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Light and lighting — Commissioning of lighting systems in buildings

*Lumière et éclairage — Mise en service des systèmes d'éclairage dans
les bâtiments*

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 274, *Light and lighting*.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

Building users are demanding a better quality of visual environment while there is a need to reduce the impact on natural resources and minimize energy use from lighting. A successful control system design can help to deliver the correct quantity and quality of light where it is needed and when it is needed. The use of a well-designed, installed and commissioned control system can provide a high level of energy efficiency, support flexibility of use of a space and increase occupant satisfaction, especially when the controls are linked to the availability of daylight.

Commissioning is a quality-oriented process for achieving, verifying and documenting whether the performance of lighting systems and assemblies meets defined objectives and criteria. Potential benefits of the commissioning include:

- reduced energy consumption and operating costs;
- higher user acceptance and satisfaction;
- enhanced marketability and value of commercial property;
- full accountability by project participants for the quality of their work;
- verification that a lighting system performs as intended.

The purpose of this document is to identify the minimum requirements for commissioning of lighting systems, including roles and responsibilities (see [Figure 1](#)), commissioning activities, documentation requirements and system handover.

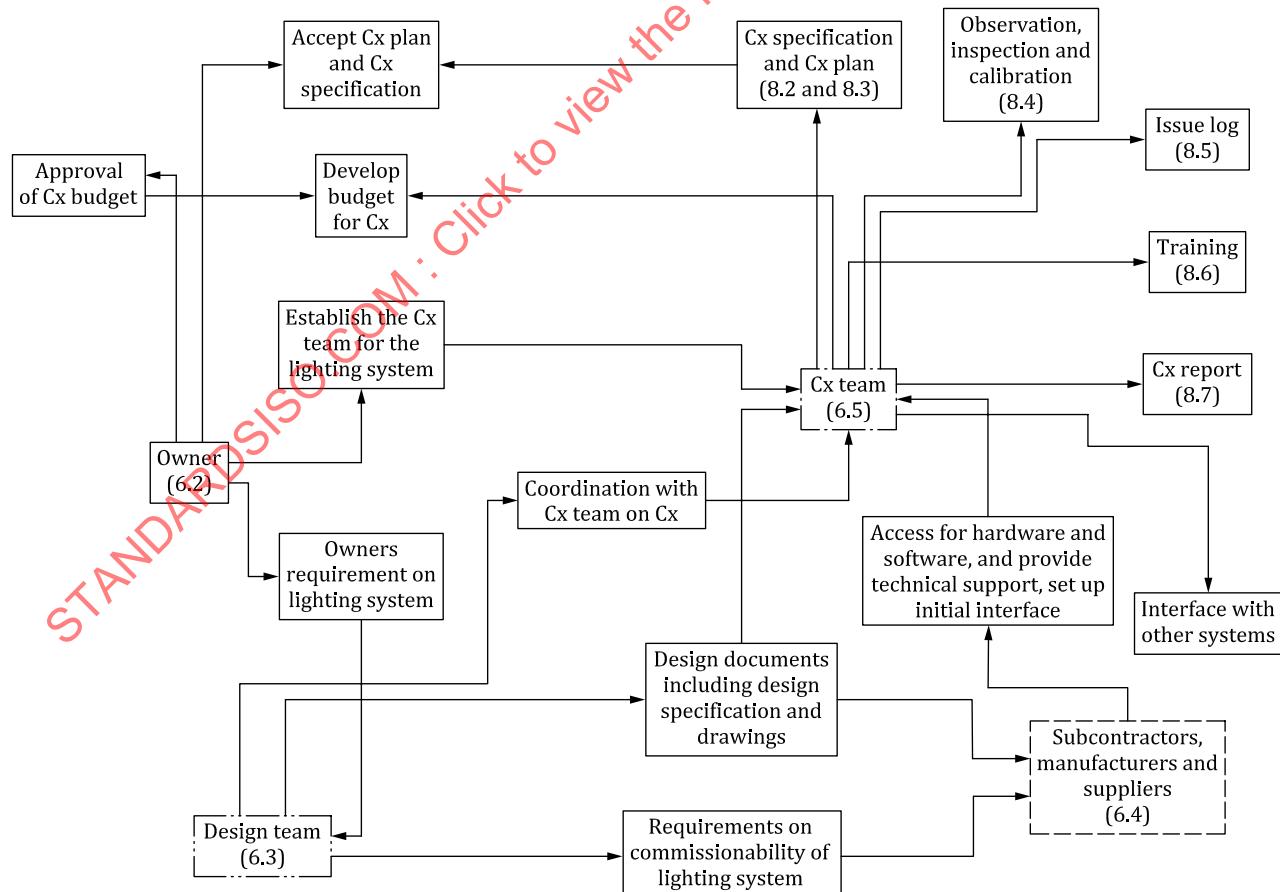


Figure 1 — Overview of roles and responsibilities during commissioning

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Light and lighting — Commissioning of lighting systems in buildings

