

# **Commissioning in Public Works and Government Services Canada**

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## ***Abstract***

This article describes some of the main features of commissioning as introduced into Public Works and Government Services Canada (PWGSC). A brief history of commissioning and issues such as reasons, risks, specifications, costs, roles and responsibilities, the commissioning manager, the commissioning engineer/designer, PWGSC design quality review team, contractor/the commissioning agent, O&M concerns, and future challenges are considered.

## **Introduction**

With its very extensive inventory of buildings of all sizes, complexity and use, the need for commissioning has long been recognized within this department [Public Works and Government Services Canada--PWGSC]. In 1977, the need for early involvement in project delivery led to the establishment of a buildings commissioning section in the department. But they faced three major obstacles:

- The lack of a substantial database;
- The lack of practical experience; and
- Resistance by designers and project managers to what was perceived as interference by non-designers in matters about which they had very limited knowledge.

We have come a long way since then. In 1987, a working group was formed with representatives from the two service branches--Architectural and Engineering Services (A&ES--responsible for design and construction) and Property and Facilities Management (PFM--responsible for facility operation and maintenance). Their mandate was to define commissioning in practical terms and to establish technical requirements for commissioning mechanical and electrical equipment and systems.

After two National Workshops, further refinements, and the production of several further drafts, the Project Commissioning Manual was produced in November 1993. In 2000, a National Commissioning Committee was established. Its membership included representatives from AES and AFMS and was co-chaired by Ed Durand, National Manager of Mechanical & Maintenance Engineering and Ralph Collins, A/director of AFMS.

As a result of the work of this committee, further changes were made to the manual in order to make it even more easily referenced by Project Managers, Commissioning Managers, Facility Managers and designers.

In November 2003, the revised Commissioning Manual and Guidelines were issued.

- **PWGSC Commissioning Manual CP.1** - clearly defines the commissioning deliverables, roles and responsibilities of key project team members, and provides guidance in the implementation of commissioning for all PWGSC real property projects. It addresses the requirements of the Commissioning Policy and includes issues which are of major concern to the PWGSC Project Manager and the Project Leader. This manual can be referenced from this site.
- **PWGSC Commissioning Guidelines** - contains the remaining documents and is generally for the benefit of in-house designers, consultants and their sub-consultants and Commissioning Managers. These guidelines (CP-3 to CP-13) includes information on Commissioning plan, Building Management Manual, Training plans, Facility Operation and Maintenance, Commissioning reports, Development and use of check lists, Development and use of report forms and schematics, Preparation of commissioning brief, Development and use of generic commissioning specifications and Facility Maintenance policy.

*The PWGSC Commissioning Manual and the PWGSC Commissioning Guidelines* have been structured so that each Region is able to adapt them to suit regional requirements, since it is recognized that each Region has a different approach to the practice of commissioning and that this will affect how each uses the *PWGSC Commissioning Manual*. It is suggested that each Region select from the *PWGSC Commissioning Guidelines* those elements which are most applicable to the Region's requirements and that will enable each Region to develop a quality deliverable which is acceptable to the Client.

It is suggested that each Region develop its own partnership agreement between the relevant branches of PWGSC relating to roles and responsibilities throughout the commissioning process so as to reflect the distinctive organizational structure of each Region. It will also promote commissioning as a tool for enhancement of Client satisfaction.

### **Partnership between all branches of PWGSC**

The role of PWGSC in commissioning and in the production of the PWGSC Commissioning Manual and the accompanying PWGSC Commissioning Guidelines has always been fully recognized by all branches of PWGSC.

Architectural and Engineering Resources will continue to provide national leadership for commissioning, while AFM will continue to provide management of the overall commissioning activities as it relates to specific projects.

It is also recognized that PWGSC, through its Design Quality Review Team, has a very important role to play in the identification of Design Criteria, Design Intents, Design Assumptions and Design Solutions to meet these Design Criteria. It is also recognized that commissioning can be properly delivered only by combining the design expertise of Architectural and Engineering Resources and the operational expertise of Maintenance and Operational Assurance (MOA) Commissioning Manager in NCA, and the Maintenance Management Commissioning Manager in the Regions.

