by the Commissioning Manager or in conjunction with the Owner's staff, or the Mechanical/Electrical Engineers of Record, acting under his direction. Regardless of who performs the commissioning activities, this arrangement must provide for the necessary interaction between the Mechanical/ Electrical Engineers of Record, starting early in the design phase and continuing until final acceptance. Option 3 introduces independent professional opinion with respect to the performance of the constructed facility. This option requires that the Owner be able and willing to coordinate and manage the interrelationship between the design, construction and commissioning functions.

A number of conditions will influence the choice of organizational relationships for any particular project. One important consideration is the experience and availability of the Owner's staff to coordinate and/or manage the design and commissioning consultants in the performance of their respective services on a project. An appropriate organizational structure should be selected by the Owner at an early stage in the project since it will influence the wording in the specifications, particularly in areas of interface between the Commissioning Manager and the Contractor. It is imperative that the responsibilities of the Commissioning Manager and the Contractor are clearly described since they both have potential to affect manufacturers' warranties. Care must be taken in describing the responsibilities of the Commissioning Manager, to avoid unnecessary conflicts and/or disputes between the Owner and Contractor.

Where a project is undertaken on a design/build basis, the commissioning function may be included in the work of the General Contractor or the mechanical and electrical subcontractors. In this situation, special attention must be given to the potential conflict of interest which may affect the objectivity of the commissioning function and its validity as a measurement of the performance capability of the as-built facility.

3.2 Roles and Responsibilities

There are many variations of the organization models identified in the preceding section. The number of parties involved can extend well beyond those shown in the options which appear in Figure 3. Typically many parties have some contractual obligation in various aspects of the commissioning. These parties are organized in different ways to suit the nature of the project. The extent of their

contribution can vary accordingly. It is essential that the role of each party, including the Commissioning Manager, is defined early in the project.

The following sections outline the roles and responsibilities of the Prime Consultant and the Mechanical and Electrical Engineers of Record in their traditional design capacities, and the additional duties assumed by the Commissioning Manager. The Commissioning Manager may be the Owner, Prime Consultant, Mechanical/Electrical Engineer of Record, or an independent commissioning consultant. The commissioning duties described in the sub-sections below may be performed under the Commissioning Manager's direction by a commissioning team comprised of various combinations of members from these other groups.

3.2.1 Prime Consultant

The Prime Consultant is the professional engineer or architect under whose overall responsibility the design is carried out and construction drawings and specifications are prepared and sealed. When the Prime Consultant reports to and/or is contracted directly by the Owner rather than a project manager, the Prime Consultant often assumes part or all of a project manager's responsibilities. In either case, it is important that a Prime Consultant's obligation for commissioning be clear. The Prime Consultant is responsible for:

(a) Determining the Owner's requirements and incorporating them in the design.

(b) Describing to the Owner the full scope of professional services required to meet the needs of the project during design, construction and commissioning including the potential consequences of limiting specific aspects of the scope of services.

(c) Selecting competent design subconsultants and assigning responsibilities with respect to services required throughout the design, construction and commissioning stages of the project.

(d) Determining through consultation with the Owner, which organizational option is to be used to perform the commissioning service.

(e) Negotiating agreements with the Owner and subconsultants which reflect appropriate scope of professional services and fees.

(f) Coordinating the design process including any elements of the design which are specified to be provided by the Contractor, and determining that all design is performed under the supervision of qualified professional engineers.

(g) Reviewing subconsultant designs and specifications for conformance to the design criteria and the integrity of the total project design.

(h) Coordinating the preparation of contract documentation including all aspects of requirements with respect to substantial completion, warranty and payment for services associated with commissioning.

(i) Ensuring that the Contractor understands the design including any special features and construction sequences.

(j) Coordinating the contract administration services for the whole design team.

(k) Coordinating the activities of the design team with the commissioning function throughout the design, construction and start-up of the facility.

3.2.2 Mechanical and Electrical Engineers of Record (Engineering and Specialist Consultants)

The Mechanical and Electrical Engineers of Record are usually the most qualified members of the project team to specify and document the system to suit the Owner's operating objectives. It is therefore essential that the Commissioning Manager work closely with the design consultants.

The Mechanical and Electrical Engineers of Record are responsible for the following in their respective disciplines:

(a) Advising the Prime Consultant regarding the scope of professional services required to meet the needs of the project during design and construction and providing those services accordingly.

