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Building environment design — Indoor environment — General principles

Conception de l'environnement des bâtiments — Environnement intérieur — Principes généraux

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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.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

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.

ISO 16813 was prepared by Technical Committee ISO/TC 205, *Building environment design*.

Introduction

This International Standard gives the general principles of building environment design and has been prepared for building designers, i.e. architects, environmental designers and building system designers, as well as building clients, contractors, government officials, and academic staff.

The aim is to assist these groups in applying an effective design process in the pursuit of high-quality indoor environment for the occupants, while also seeking to protect the environment for the future generations. This International Standard provides the framework for sustainability issues to be taken into account in the design constraints from the very early stages of building design and requires the design drawings and specifications to be evaluated at every design stage according to the criteria provided by other relevant standards.

Building environment design — Indoor environment — General principles

1 Scope

This International Standard establishes the general principles of building environment design taking into account healthy indoor environment for the occupants, and protecting the environment for future generations. This International Standard promotes an approach in which the various parties involved in building environmental design collaborate with one another to provide a sustainable building environment. The unique features of the design process are articulated by the following aims:

— to provide the constraints concerning sustainability issues from the initial stage of the design process, including building and plant life cycle together with owning and operating costs to be considered at all stages in the design process;

— to assess the proposed design with rational criteria for indoor air quality, thermal comfort, acoustical comfort, visual comfort, energy efficiency and HVAC system controls at every stage of the design process;

— to make iterations between decisions and evaluations of the design throughout the design process.

The building environment design involves not only architectural design associated with environmental quality but also environmental system design associated with effective controls. This International Standard is applicable to building environment design for new construction and the retrofit of existing buildings.

2 Normative references

The following referenced documents are indispensable for the application 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 15686-1, *Buildings and constructed assets —Service life planning — Part 1: General principles*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
acoustic comfort
reaction of occupants to the indoor acoustical environment, described in terms of sound pressure level and audibility

3.2
competent person
person who is capable of relating and understanding all the design parameters involved in the design of the building and its associated services

3.3
computer analysis
detailed examination to quantify the effects of the proposed building design in terms of energy requirements and the indoor environment

NOTE Ideally by hourly computer simulation on annual basis during the lifetime of the building.

3.4
assumptions
set of descriptions that are required to be considered by the designer if the actual requirements are difficult to identify at the design decision-making stage

3.5
building environment design
course of action to be taken in building design, involving architectural and environmental system design of the building, its parts or its building service components

NOTE Sustainability issues are considered as being significant in building environment design.

3.6
building system control
measures taken to ensure the system operates in accordance with the specified conditions

3.7
commissioning
sequence of events that ensure the building and the HVAC systems are functioning in accordance with the design parameters for the building lifetime

3.8
constraints
fixed items including the requirements of local building regulations, health and occupational legislation, and design fundamentals that are required to be met during the design process

3.9
design aids
set of guidelines used for conceptual details and final designs for the indoor environment, based on the requirements whether or not expressed by the client and stakeholders

3.10
design concept
set of fundamental thoughts for the project starting at the design work stage taking into account the constraints

3.11
design criteria
set of descriptions based on a particular environmental element and the associated system controls used for assessing the presented design

EXAMPLE Examples of environmental elements are indoor air quality, thermal, acoustical and visual comfort, energy efficiency and electromagnetic fields.

3.12
design parameters
set values of the internal environmental conditions to be achieved regardless of the changing external environmental conditions

3.13
design process
course of actions performed to produce a set of design drawings and specifications describing the functions for which a building has the potential to provide

NOTE Any changes in the building environment design after iterations of decisions and evaluations of the design have been made are required to be analysed until the final design stage is achieved.