1 Scope

This document specifies requirements for the commissioning of lighting systems in buildings to meet design specifications. This document presents details of the commissioning of lighting systems without focusing on the technical characteristics of specific components.

This document can be applied to new installations of non-residential buildings and public spaces of multi-residence buildings.

This document does not cover the commissioning of lighting systems concerning the electrical power connection aspects which are deemed to be in compliance with relevant legislation or standards.

This document is not applicable to the commissioning of emergency lighting.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 52000-1, *Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures*

CIE DIS 017:2016, *ILV: International Lighting Vocabulary*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 52000-1 and CIE DIS 017 and the following apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

lighting system

system designed to provide lighting

Note 1 to entry: The lighting system can be dedicated to:

- a) the support of (a) specified visual task(s) under specified conditions considering other requirements such as human comfort, safety, the appearance of the surrounding environment and energy consumption;
- b) the support of other than human tasks.

Note 2 to entry: The lighting system can include a set of light sources, other physical components, communication protocols, *user interfaces* (3.5), software and networks to provide central control and monitoring functions.

Note 3 to entry: The light source(s) and the related equipment can be integrated in a single item, e.g. an LED module, a lamp or a luminaire.

Note 4 to entry: A lighting system can be networked to provide central or remote control and monitoring functions.

Note 5 to entry: A lighting system can be connected to or integrated with other systems or devices.

[SOURCE: CIE DIS 017:2016, 17-29-029]

3.2

commissioning

Cx

<lighting system> quality-oriented process for verifying and documenting whether the performance of a building's systems and assemblies meets the defined design specification

Note 1 to entry: Typically, a *lighting system* (3.1) is classed as a technical building system.

Note 2 to entry: Adjustment can be made if applicable, e.g. the aiming angle of luminaires or sensors, or programming in order to meet the design specifications.

3.3

calibration

adjustment of control devices to meet the performance requirements of the *lighting system* (3.1) specification

[SOURCE: CIBSE Commissioning Code M: Commissioning Management, 2003, modified; used with permission.]

3.4

commissioning team

Cx team

individuals or entities who, through coordinated actions, are responsible for planning and implementing the *commissioning* (3.2)

3.5

user interface

device intended to provide a direct means of communication between the user and the *lighting system* (3.1), which enables the user to control and monitor the operation of the lighting system

4 General aspects

4.1 Benefits of commissioning for lighting systems

As lighting systems are becoming increasingly connected and interactive, a deficiency in one or more components can prevent the correct operation of the lighting system. Commissioning is a process for identifying and remedying any deficiencies caused by improper installation, calibration or operation. The purpose of commissioning is to ensure that the operation of a lighting system meets the design specifications.

4.2 The need for commissioning

The scope of commissioning depends upon the owner or tenant's requirements for the lighting system, and the corresponding design solution for this requirement, which shall be defined in the design documents. This specification can be supplemented by companion technical documents and guidelines to describe the specific details for the proper implementation of the commissioning relative to a specific lighting system.

4.3 Content of commissioning for lighting systems

Commissioning shall be conducted to ensure that the lighting systems function as close to the design specification as possible after installation. The following points shall be checked and verified:

- It shall be verified that all components of a lighting system have been properly installed and connected and are operating.
- The aiming of luminaires shall be verified in the case of adjustable luminaires.
- In the case of local control of the lighting system or any part of it, the correct operation of the local control shall be verified.
- The system-wide functioning of the lighting system shall be tested and verified according to the design specification.
- It should be verified that daylighting systems such as solar shading systems or daylight redirecting systems have been properly installed and connected and are operating.
- Where applicable, interactions with other systems in the building shall be tested to ensure the correct response to system inputs from and the correct communication of system outputs to the external system(s).

4.4 The acceptance of commissioning deliverables

The process for each activity and deliverable shall include an acceptance step as defined in the commissioning plan (Cx plan). This step shall formalize the acceptance of the commissioning deliverable by the owner or tenant.