(b) Preparing design drawings and specifications which conform to applicable codes and standards and which reflect the respective scopes of work including that which is required to incorporate the commissioning process as established by the Prime Consultant.

(c) Selecting qualified subconsultants in specialized areas of engineering, as required.

(d) Interpreting the intent of the drawings and specifications during construction as required.

(e) Reviewing shop drawings and other submissions from the Contractor for conformance to the intent of the design.

(f) Reviewing drawings and documents prepared by the Contractor or subcontractors which describe techniques, procedures and sequences for conformance to the intent of the design, including any special criteria established by the client that affects the design.

(g) Specifying special construction procedures when required to meet the intent of the design.

(h) Reviewing the qualifications of contractors and subcontractors for conformance to the requirements specified in the contract documents and making recommendations on their selection. If the recommendations are overruled, the consequences of the decision must be communicated in writing to the Prime Consultant and the Owner.

(i) Providing contract administration services to the Prime Consultant in accordance with the scope of professional services in the subconsultant agreement.
(j) Contributing to the preparation of Operating Manuals by compiling systems descriptions, maintenance and warranty information.

3.2.3 Commissioning Manager

The Commissioning Manager may be the Owner, Prime Consultant, Mechanical/Electrical Engineer of Record, or an independent commissioning consultant.

The function of the Commissioning Manager is to determine, in consultation with the Prime Consultant and Electrical/Mechanical Engineers of Record, if the installed mechanical and electrical systems are capable of operating in accordance with the design as specified, and to test and observe their initial operation. Regardless of the organizational arrangement within which the

Commissioning Manager is engaged (see Figure 3), the scope of services for the commissioning function should be clearly established.

On a project that requires the full scope of services, the Commissioning Manager is responsible for the following:

(a) Reviewing the design concept for conditions that affect the commissioning function. Recording the results of the review in a written report to the Prime Consultant.

(b) Preparing commissioning specifications and payment clauses in the format and standard established by the Prime Consultant and/or Owner as applicable. Responsibility for the cost of utilities and labour expended in commissioning, as well as special costs for items such as extended warranty, should be included in the documentation submitted to the Prime Consultant.

(c) Measuring and recording systems and equipment performance in accordance with established and logical procedures.

(d) Comparing measured performance with specified performance andcertifying satisfactory operation if performance does conform to specifications.

(e) Advising the Owner and/or the Prime Consultant (as applicable) of all inconsistencies between measured performance and specified performance.

(f) Providing a permanent record of the commissioning work suitable for the operational and maintenance use of the Owner.

(g) Defining the specific tasks that need to be executed, in consultation with the Owner and the Prime Consultant. The Scope of Work may include, but should not necessarily be limited to, the following:

(i) definition of the Systems and Equipment to be commissioned;
(ii) procedures for Systems and Equipment commissioning;
(iii) documentation format for recording measurements;
(iv) documentation format for certifying equipment and system performance to establish standards.

(h) Special tasks associated with the commissioning process that may be requested by the Owner as follows:[1]

- availability to discuss aspects of commissioning at the design and construction stage;
- review of maintenance procedures;
- preparation of operating and maintenance manuals;
- preparation of a preventive maintenance program;
- classroom seminars on systems description and operating requirements;
- video tape operating and maintenance instructional seminar material;
- availability to monitor system or equipment performance throughout warranty period and/or first change of season.

It should be noted that responsibility associated with the commissioning function does not overlap the professional responsibility of the members of the design team. The Commissioning Manager should avoid giving professional advice to the Owner which extends beyond commissioning, to matters of design. Since the results of commissioning activities on a project have potential to identify design deficiencies, it is imperative that all communications be performed in strict conformance with the Code of Ethics.

3.2.4 Other Participants in the Commissioning Process

In addition to the key participants referred to above, there are a number of other parties that are likely to be involved in the commissioning process. Depending on the structure of the Owner's organization these participants may include the Owner, or the Owner's project manager, and the Owner's operating staff, or contract operator. The operating philosophy of the Owner must be determined before preparing the commissioning plan for the building or facility. Systems, equipment, devices and documentation must be designed to suit the capability of the Owner's operating staff and organization. The Owner's operating staff or contract operator must be involved throughout the commissioning process.

The General Contractor and trade subcontractors are also participants in the commissioning process. The General Contractor assumes responsibility under the contract, for the completion of all the "work", including commissioning.