3.14
detail design
design developed during the third stage of the design process based on the approved evaluation of the schematic design

3.15
document
written description of the essential factors of every design stage to be retained for future information

3.16
energy conservation
measures applied to reduce building energy use without seriously influencing the global environment and to provide the environment that achieves the design criteria

3.17
energy efficiency
measures that ensure the building and system function in accordance with the design parameters by the efficient use of energy

3.18
evaluation
sub-process to assess the proposed design with regard to the design criteria at each of the design stages

3.19
final design
design of the final stage of the design process based on the approved evaluation of the design detail

3.20
global cost
life cycle cost plus social cost for sustainability, all costs related to the measures deemed necessary to ensure the efficient running of the building, including the energy and other conservation issues that can apply

See ISO 15686-1.

3.21
indoor air quality
quality of air inside non-industrial buildings, described in terms of odour, chemical and biological pollutants, is related to the ventilation rate, air distribution patterns and pollution sources to ensure human health, olfactory comfort and perceived comfort

3.22
life cycle cost
total costs of a building of or its parts throughout its life, including the costs of planning, design, acquisition, operations, maintenance and disposal, less any residual value

See ISO 15686-1.

3.23
project
course of action necessary to ensure that a new or existing building meets the requirements of its clients and the constraints applied

NOTE A project starts when the client formally or informally requests the architect or building engineer to perform actions to create a building. The project ends when the requirements and constraints set by the client or the project regulations are achieved, or when it is found it is impossible to fulfil the client's requirements and constraints.

3.24
requirements
important but revisable items required by the client as well as the circumstances of a project that the designer should take into account throughout the design process

EXAMPLES Budget, physical dimensions, performance and general sustainability issues.

3.25
schematic design
initial design presented early in the design process based on the design concept

3.26
structure
physical shape, dimensions, and configuration of a building, its parts, or its building service components

3.27
sustainability
maintenance of ecosystem components and functions for future generations, to address economic efficiency, social issues and environmental preservation

3.28
thermal comfort
condition of mind derived from satisfaction with the thermal environment

NOTE Thermal comfort is the combined thermal effect of environmental parameters including air temperature, vapour pressure, air velocity, mean radiant temperature (fixed factors) and clothing and activity level of occupants (variable factors).

3.29
visual comfort
occupant satisfaction with the indoor visual environment, described in terms of illumination level, glare, visibility, reflection and psychological and physiological content with natural and artificial illumination

4 Fundamentals

4.1 General

General principles of indoor environment design allow the clients and designers to provide the desired quality of indoor environment in a sustainable building according to the fundamentals of the design process.

The design process aims to ensure efficient environmental building design providing the specified quality and performance level involving safety, health, comfort, and energy use, as well as sustainability and the philosophy, ethics, and assumptions taken by the people concerned. Building designers should define the goals based on the requirements, constraints and actual conditions to be achieved, integrating the owning and operating costs during the design stage.

4.2 Project information

The available project information that influences the development of design concepts together with constraints and all requirements shall be documented. When assumptions are made in lieu of necessary information related to the standards or regulations for building environment design, with respect to the indoor environment, these assumptions shall be documented. The project information provided by the users of this International Standard that influence the programming, development, and/or the design of building components and the building service systems shall also be documented.

4.3 Framework of generation and verification

Architectural design and building system design are goal-driven activities. The routes necessary to achieve the end result are not straightforward and shall be flexible. In some instances, the assumptions are made under uncertain conditions. Hence, the design process involves the iteration of generation and verification. The generation process is a sub-process where a design solution is synthesized, while the verification process is another sub-process in which the design solution depends on different design criteria.

4.4 Framework of documentation at approval

The evaluation and approval processes shall be documented. The documentation process shall explicitly state what is to be provided by the project. The evaluation and approval process shall demonstrate the stated goals can be achieved. Every document provided shall describe the characteristics planned and verify whether they are actually achieved. Approval should be obtained at each design stage.

The documents issued during this design process must cover the following questions.

— Is the stated definition adequate and feasible?

— Is the environmental design feasible?

— Is the specified structure expected to satisfy the constraints and requirements?

— Is the building capable of providing the quality and performance required?

4.5 Harmonization of architectural and system design

Since architectural design as well as the building system design contributes to the realization of the indoor environment, the general principles of building environment design should be used to harmonize the architectural and system design.

