GUIDELINE

Professional Engineers Providing Commissioning Work in Buildings

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This document should be read in conjunction with the Foreword.

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INTRODUCTION

Traditionally, the responsibility for commissioning of buildings has been distributed among parties forming a project team. There are few cases where a single entity has been made clearly responsible for detailed coordination of the process from determining the owner's specific requirements through to follow up testing after full occupation. The complexity of building systems, particularly those related to life safety, environmental quality and energy efficiency give the commissioning process increasing importance.

There is widespread concern about the need to clarify contractual obligations and to review the adequacy of the commissioning process for buildings.

The present system is generally considered to be inadequate and a managed commissioning team approach must be adopted.

This guideline is intended to assist a professional engineer providing services in the commissioning process, either as a manager or a team member. In this guide, that engineer is termed a "commissioning engineer". These services are separate from and, with respect to commissioning, are more extensive than those usually included in building design consulting service assignments.

DEFINITION

Commissioning is a process of achieving, verifying and documenting the performance of building systems to meet the owner's functional criteria, and operational needs of the building, as may be defined in the design documentation.

ORGANIZATIONAL RELATIONSHIPS

Typically, many parties have some contractual obligation in the various aspects of the commissioning of building systems and equipment. These various parties are assembled 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 engineer, is defined early in the project. Besides the commissioning engineer, the other parties involved and their respective responsibilities are:

Owner

The operating philosophy of the owner must be determined before preparing the commissioning plan for the building. There is a great variation in sophistication and style of operation. Systems, equipment, devices and documentation must be designed to suit the capability of the owner's operating staff and organization.

Building Operator

In some cases, the building operator may not be a part of the owner's staff. The operator may be a separate organization, such as a hotel chain, a group of tenants whose leases make them responsible for the building operation, or specialist contractors. In each case, the individual building operator's operating philosophy must be taken into consideration.

Project Director

There are different interpretations of this role. In this guideline, the project director is considered to be the owner's representative who is the interface between the project team and the owner. The project director may or may not be a member of the owner's staff but is responsible for ensuring that the interests of the owner and/or the owner's operating staff are presented to the design and commissioning teams, regarding all information on the operating philosophy and building requirements.

Project Manager

For some projects, this role is combined with that of the project director, who may be a member of the owner's staff or an independent entity. PEO's *Guideline for Professional Engineers Providing Project Management Services* includes a section on "Commissioning" that generally describes the project manager's role as one of assisting the client by setting out procedures covering each party's responsibilities. Should a commissioning engineer be appointed for the project, this person could develop these procedures on behalf of the project manager.

Prime Consultant

In building projects, an engineer or architect is the prime consultant and is responsible primarily for the project's design coordination. When the prime consultant reports to and/or is contracted directly by the owner rather than the 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.

Engineering and Specialist Consultants

Commissioning relates primarily to mechanical and electrical engineering, but passive systems such as roofs, walls and waterproofing should be included. PEO's guidelines state that the obligations of a mechanical or electrical consultant may include "working with the clients' and contractor's personnel to ensure that the systems are operating as per design" and that they may be requested to "aid in the process of commissioning...". The engineering consultants 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 engineer work closely with the design consultants.

Where applicable, the work of other engineering and specialist consultants in such areas as telecommunications, security, etc. should also be included in the commissioning process.

General Contractor/Construction Manager

Often termed the "prime contractor", this person assumes responsibility under the contract for completion of all the "work", including commissioning. In most cases, the general contractor relies heavily on the subtrades to carry out commissioning obligations. In the case of a project utilizing a construction manager, where the work is let in packages throughout the project's duration, it is important to ensure a consistent approach to commissioning.

Trade Subcontractors

The mechanical and electrical subcontractors 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 subtrades as plumbing and drainage, sheet metal (HVAC Systems), refrigeration, controls, etc. While electrical contractor's do most of their own work, there are some systems (e.g. telecommunications, security and controls) where subtrades are utilized. The interface between the commissioning work of various mechanical and electrical subtrades must be clearly defined. Subcontractors 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.

Suppliers

Equipment suppliers' responsibility in the commissioning process is often limited to providing documentation. However, they are usually made responsible for the start-up and testing of the more complex equipment (e.g. boilers, chillers, diesel generators, etc.).

Unless there is a strong reason not to, it is wise to maintain the traditional contractual relationships listed above. The commissioning engineer's assignment would then be to ensure that systems, devices, equipment and documentation are entirely suitable to permit an orderly successful start-up, and continued reliable operation. Since the commissioning engineer's responsibilities include co-ordinating the activities of all the consultants, this person could be appointed directly by the owner, the project manager or the prime consultant.

SCOPE OF SERVICES

PHASE I - Preliminary

The commissioning engineer should secure a definition of the client's requirements, identify all parties and their responsibilities, establish reporting relationships and procedures, and prepare a plan for the client's consideration, with costs and alternatives where necessary.

In determining the above, the engineer should:

- abide by the requirements of all Codes and Regulations;
- prepare a preliminary commissioning plan, with alternatives describing each significant section;
- prepare a cost estimate for each of the alternatives and make recommendations;
- take into account the requirements and responsibilities of other design professionals, and provide them with any information they may require, and
- recommend to the client what other services are required from other parties, including design professionals, and prepare terms of reference for these specialized services, commenting when necessary on the submissions made in response to these terms of reference.

When the commissioning plan has been previously agreed upon, the commissioning engineer should report to the client on the preferred commissioning plan and the reasons for its recommendation. The report should give alternatives studied, their advantages or disadvantages, a preliminary cost estimate for the recommended plan and any other information the client may require to fully assess the choice.