[1] The tasks listed are examples and do not represent all activities which the commissioning manager may be requested to undertake. Some items listed may be included in the scope of assignment of the Mechanical or Electrical Engineer of Record.

Where work is let in packages throughout the project's duration, it is important to ensure a consistent approach to commissioning.

In most cases the General Contractor relies heavily on the sub-trades to carry out commissioning obligations. The mechanical and electrical sub-contractors typically have the most extensive responsibility for providing and setting into operation systems and equipment. The mechanical contractor usually has to coordinate the work of such sub-trades as plumbing, and drainage, sheet metal (HVAC Systems), refrigeration, controls, etc. While electrical contractors do most of their own work, there are some systems (e.g. Telecommunications, security and controls) where sub-trades are utilized. The interface between the commissioning work of various mechanical and electrical sub-trades must be clearly defined. Sub-contractors usually have the responsibility of assembling the documentation for the systems they supply. This documentation comprises reports on:

- Air /water balancing and recording
- System and equipment start-up and proving
- Control sequence and operation testing
- Load Checks
- Operating and maintenance manuals
- Tagging of devices and equipment, and
- Record drawings.

It is important to ensure that this documentation is complete, well indexed and well presented with no superfluous or irrelevant information

Finally, the various suppliers of equipment to a project are also involved in the commissioning process. Although their responsibility is often limited to providing documentation, for complex equipment they may be made responsible for the initial start-up and testing.

Appendix A

Systems to be Considered for Commissioning

Commissioning is not a replacement for, or a duplication of "review during construction" as described in the APEGM Guideline for Providing Mechanical and Electrical Engineering Services in Buildings. It is a distinct and separate engineering service covering the start-up and testing of electrical and mechanical systems to confirm performance capability.

The following list of activities is applicable to many types of complex buildings, but is not meant to be in any way exhaustive or limiting. The Commissioning Manager should compile a specific list for each project.

Power Systems

- primary switchgear
- normal power system
- emergency power switchgear and distribution
- emergency power generation (including any special ventilation system that may be required)
- miscellaneous electrical systems (such as clocks, uninterruptible power to computers, etc.)
- special project-related electrical systems (such as isolated power for operating rooms, etc.).

Lighting Systems

- normal interior lighting
- exterior lighting
- economy measures (such as block lighting programs)
- special lighting (such as battery-powered emergency system for stairwells and corridors).

Heating Systems

- central heating plants
- heating and cooling systems
- plant controls and automation
- alternative fuel supplies (natural gas/fuel oil)
- special project-related heating systems.

Ventilation and Air-Conditioning

- central supply and return air systems
- stand-alone air handling systems
- exhaust air systems (such as kitchens, fume hoods, washrooms, cyclone, laboratories, etc.)
- special project-related ventilation (such as loading dock or ambulance bay airlock, connecting links between buildings, electrical rooms, volatile stores, etc.).

Refrigeration Systems

- central plant chilled water systems
- isolated chiller and cooling tower systems
- heat recovery systems
- special project-related refrigeration systems.

Plumbing Systems

- hot and cold water service systems
- domestic water and fire protection system
- chemical treatment and water softening systems (such as water softener, feeders, chemicals, testing and controls)
- sanitary sewerage system
- storm water management system (such as roof and catchbasin flow controls, sewers and site storage ponds
- liquid water treatment and disposal system special project-related drainage (such as chemical resistant drains, toxic effluent discharge, etc.).

Fire and Smoke Safety Systems

- electrical hardware and operation
- mechanical hardware and operation
- fire alarm and zone isolation
- integration of fire system with building systems control (such as air-conditioning, elevators, etc.)
- testing and certification to CAN 4 0 S524.

Communication and Signal Systems

- telephone systems and link-up with authorities
- security systems (such as CCTV, card control, door position switches, etc.)
- public address and intercom
- entertainment and background music
- special project-related systems (such as pocket paging, central dictation, nurse

call, etc.).

Vertical Transportation Systems

- elevator operation and control features, including emergency power and emergency response (hospitals)
- interconnection with fire alarm procedures (i.e. firefighter's feature)
- normal and emergency operation of escalators, conveyors and pneumatic tube systems.

Waste Disposal Systems

- garbage collection and chutes
- compactors
- destructors
- incinerator, possibly with heat recovery
- licensing of competent authority.