5 Commissioning methods and selection

5.1 Classification of commissioning methods

This document covers two methods for the commissioning of lighting systems.

Method 1 is the basic method that requires the commissioning activities listed in [7.4](#) to be conducted between the installation stage and operation stage to guarantee the lighting system has been installed, calibrated and configured according to the design documents.

Method 2 is a full life-cycle commissioning method, requiring that the commissioning activities listed in [Clause 7](#) are conducted and that the commissioning team is involved throughout the whole process from the design stage to the post occupation stage to ensure the design of commissionable lighting systems and that the lighting system meets the requirements in the design specification. Minor changes may be made depending upon the agreed contract and clients' written confirmation of the change required.

5.2 Selection of commissioning methods

The increasing use of solid-state lighting technology, the growing scientific insight on the impact of light on humans and also individuals' diverse demands for lighting functions bring a significant incentive for the application of lighting control. However, the resulting complexity of installed systems need more professional skills to design, install and maintain. Therefore, a commissioning method should be selected on the basis of the complexity of the lighting system (see [Table 1](#)).

Table 1 — Principles for commissioning method selection

Control strategy		Characteristics	Commissioning method	
			Method 1	Method 2
Manual control		Solely depending on human behaviour	•	
Automatic control	Non-programmable control	Control through hardware Difficult to modify control parameters	•	
	Programmable control	Programmable Modify control parameters manually	•	○
	Non-self-learning	Learns from previous switching patterns	•	○
	Self-learning			

Key

- The method shall be performed.
- The method is recommended.

As the lighting system performance can change through time, and occupants' requirements for the lighting system operation can also change through time, ongoing commissioning should be performed as required to meet the clients' requirements and energy efficiency for the lighting system.

6 Roles and responsibilities

6.1 General

In order to maximize the value and benefits from commissioning, it is necessary to specify the roles and responsibilities of all the responsible parties related to commissioning, including the owner or tenant, the design team, the contractors and subcontractors, manufacturers, suppliers and Cx team.

6.2 Owner or tenant

The owner or tenant shall be responsible for the composition of the Cx team, approval of the necessary budget for commissioning and design, ensuring that the Cx team is involved during the early stage of design, providing requirements on lighting systems to the design team, and confirmation and acceptance of the plan and targets for commissioning. The owner or tenant should also coordinate actions among the relevant participants during the Cx process.

The owner or tenant may subcontract some or all of these functions to a third party.

6.3 Design team

The design team is responsible for addressing human and technical issues concerning the visual environment (see ISO 16817). The design of the lighting system has a major impact on the success and feasibility of the commissioning.

Therefore, the design team shall be at least responsible for:

- providing the Cx team with all necessary design documents for developing the Cx plan and working in collaboration with the Cx team in the early design stage to maximize the functionality, operability, maintainability and ease of commissioning of the lighting system;
- reviewing the Cx plan and participating in all relevant activities during the Cx process;

- c) specifying all necessary requirements to all related contractors, subcontractors and suppliers for implementing the Cx plan during the installation stage, including the access to hardware, software or onsite technical support required to assist the Cx effort.

6.4 Contractors, subcontractors and suppliers

The contractors, subcontractors and suppliers shall do at least the following:

- a) ensure the lighting system is ready for operation and functional testing according to the design specifications;
- b) provide the necessary operating interface for hardware, software or onsite technical support required for commissioning or operation of the lighting system to the Cx team.

NOTE The supplier and manufacturer can be the same entity.

6.5 Commissioning team

The responsibilities of the Cx team can be extensive depending upon how early they are involved. The Cx team may be appointed in the early design stage as their input can make a significant contribution to ensuring that the design specification can be achieved. The Cx team shall do at least the following:

- a) create the budget for commissioning according to the scope (i.e. the systems and assemblies to be included);
- b) develop the commissioning specification (Cx specification) on the basis of design documents and provide detailed performance criteria and tolerances for each assembly and lighting system, with corresponding sampling, test and calibration methods;
- c) develop the Cx plan, covering the list of commissioned systems and assemblies, commissioning management framework, the Cx activities and output from different stages, the Cx timetable, related tool or instrument requirements during Cx, and the management procedure for system failure during Cx;
- d) witness the degree to which the requirements of the Cx specification have been met;
- e) inspect the installation of the lighting system and with the support of the contractors and subcontractors verify:
 - 1) performance;
 - 2) field adjustment, including the aiming and orientation of components or luminaires of the installation;
 - 3) calibration of controls;
 - 4) the regulation and fine tuning of the system included in the scope of work;
- f) create, utilize and maintain the commissioning issue log to resolve all issues discovered during the commissioning process;
- g) offer training to managing team members of the lighting system and related occupants to help them better operate and maintain the system;
- h) provide the commissioning report, with a summary of the commissioning activities and related document collection;
- i) where applicable, verify the communication with other building services, such as heating, ventilation and air conditioning.