The engineer should explain to the client all proposed new materials or techniques and their significance, including the advantages and disadvantages over both the short and long term. The client can then weigh the choices and make a decision before the commissioning engineer proceeds further.

Certain clients may wish to perform all or part of the foregoing preliminary design functions. As long as the responsibility for such preliminary functions is clearly defined, and the commissioning engineer's ability to satisfy the requirements of phases **II** and **III** of this guideline is unimpaired, the commissioning engineer may waive responsibility for the affected parts of this preliminary section.

PHASE II - Final Plans and Specifications

From the preliminary design, the commissioning engineer should prepare a final commissioning plan, which clearly identifies the scope of the commissioning engineer's activities together with the scope to be covered by each party in the final plans and specifications.

The commissioning plan should cover all aspects of the commissioning process so that on completion of its implementation, the building has been commissioned in accordance with the client's directions, and all documentation and training provided. The subjects covered should include:

- system design criteria;
- description of systems and the functionable equipment in each;
- documentation requirements (balancing reports, equipment start-up reports, fire system certification, reporting forms, etc.);

- system performance verification procedures, and
- requirements for assembly and presentation of commissioning documentation.

During the preparation of final plans and specifications, and before issuing tender documents to contractors for pricing, the commissioning engineer should:

- wherever required, provide general commissioning clauses to the parties involved in preparing specifications, to ensure a consistent approach throughout the document;
- attend project meetings as required, to ensure that all requirements of the commissioning plan are fully understood, and
- review progress issues of the plans and specifications to:
  - (i) assist in ensuring that all devices required for commissioning are being provided (e.g. test holes in ductwork, thermometers and wells, pressure gauges, balancing valves, access doors, ammeters, volt meters, etc.), and
  - (ii) assist in ensuring a coordinated approach to the contractor's commissioning-related work (e.g. testing and balancing, cleaning, provision of shop drawings, as-built drawings, operating and maintenance manuals, training, handover procedures, warranties, control sequences, etc.).

PHASE III - Construction

After the contract for the work has been awarded to a contractor, the commissioning engineer should:

- assist the project manager in establishing a schedule for testing, handover, and training activities, and
- assist the client in determining building operating staffing requirements, and the timing and degree of this staff's involvement.

The commissioning engineer should meet as necessary with the contractor and other consultants to explain the commissioning-related contract requirements, interpret them where necessary, and provide input into a testing, handover and training schedule.

During construction, the commissioning engineer should receive and review, where appropriate, copies of all commissioning-related documentation submitted by the contractor.

Before completion of construction, the commissioning engineer should receive the required quantity of finalized as-built drawings, test reports, shop drawings, control diagrams, performance certifications, etc., and review that they are complete, and in an appropriate format, before handing them over to the client, together with any documentation provided by other parties, such as systems manuals prepared by consultants. The commissioning engineer should comment on the documentation in accordance with the terms of reference.

At the appropriate stages of construction, the commissioning engineer should visit the construction site to inspect and confirm that the provisions for commissioning are being incorporated, and should comment in accordance with the terms of reference.

The commissioning engineer should be present at selected testing activities, to represent the client and assist other consultants in accepting that the tests truly represent the specified requirements. If required, the test results may be presented by the contractor on standard forms provided by the commissioning engineer. Typical testing would include:

ïair and water volumes and distribution temperatures;

- fan and pump capacity;
- load and efficiency checks of chillers, boilers, diesel generators, and
- control sequences for heating, air-conditioning, fire, security, power and lighting systems, etc.
- infiltration rates for air and/or water

The commissioning engineer may assist the client in determining how many of what type of operating staff are required, their qualifications, and the degree and timing of their involvement in the commissioning process. The commissioning engineer may arrange for familiarization and training in a timely manner, to ensure that, on completion of handover, operating staff are completely ready for their responsibilities. The commissioning engineer may also be involved directly in the training of such personnel.

In many buildings, tenant fit-up and occupancy is not included in the base building construction contract. It is important that the commissioning plan address the requirements for the occupied

building. A review of the system and equipment performance and operating procedures could also be implemented at the end of the warranty period and at pre-determined intervals, if so desired by the client.

During tenant fit-up work, commissioning engineers should be involved in each fit-up contract, just as they were involved in the base building contract.

The commissioning engineer should develop report formats for recording performance testing results and compile a permanent record of commissioning activities. This record should state professional responsibility for commissioning activities, and include formal procedures for reporting on:

- performance test results;
- individual system and equipment acceptance;
- integrated building acceptance;
- investigations of complaints;
- deficiencies, and
- final completion.

The commissioning engineer should also prepare a check sheet for each piece of equipment, and pre-identify design criteria selection requirements and shop drawing information.

In addition, the commissioning engineer should prepare a commissioning record manual containing equipment check sheets, performance test results, listing of deficiencies and recommended system improvements, all arranged into systems format.

PHASE IV - Post Construction

At the completion of the warranty period and/or at such intervals as arranged with the client, the commissioning engineer may:

- verify system capacity and operation;
- review the activities of the operating personnel, including inspection of logs, reports, as-built drawings, etc;
- arrange for the assistance of the design engineer, where necessary, and report findings to the client in a clear, logical manner including recommendations and associated costs, as necessary.

SYSTEMS TO BE COMMISSIONED

The following are systems that should be considered for commissioning where applicable:

Power System

- primary switchgear
- normal power system
- emergency power switchgear and distribution
- emergency power generation (including any special ventilation systems 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 System

- 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 System

- central heating plant
- 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 system
- 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 System

- 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 waste 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 System

- 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-condtioning 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 penetration rates
- water shedding systems
- thermal performance
- light transmittance

Structural System

- 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.)

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