The general principles of building environment design should not restrict creative architectural design. These principles do not predefine the order or precedence of individual tasks in either the architectural or the building system design.

5 Design process

5.1 Stage I — Formulation of project definition

5.1.1 General

The objective of stage I is to clarify the project constraints and requirements. The client defines the constraints and requirements of the building and the required environment. The client might not state some of the constraints and requirements.

All constraints and requirements shall be explicitly described in document I. Consistency of the constraints and requirements shall be approved in the sub-process evaluation I. The approved conditions form the basis of the building project definition.

The approved constraints and requirements can diverge when unknown conditions exist, even though they appear consistent at this stage. In this case, the project definition should be revised to restore consistency.

5.1.2 Project definition

A project definition is the process of providing the relevant information for designers and others to define the scope of the work. The project definition lists the given constraints, which cannot be revised, and the project requirements, the theories and assumptions. All of these might not be completely defined at this stage. Some of these may be revised in response to feedback from later stages of the design process.

5.1.3 Constraints

The constraints are the conditions that shall be met by the project and the properties of the location of the building. The conditions can be related to health and safety issues, energy availability and environmental quality for the project. The properties of the location include climate, geometry, geography, culture, building codes, etc. The constraints, in principle, cannot be revised.

5.1.4 Requirements

The requirements describe the quality of indoor environment, budget, schedule, sustainability and other restraints, as well as building performance and its interior spaces required by the parties concerned. Some requirements are latent and are not explicitly expressed in the initial stages. The requirements can be inconsistent with the constraints and might be impossible under the given constraints. In such cases, the requirements should be revised.

5.1.5 Assumptions

The theories form a portion of the assumptions. Any issue that cannot be fully identified in the course of the design shall be assumed and the designer shall take these into account in the final design decision. The assumptions framed as a set of descriptions of uncertainties to be dealt with in the early design stage will not create problems at a later stage.

5.1.6 Philosophy, ethics and theories

Both the client and the designer may have a philosophy and set ethics concerning building environment in general terms. They can also rely on ideas related to architectural and environmental design. Philosophy and ethics is a base with reference to which the target level of each environmental item is determined and the design strategies are planned. A building is evaluated by different aspects. Clients and designers might wish to decide which aspect they consider to be critical or less critical on the basis of their own philosophy and ethics. This consideration is possible, provided it does not violate the environment design criteria. Philosophy and ethics relate to the aspects that should be considered more than the others. The theories also encourage a designer to employ a particular design strategy and work as the rationale on which the structural behaviour and functions of a building are based.

5.1.7 Output — Document

Document I shall be issued as an output product of the project definition process and as an explicit description of the project definition, i.e., the constraints, the requirements and the assumptions.

5.1.8 Evaluation I

Evaluation I is the process of approving document I. The consistency of the contents of the constraints, the requirements and the assumptions shall be verified in reference to the design criteria. The feasibility of the given requirements under the constraints and the assumptions should be verified. The major concern is whether or not the project definition is adequate and optimal under the given constraints.

5.1.9 Output — Approval of document I

Once the evaluation I process succeeds, an approval of document I has to be issued as an output in order to validate document I. Approval of document I should contain how document I was evaluated together with the results of the evaluation. Unless document I is approved, stage II cannot be started.

5.1.10 Iteration

If document I was not approved, it should be revised by iterating the steps beginning with the project definition.

If there is any contradiction in the compilation of the requirements and constraints described in document I, some of the requirements should be revised and then iteration started with the revised requirements.

5.2 Stage II — Schematic design

5.2.1 General

The objective of stage II is to determine the schematic framework of the building and its environment systems as requested by the client. Once a design problem is defined, the following processes concentrate on a solution. Stage II focuses on the concepts and scheme concerning the building and its environment systems, whose structure determines the following process, i.e., stage III.

The framework concerning how the design problem as formalized in the previous step is solved shall be determined. The framework is expressed in terms of the building scheme, i.e., the zoning, the circulation, the prospected use, and the diagrams to describe the building environment systems such as HVAC, lighting, water service, etc. What building environment systems are employed is determined in this process.