## **What is Commissioning?**

- Commissioning is a planned program of activities that advances built works from the earliest stages of the Project Identification Stage to a condition of full operation, meeting all objectives of commissioning as defined herein. Commissioning starts in NPMS Project Identification stage with the production of the Investment Analysis Report (IAR) and ends when the delivered, fully occupied facility has been proven to operate satisfactorily under all weather and occupancy conditions and the Evaluation Report has been written and accepted. Commissioning addresses not only technical systems requirements and the functional and operational needs of the occupants and the Owner including health and safety, security, comfort, and cost effectiveness of operations and maintenance but also protection of the architectural character of new buildings and the heritage character of historical buildings.

Much like the commissioning of ships, commissioning of buildings ensures that when the built works are handed over to its owner occupant or operator as an operating entity it will meet all requirements as described in the Request for Proposal (RFP) or the Project Brief. It requires coordinated efforts on the part of the Project Planning Team, the Design Team, the Commissioning Team, the Construction Team and the Project Management Team.

During commissioning, systems and environmental performances are verified, and the project is moved from a static form to a dynamic state and the facility is accepted for occupancy. After construction is complete, commissioning:

- provides a bridge between construction activities and ongoing operation and maintenance,
- provides the necessary technology transfer (training) tools for O&M activities to be performed properly for the entire service life of the facility,
- focuses on the operation of all systems as an integrated whole and verifies the performance and interaction of all systems operating together under a full range of operating conditions with simulated full occupancy.

## **Why do Commissioning?**

Building commissioning has often been likened to commissioning of ships--and rightly so. Who would ever take a ship straight from the fit-up dock directly on to a summer cruise without first checking and proving performance of all parts--engines, compasses, sonar, radar, radio, generators, potable water systems, etc, etc.? Or checking the presence and availability of the correct charts and that these charts are up-to-date? Or training the crew in the operation of the ship and what to do in the event of emergencies? No-one!! Or who would ever buy a new sailboat and take it on to a race course without first checking that all components are in the right place, properly secured, working properly under all conditions and adjusted for maximum performance? No-one!! But that is exactly what we been doing so often in the past with buildings--we complete an installation, throw the switch, make a few adjustments, spend minimal time with the operators, then walk away. We return only when the operating personnel or owner complain.

A successful project is assumed to be the one with the fewest extras and change orders, and the one with the shortest occupants' complaints list--not the one with the most satisfied client and operators or the one which operates at maximum efficiency at all times. Systems are assumed to be operating properly by default; at least until an emergency hits--power failure, controls failures, extreme exterior ambient conditions, accidents, emergencies, etc.

All that changes when we do commissioning. Projects "leave port" only when they are fully operational, functioning as the owner/investor intended, fine-tuned for maximum performance, with "crews" who are fully trained in regular and emergency operation of the facility and furnished with a complete set of relevant O&M documentation.

### **Commissioning requirements**

All projects managed by PWGSC shall undergo a Commissioning process which is appropriate for the size, scope and, complexity of the project.

Project Managers and Commissioning Managers shall ensure that the client understands the full requirements of commissioning such as:

- Do they realize that commissioning is far more than start-up and operation (which is what they have been getting all along)?
- Have they been assured (with proof) that all systems, as built, not only operate properly, but operate as they intended that it should under all defined modes of operation?
- If they opt, for some reason, not to pay for commissioning, are they aware that they leave themselves open to receiving a facility for which they have little or no assurance that they are getting value for their investment?
- Are they aware that documentation may be inadequate or missing altogether?
- Do they know training will probably be very limited?

### **The Cost of Commissioning**

Commissioning adds 1% to 4% to the cost of the project--and is more than recovered during the initial year of operation.

The cost of commissioning depends upon the degree of risk of non-compliance with the user's requirements or the life cycle quality, the cost plan that the owner is prepared to undertake, as well as other factors such as the complexity of the systems and the tightness of the application tolerances required by the design criteria. Experience to date indicates that full commissioning adds 1% to 4% to the cost of the project. However, experience also indicates that the cost of commissioning is more than recovered during the initial year of operation.

### **Roles and Responsibilities**

Commissioning is a team effort right from the start of the project. The team members include the owner/investor, the project leader, the project manager, the commissioning manager, the designer, the contractor, the commissioning agent and the property (facility) manager.