Automation

- mechanical control systems
- provision of special power (such as compressed air)
- building control components
- central plant control room components
- central system programming
- diversified control (such as to "smart panels" wiring in central and local air-conditioning plant, room condition equipment, e.g. thermostats, etc.)
- special project-related controls (such as humidistat in intensive care areas of hospitals, swimming pool area dehumidification, etc.) control software (debugging).
-

Building Envelope

- air/water and vapour penetration rates
- water shedding systems
- thermal performance
- light transmittance.

Structural Systems

- deflection
- chemical/moisture.

Special Systems and Processes

- job specific systems (such as medical gases supply and distribution in hospitals, water treatment for communal pools in recreation facilities, etc.).

Appendix B

Operation and Maintenance Manuals

B-1 Introduction

It is intended that the Operation and Maintenance Manual transfer the design intent to the Building Operators. Operation and Maintenance Manuals must be:

- Thorough
- Detailed
- Accurate
- Project specific, and
- Written in plain English.

Because the Design Consultant(s) develops the system(s), it should be the responsibility of the Design Consultant(s) to write and assemble the entire manual. Information generated or received by the Contractor and the Owner would be provided to the Design Consultant(s) for inclusion in the manual.

B-2 Organization of the Manual

This Guideline proposes organizing the Operations and Maintenance Manual in the format adopted by the Alberta Public works, Supply and Services Commissioning Branch().

This format divides the manual into four divisions:

1. Operations Division
2. Maintenance Division
3. Contract Documentation Division
4. Standards Division.

The content and purpose of each manual division is as follows.

Operations Division

Each individual system is described in terms of design intent including specific criteria, composition supported by a schematic drawing of the central system, and operating instructions defining each mode of operation including specific operating devices, interlocks and so on. The basic data for each component is recorded for ease of future reference. This information will be used for initial training as operators change in the future, as reference material for the Contractor during project completion and as a day-to-day reference for system operation. Also the Performance testing program is developed on the basis of this information.

Maintenance Division

The maintenance requirements for each component are summarized, in a concise manner, from manufacturers' literature for ease of reference and to highlight the daily, weekly, monthly and so on requirements. This information could be used as the basis for a preventative maintenance program, or in the absence of such a program, at least provide minimal direction in this regard. Furthermore, information on equipment Suppliers, installing Contractors, required spare parts and identification directories are provided; all for future reference if the need arises.

Contract Documentation Division

This division is a collection of data generated by the construction process. This data is organized for each of reference and includes the:

- Drawing list
- Shop drawings
- Certificates
- Warranties and bonds
- Maintenance brochures, and
- Reports (i.e. test and balance, chemical treatments, etc.).

The purpose of this division is to simply organize this information for permanent storage and east of future reference.

Standards Division

This Division includes any standards that may be beneficial for reference by the Operators during future operations such as safety standards, administrative standards and the like.

Appendix C

Internet Websites Applicable to Building Commissioning

There are numerous websites on the internet which are devoted solely to building commissioning. These sites can be easily located by conducting a keyword search ("building commissioning") using any one of the search engines available. Examples of sites where information on commissioning can be found are;

http:/www.ashrae.org/
http:/www.ecw.org/tc99/
http:/www.eren.doe.gov/femp/techassist/bldguide.pdf
http:/www.bcxa.org/
http:/www .energy.state.or.us/bus/comm/bldgcx.html
http:/www.lightforum.com/design/buildcomm1.htm
http:/www .teamkd.com/New%20KDWEB/KD-BCMI-CommPage.htm
http:/www .eren.doe.gov/femp/techassist/bldgcomgd.html
http:/www.aabchq.com/examplefpt.htm
http:/www.state.fl.us/fdi/edesign/news/9708/odom.htm
http:/www.state.fl.us/fdi/edesign/news/9708/odom.htm
http:/www.es.wapa.gov/pubs/briefs/Bld_comm/tb_bldcm.cfm

Appendix D

Bibliography

1 Alberta Public Works, Supply and Services, Capital Development Project Management Division, Commissioning Branch", Project Commissioning – Scope and Process", November 22, 1991.

2. Association of Professional Engineers, Geologists and Geophysicists of Alberta, "Commissioning - A Guideline", September 1990.

3. Canadian Standards Association, "Questionnaire on Building Commissioning", December 1991.

4. Professional Engineers of Ontario, "Guideline - Professional Engineers Providing Commissioning Work in Buildings", 1992.