5.2.2 Input — Background

Document I approved in stage I represents both the input and the background to stage II.

5.2.3 Output — Document II

Design concept shall be developed in response to document I and should be outlined in a written narrative.

Document II should be issued as the product of the schematic design process. Document II is the explicit description of the framework of the building and its environment systems. Document II also explains the rationale of the framework.

Document II shall be issued as the formal record, although the concepts, scheme and diagrams may be flexible due to the uncertainties involved.

5.2.4 Evaluation II

The consistency of the framework described in document II shall be verified in reference to the design criteria and document I. The fitness of the program and the diagrams shall be verified. The major concern is whether or not the design is headed on the right track.

5.2.5 Output — Approval of document II

When the evaluation II process is successful, document II shall be approved. Approval of document II shall include how document II was evaluated.

If document II is found to be inconsistent with the requirements and constraints, document II shall be revised with the iteration starting from the conceptual design and schematic design process or from the project definition process.

5.2.6 Iteration from conceptual design and schematic design

If the predicted initial concept of a building established during the design process does not meet the requirements and constraints described in document I, then an alternative concept and scheme shall be presented. Minor changes can work in some instances; however, major changes are necessary in others.

5.2.7 Iteration from project definition

If no change in the concept and scheme is found necessary, the design may proceed to stage III.

If changes in the requirements are made to provide improved solutions, then the project definition shall be revised.

If modification of the project definition does not improve the issue, then the project parameters shall be reconsidered.

5.3 Stage III — Detail design

5.3.1 General

Stage III is the main stage of the design process where detailed design is performed. The structure of the building, i.e. the shape and dimension of the building elements and the relationship between them, as well as the components of the building environmental control systems shall be specified

The structure of a building is determined during this process, and is expressed in terms of shape, dimensions, and the material of the building components and spatial relations and/or the functional relations among the structural elements. All system design shall be included.

5.3.2 Input — Background

Document II approved in stage II represents both the input and the background for stage III.

5.3.3 Output — Document IIIa

Document IIIa is the explicit description of the building structure. It consists of the drawings and building specifications, including the building's environment systems.

5.3.4 Analysis

The building performance shall be predicted in the detailed design description in document II and be expressed both in terms of the building's physical properties and the building's environmental systems. Use of computational tools, such as a simulation program of the building's thermal behaviour or energy demands, shall be considered.

The functions provided by the building shall be determined by a competent person based on the building performance.

5.3.5 Output — Document IIIb

Document IIIb is the explicit description of the results of the analysis process, i.e., the predicted performance of the building as a whole.

The performance shall be expressed in terms of the estimated values of the building's physical properties, such as air quality, temperature, energy use, etc. The rationale of the derived performance shall also be considered.

The details of the criteria adopted shall be recorded for future evaluation.

5.3.6 Evaluation III

The results of the analysis described in document IIIb shall be evaluated to determine if the requirements described in document I are achieved without violating the constraints described in document I and the issues raised in document II and document IIIa.

5.3.7 Output — Approval of documents IIIa and IIIb

While evaluation III is under process, documents IIIa and IIIb shall be approved. Approval of documents IIIa and IIIb shall include how documents IIIa and IIIb were evaluated.

Stage IV cannot be started until documents IIIa and IIIb are approved. If the building design described in document IIIa is found not meet the contents of document I, documents IIIa and IIIb shall be revised by iteration against the project definition.

5.3.8 Iteration into detail design

If the current building design concept is shown not meet the contents described in document II, then an alternative design shall be provided. At this stage, only minor changes requested by the clients shall be made.

If documents IIIa and IIIb show that the quality and performance described in document II is not provided by the building design, then the current design shall be modified without changing the overall design concept.

5.4 Stage IV — Final design

5.4.1 General

The elements and the relations that have not already been determined shall be determined in this process.

5.4.2 Commissioning plan

A commissioning plan is necessary to ensure that the building components and systems meet the requirements as specified in document I.

5.4.3 Commissioning test

The final design shall be subject to the commissioning test requirements for all the design parameters.