**The Project Leader** is responsible for initiating the project on behalf of the Owner/Investor, for accepting the facility from the Project Manager and for handing it over to the Property Manager for operation. The Project Leader is also responsible to securing approved project funding.

**The Project Manager** has overall responsibility for managing the project, and for demonstrating to the Project Leader that the installed systems and overall facility meet the requirements defined in the Project Brief.

**PWGSC Design Quality Review Team:** reviews all aspects of design from development of the RFP to Conceptual Design Report, agreement with proposed design solutions, quality assurance, quality control, quality management, detailed design, working documents, and the final evaluation including value for money, adherence to standards.

**PWGSC QA Commissioning Manager:** provides planning and technical advice on O&M matters, coordinates commissioning activities from Project Stage to Project Delivery Close-out Phase, ensures O&M concerns are addressed, provides quality assurance and reviews commissioning documentation at all stages of project delivery including accuracy of Product Information (PI), Performance Verification (PV) and commissioning reports. Communications between the Commissioning Manager, the Designer and the Contractor is through the Project Manager. The Project Manager may delegate authority to the Commissioning Manager in matters relating to commissioning, while retaining overall responsibility for the project.

**Consultant (Designer):** refers to private sector consultant with its internal commissioning resources, an independent commissioning firm, and, to in-house designers. Develops the Commissioning Plan, design intent, system operating manual, proposed design solutions, prepares commissioning specifications and other commissioning documentation, develops training plan, witnesses and certifies performance of all commissioning activities and organizes and monitors all activities as per the Contract Agreement, and is responsible for its contractual design, construction, and warranty-related commitments. The appointment of a Commissioning Manager does not permit the Consultant (Designer) to abrogate traditional responsibilities (e.g site supervision and ensuring that construction conforms to the design intent).

**The Contractor/Commissioning Agent:** carries out many start-up and performance verification activities and carries out demonstrations and acceptance tests and related procedures. The Contractor acts as a coordinator only in matters relating to commissioning, refines the Commissioning Plan develops the Commissioning Schedule, coordinates all commissioning activities in accordance with contract documents, including all tests for equipment, systems and integrated systems and provides required documentation. The Contractor identifies both the site coordinator and the Commissioning Agent.

**The Property Manager** represents the Operator and is responsible for the day-to-day management and operation of the completed facility after it has been accepted from the Project Leader. During commissioning, the Property Manager consults with the Project Manager on the acceptability of the facility, including training and documentation, before accepting the project for operation.

## **Commissioning documentation**

### Design Criteria and Design Intents

All design criteria and design intents are required to be identified on "Performance Verification Report Forms" or other approved format during the design stage.

- Design Criteria: include all those aspects of the design as set out in the Project Brief. Design criteria also include equipment and system sizing information and application tolerances determined by the designer during design and anything else that will be required by the commissioning agency for performance verification and for the owner and operator for proper operation, maintenance and servicing.
- Design Intents: describe how the designer proposes to meet the design criteria. They may be in the form of narrative type descriptions accompanied by schematics, single line diagrams and other supporting data.

### O&M Issues

Long-term and short-term operating and maintenance issues that require input from the commissioning manager during design development include:

- spatial provisions for facility and grounds operation, maintenance and management; staffing requirements (numbers, prerequisites, training);
- provisions for waste storage and handling, including hazardous building and program wastes, refrigerated wastes, security-type wastes, and recyclable or reusable wastes;
- window cleaning, exterior envelope maintenance;
- provisions for security against unwanted intrusion, natural disasters;
- provisions for life safety, including emergency evacuation plans, fire plans, fire alarm user diagrams, emergency power, lighting and communications;
- indoor air quality issues such as containment of major spills, off-gassing;
- barrier-free access, signage, way-finding, column, room and door numbering systems, PMSS alpha numeric identification systems, relationship to EMC systems;
- service contract issues, including access of facility to service centres, availability of service.

### Commissioning Brief

The Commissioning Brief defines the designer's obligations.

The Commissioning Brief is the section of the RFP (request for proposals) or Project Brief which defines the designer's scope of work and deliverables for commissioning services.

### The Commissioning Plan

The commissioning plan describes implementation of all commissioning activities.