7 Commissioning activities

7.1 General

The commissioning process covers a sequence of phases, including pre-commissioning, installation, field commissioning and post occupancy.

7.2 Pre-commissioning phase

As the design sets the tone for the entire project and defines how effectively it can be commissioned, it is important that the design team is aware of the requirements on ease of commissioning of the lighting systems. Coordination between the Cx team and the design team is therefore necessary for the design of commissionable lighting systems.

During the pre-commissioning phase, the owner or tenant shall determine the scope of the Cx plan (i.e. the systems and assemblies to be included) and select the Cx team for the project. The commissioning team is responsible for creating a Cx plan, specification and budget (including training issues) on the basis of the scope of commissioning and its related design documents, with comments collected from related stakeholders, such as the owner or tenant, design team or technical experts of other systems.

All these Cx documents shall be approved by the owner or tenant.

7.3 Installation phase

The lighting system and its components shall be installed, connected and configured according to the final design documents, including lighting design drawing(s) and lighting specification. All specified components shall be procured as specified, with substitutions only allowed with written approval of the lighting designer. In the case of component substitutions, all design and commissioning documents shall be updated accordingly.

During project handover, the subcontractor or other responsible entity shall submit a systems manual to the Cx team for formal acceptance as part of project handover and provide the necessary information on the operating interface for hardware, software or onsite technical support required to the Cx team according to the design documents.

At this stage a report should be obtained confirming that the lighting system is ready for commissioning after the inspection during the installation phase. As a minimum:

- the pre-commissioning and installation phases shall already have been completed;
- the lighting system shall be operable to design specification;
- data communication conformance and validity testing of the lighting system shall have been accepted, if applicable;
- the control software of the lighting system shall have been compiled, with all control parameters editable by the Cx team.

7.4 Field commissioning phase

The Cx team shall be responsible for verifying all devices work properly under different control modes as the design documents require.

The Cx team shall be responsible for verification of lighting controls calibration in different lighting scenes and all test data of lighting controls calibration shall be recorded in a commissioning observation inspection and calibration report (see [8.4](#)), which is the key document for system troubleshooting of commissioning. The Cx team shall list all items not working as intended in the issue log and take measures for adjusting the system to work correctly. If components or systems are found to be malfunctioning, these problems shall be documented and listed in the issues log for resolution. It is

important that the issues log is very clear about the test, system(s) involved and tracking of the problem as it is corrected.

For lighting system with control software, the Cx team should also be responsible for control software functionality tests, control sequence tests [possibly including start and stop (on and off), time schedule, reset, power failure] and permit to access test.

Before the end of the commissioning phase, the Cx team shall be responsible for facilitating the training process for related operations personnel of the lighting system to ensure they have the knowledge and skills required to operate and maintain the system correctly.

All commissioning documentation developed throughout the Cx process shall be summarized as the Cx report and submitted to the owner or tenant for approval.

7.5 Post occupancy phase

Depending upon the contractual agreement, the Cx may extend well into the occupancy and operations phase to verify that the project meets the initial requirements of design documents on an ongoing basis. The primary goal of Cx activities during this phase is to provide ongoing guidance to operations and maintenance personnel, and ensure continued performance via periodic testing, which can maximize the performance of the lighting system. This involves ongoing training, periodic system testing, checking and validation of control system settings.

When modification(s) are made to the lighting system or after a specified operation cycle required by the Cx plan, commissioning shall be conducted.

8 Documentation requirements

8.1 General

This clause establishes the deliverables and documentation for the process application, including the Cx plan, commissioning specification, commissioning observation and test, training plan and commissioning report.

8.2 Commissioning plan

The Cx team shall, with input from related stakeholders of the project team, develop the initial Cx plan at the initiation of the project. The Cx plan shall be a formal written document and shall be kept updated as the project advances.