5.4.4 Cost estimation

A cost estimation shall be made for the final design. If the results of this do not meet the client's budget, the design process should be repeated until a satisfactory agreement is achieved or the budget reviewed.

5.4.5 Output — Final document

The final document shall consist of the building drawings and specifications and the building services components to be installed complete with the results approved in the commissioning tests.

5.5 End of design

If no problems are found with the final design, the design process comes to an end and the realization process can commence.

6 Development of design criteria

The design criteria and energy efficiency shall be referred to in the evaluation of the proposed design at each stage of the design process. Different design criteria as above shall be by documentation related to International Standards, or regional or national standards.

7 Development of design aids

The design aids on indoor air quality, thermal, acoustic and visual comfort, and energy efficiency for designers should be developed together with the design criteria for the efficient design process.

8 Cost evaluation

8.1 Estimation of primary costs

A qualitative comparison of the initial and operating cost characteristics of the initial design is encouraged. This qualitative approach may be based on experience or by methods approved by the industry.

Since sufficient design detail is not normally available at the initial design stage, cost comparisons are not necessarily based on the actual project, equipment and energy data. Unless otherwise specified by contractual arrangements, one approach is to proceed from the initial stage based on 8.2.

8.2 Evaluation of design benefits versus costs as required by client

There are several levels of sophistication in cost analysis:

a) basic cost of the initial construction;

b) cost including operation and predictive maintenance of systems and components (owning and operating costs), which can include building, plant and safety insurance costs;

c) life cycle cost as in a) and b) plus predictive consumption of resources and conservation measures;

d) as in c) plus the whole life costs, including external environmental costs and demolition cost;

e) as in d) plus the benefits to productivity in the workplace, for example by improving indoor environment quality.

Cost estimates at one of these five levels of detail in the selected design for the aspects of the indoor environment in the designer's preview should be developed. These estimates should be based on the actual project equipment and energy data to the extent that these have been determined at the final design stage.

The cost estimates shall be documented and evaluated for acceptability in terms of overall project requirements.

If the estimates are unacceptable, the design detail or concept shall be reconsidered in an attempt to achieve cost acceptability. Changes to the performance criteria shall be considered only when changes to design detail or concepts cannot achieve cost acceptability or the benefits cannot justify the extra costs.

8.3 Compliance review

The plans and specifications for the aspects of the indoor environment in the designer's preview shall be reviewed and documented as to

— meeting the legal requirements of applicable codes, regulations, and laws;

— capable of meeting the design performance criteria;

— meeting the estimated cost within the project budget;

— having no conflict with other building systems at this stage.

If the plans and specifications fail to meet any of these requirements, they shall be reconsidered to ensure compliance with these requirements. Changes to the performance criteria, shall be considered only when changes to plans, specifications, design detail or the design concept do not achieve these requirements.

Annex A
(normative)