The commissioning plan describes the process proposed by the commissioning engineer/designer in conjunction with the commissioning manager for the implementation of all commissioning activities. It is prepared very early in the design stage and is continually refined as the design progresses. It has two basic functions:

1. As a communications tool, it informs each member of the commissioning team, in general terms, of their roles and responsibilities;
2. As a management tool, it sets out the scope, standards of commissioning, and deliverables relating both to commissioning process and to O&M perspectives.

### Commissioning Specifications

Although these form an integral part of the working documents, they are listed separately because of their importance in commissioning the built works. They must include sufficient details to enable the contractor to understand all requirements clearly and to submit an accurate price for commissioning and must include:

1. All required performance verification procedures if not already covered in the Commissioning Procedures Manual of the discipline involved.
2. All systems and integrated systems test procedures.
3. All requirements for preparation of the Maintenance Manual, including maintenance materials, spare parts, special tools, together with instructions for identification, inventory, storage and instructions for use.
4. A list of all factory and on-site performance tests; all to be witnessed and certified.
5. List of activities to be performed by the contractor as part of the Add-on Contract during the Warranty Period.
6. All conditions under which installed equipment may be temporarily operated by the Contractor and all refurbishing requirements
7. Training requirements.
8. Requirements for preparation of O&M documentation

### Commissioning Forms

The following generic documentation have been developed for commissioning the project. However the Commissioning Engineer is responsible to verify their accuracy and to make them project specific.

The examples include:

- Installation/Commissioning Checklists;
- Product Information (PI) Report Forms to capture purchasing information;
- Performance Verification (PV) Report Forms to identify design criteria and approved product data and with provision for recording "as measured" data. Building Management Manual

This is fully described in *CP.4: Guide to the development of Building Management Manuals*.

It consists of five discrete sections:

- Section 1: containing names of participants, functional and operational requirements, description of the project and its systems, accessibility, any FHBRO statements
- Section 2: Design criteria, design intents, design philosophy, applicable codes and standards
- Section 3: Standard Operating Procedures/Systems Operations Manual and, Operation and Maintenance (O&M) manuals
- Section 4: Maintenance and service contracts
- Section 5: Supporting appendices such as: architectural, structural, fire protection and fire prevention, mechanical, electrical, appendices, WHMIS information manual, O&M budget, "as-built" construction documents.

### Commissioning Reports

These documents describe the commissioning processes used during the delivery cycle and provides assessment of the facility as to its compliance with the requirements identified in the IAR and the Project Brief.

### **Training of O&M Personnel**

In summary:

Training includes construction observation, classroom sessions, and hands-on experience.

- trainers include the designer (for his design expertise), the contractor (for his knowledge of the systems as installed), the equipment manufacturer (for his knowledge of the installed equipment);
- trainees include operators, maintenance staff, property manager, user (occupant of the facility);
- training sessions include observation during construction and commissioning, classroom sessions, and hands-on experience;
- training materials include "as-builts" drawings and specifications, videos, hard copy, electronic copy, models.

### **Final Commissioning Evaluation Report**

The Final Commissioning, or Evaluation, Report is prepared by the Commissioning Manager at the end of Project delivery stage - close-out phase.

It is essentially a debriefing report and building evaluation summary and includes:

- .1 a complete assessment of the project,
- .2 lessons learned from this project and any necessary recommendations.

- .3 variances between the actual and planned levels of performance as defined in the IAR and Project Brief.
- .4 an evaluation of the Validation and Acceptance Process and of the commissioning phase.
- .5 What components and systems which were not commissioned reasons for this
- .6 a remedial work plan outlining recommended follow-up actions or projects to be undertaken by PWGSC.
- .7 Other related information

### **Future Developments**

The National Commissioning Committee will continue to direct and advise on all matters relating to commissioning.

Future changes to commissioning will include experiences gained from commissioning activities in PWGSC Regions, as well as knowledge gained from the professional community and from the construction industry. This is essential to the provision of an up-to-date, viable and useful Project Commissioning Manual.

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*Paul Sra has more than 20 years of experience in the design and operation of HVAC, plumbing, fire protection, EMCS controls and commissioning. He has been involved in the development of various commissioning documentation such as commissioning manual, guidelines and specifications. He holds bachelor degree in Mechanical Engineering and is working at Mechanical and Maintenance Engineering, NCA as a Senior Mechanical Engineer. He has provided training sessions to PWGSC regions and to private sector as it relates to commissioning.*