The Cx plan shall include the following information:

- a general description of the systems to be commissioned;
- the commissioning scope and object developed on the basis of design documents;
- the roles and responsibilities of the Cx team members throughout the project;
- the communication and organization structure for related participants of commissioning;
- a detailed description of the project-specific tasks to be accomplished during commissioning with time schedule and associated roles and responsibilities;
- a list of instruments, tools and suppliers for each commissioning test, and their corresponding specification;
- the Cx evaluation checklists (an example evaluation checklist is included in [Annex A](#)) defining the verifications to be performed to ensure that critical actions were effectively completed;

- the listing and format for testing forms, issues log and the Cx progress reports that is used during the project to communicate and track critical Cx information;
- the procedures to follow whenever the Cx evaluation does not meet the design documents.

The Cx plan shall be approved by the owner or tenant. Once the Cx plan, including the checklists, have been developed and provided to the related stakeholders, the Cx team shall regularly review and update the document to reflect any change in design specification and commissioning requirements. The process for approval of the subsequent revisions should also be recorded in the Cx plan.

8.3 Commissioning specification

The Cx specification shall be developed on the basis of the design documents, including design drawings, design specification, calculation report of the lighting systems for different control modes, control system drawings, control strategy and specifications for each component of the lighting systems.

The Cx specification shall include at least the following information:

- detailed performance for each lighting scene of the lighting system defined by the design documents;
- detailed performance criteria and tolerance for components of the lighting system, including sensors and control gear;
- sampling method for inspection of large lighting systems.

Verification procedures should be identified for components, interaction between control points and the systems.

The Cx specification shall be confirmed by the design team.

8.4 Commissioning observation inspection and calibration report

The proper installation, coordination and interaction among all components of the commissioned systems shall be evaluated according to the approved Cx plan and Cx specification.

The commissioning observation inspection and calibration report shall include at least the following information:

- the systems or components under test;
- conditions under which the test was conducted (i.e. ambient conditions, control mode), which shall be stable when the test is conducted;
- first test or retest following correction of an issue;
- test date and time;
- design specification for the tested system or assemblies;
- test reference;
- test data with indication of whether this performance is acceptable;
- diagnosis and follow-up measures for failed test.

Any commissioned system or assembly that fails to meet the requirements and that cannot be resolved in a timely manner shall be given an issue number and recorded in the issues log to facilitate follow-up. All checklists and test results during commissioning shall be compiled in the final Cx report.

8.5 Issues log

The Cx team should be primarily responsible for maintaining the issues log according to the Cx plan. It is important that all comments and issues identified are recorded and tracked in a formal issues log in sufficient detail so as to provide clarity and a point of future reference for the comments. The updated issues log should be distributed periodically to any persons relevant to commissioning so that everybody is operating with the same information. The issues log shall contain as a minimum:

- description of the issue (including name, location, date and reference number) and pictures of the item if available and appropriate;
- relevant individuals or entities;
- effects of the issue on lighting system operation;
- possible cause of the issue or problem;
- any further confirmation on the cause of this issue;
- priority of the issue;
- confirmation of issue resolution [including person(s) assigned to resolve the issue, actions taken].

8.6 Training plan

The training plan shall include the lighting system manual covering all measurable learning objectives and describe the knowledge that each participant is expected to acquire, which may include procedures for normal operation (how to adjust the systems, maintenance and inspection, troubleshooting and repair) and procedures for keeping critical lighting systems operational during emergencies. The planned location of the training sessions (classroom, on-site or off-site), the minimum duration and instructor of each training session shall be provided in the training plan. A feedback method from trainees should be defined in the plan.

The training plan shall be submitted and accepted by the owner or tenant prior to the delivery of any instruction.

8.7 Commissioning report

A commissioning report shall be provided to summarize the commissioning documentation developed throughout the Cx process for delivery to the owner or tenant and other nominated persons for review and acceptance.

Intermediate Cx progress reports shall be issued as required in the Cx plan and the applicable jurisdictional requirements.

The Cx team shall provide a final commissioning report.

The final commissioning report shall include the following as a minimum:

- executive summary;
- copy of the final Cx plan;
- copy of the final Cx specification;
- copy of the Cx observation inspection and calibration report;
- copy of all Cx progress reports;
- copy of the latest version of issues log;
- copy of the training plan;

- for all incomplete issues, delayed or seasonal tests, a resolution plan approved by the owner or tenant identifying who is responsible for resolution.

9 Contractual completion

Once all documents are approved and accepted on the basis of design documents, by the owner or tenant or his nominated person, the lighting system commissioning contract is completed.

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Annex A (informative)

Example checklist for commissioning of lighting systems

The checklists given in [Table A.1](#) and Table A.2 are examples of checklists for the commissioning of a lighting system.

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