Flow diagram of design process

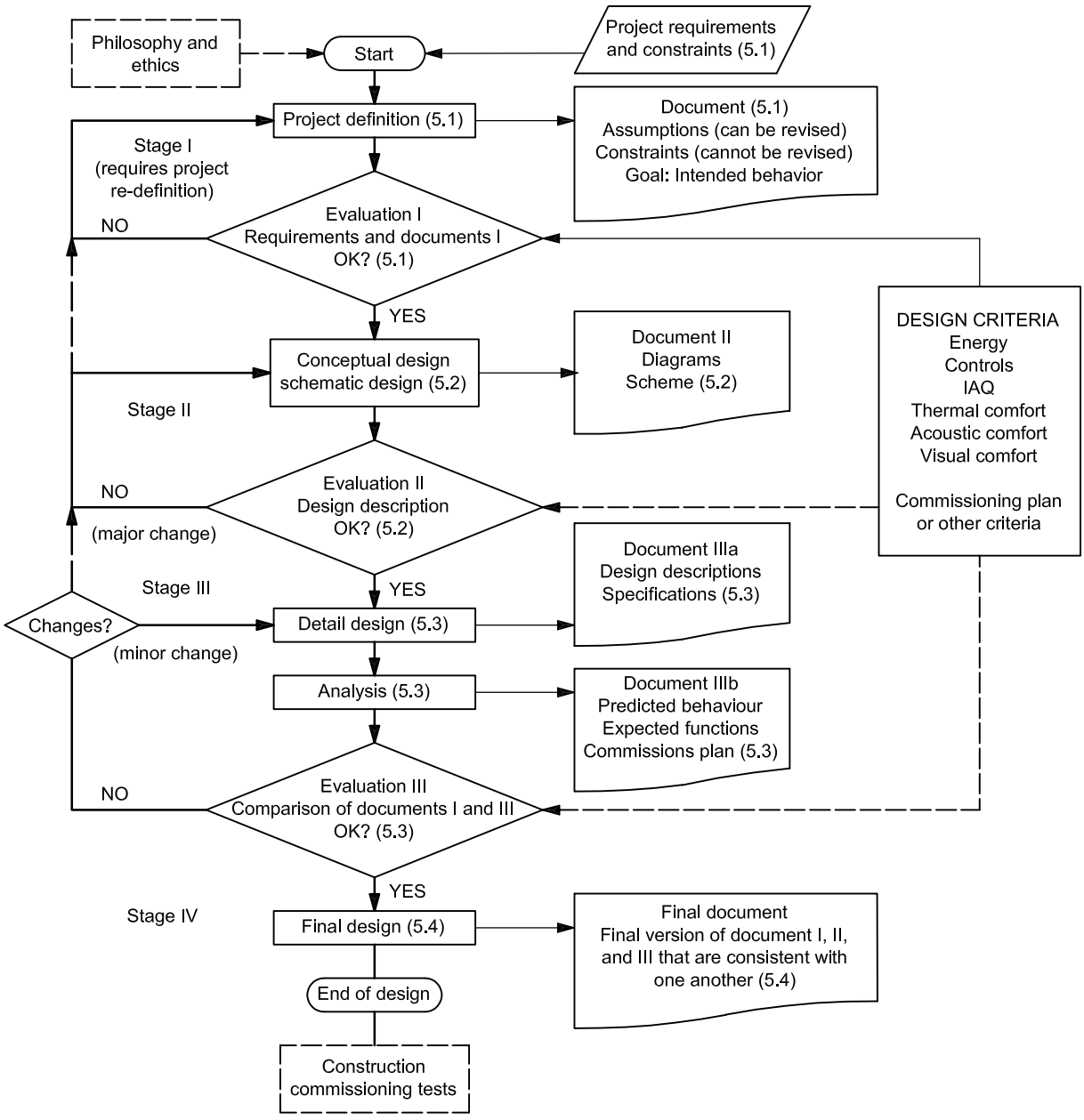

Figure A.1 — Flow diagram of design process

Annex B
(informative)

Flow diagram of design process

B.1 Issuing or approval of construction documents

Plans and specifications should be finalized as construction documents. These documents should be in accordance with applicable International Standards.

B.2 Monitoring or supervision of the construction phase

There are no provisions in this International Standard for defining this phase, as it varies depending on the contractual arrangements. Nevertheless, it is clearly vital that the building is built as designed.

In order that the indoor environment and energy performance be delivered as designed, the designer should have an important role in the construction phase and in its control and inspection.

B.3 Handover and commissioning of the built works

At the completion of the construction phase, the building is handed over to the client. All information regarding the building is given to the client and the staff are trained, This is beyond the scope of this International Standard.

However, in order to preserve the building's design performance, the design occupancy conditions, maintenance and management control of the building should be provided to the client and to the prospective users of the building.

Nevertheless, it is important to the effectiveness of any design that this part of the process be considered in detail as described in an accepted commissioning procedure, e.g. EN 12599.

B.4 Post-design and post-construction commitment

If a part of the designer’s fee or an additional sum is set aside, the continued involvement of the designer with the running of the building is desirable for a set period after construction. This allows for making minor adjustments to the systems' operating routines, taking into account changes of the user requirements or any unexpected events.

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