TECHNICAL REPORT

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Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads —

Part 2: Explanation and justification of ISO 52016-1 and ISO 52017-1

Performance énergétiques des bâtiments — Besoins d'énergie pour le chauffage et le refroidissement, les températures intérieures et les chaleurs sensible et latentes —

Partie 2: Explication et justification pout ISO 52016-1 et ISO 52017-1

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Contents

Page

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 on 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 the following URL www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 163, *Thermal performance and energy use in the built environment*, Subcommittee SC 2, *Calculation methods*, in cooperation with the European Committee for Standardization (CEN) Technical Committee CEN/TC 89 *Thermal performance of buildings and building components,* in accordance with the Agreement on technical cooperation between ISO and CEN (Vienna Agreement).

A list of all parts in the ISO 52016 series can be found on the ISO website.

Introduction

The set of EPB standards, Technical Reports and supporting tools

In order to facilitate the necessary overall consistency and coherence, in terminology, approach, input/output relations and formats, for the whole set of EPB-standards, the following documents and tools are available:

a) a document with basic principles to be followed in drafting EPB-standards: CEN/TS 16628:2014, *Energy Performance of Buildings — Basic Principles for the set of EPB standards* [1];

b) a document with detailed technical rules to be followed in drafting EPB-standards; CEN/TS 16629:2014, *Energy Performance of Buildings — Detailed Technical Rules for the set of EPB-standards* [2].

The detailed technical rules are the basis for the following tools:

1) a common template for each EPB-standard, including specific drafting instructions for the relevant clauses;

2) a common template for each technical report that accompanies an EPB standard or a cluster of EPB standards, including specific drafting instructions for the relevant clauses;

3) a common template for the spreadsheet that accompanies each EPB standard, to demonstrate the correctness of the EPB calculation procedures.

Each EPB-standard follows the basic principles and the detailed technical rules and relates to the overarching EPB-standard, ISO 52000-1 [3].

One of the main purposes of the revision of the EPB-standards is to enable that laws and regulations directly refer to the EPB-standards and make compliance with them compulsory. This requires that the set of EPB-standards consists of a systematic, clear, comprehensive and unambiguous set of energy performance procedures. The number of options provided is kept as low as possible, taking into account national and regional differences in climate, culture and building tradition, policy and legal frameworks (subsidiarity principle). For each option, an informative default option is provided (Annex B).

Rationale behind the EPB Technical Reports

There is a risk that the purpose and limitations of the EPB standards will be misunderstood, unless the background and context to their contents – and the thinking behind them – is explained in some detail to readers of the standards. Consequently, various types of informative contents are recorded and made available for users to properly understand, apply and nationally or regionally implement the EPB standards.

If this explanation would have been attempted in the standards themselves, the result is likely to be confusing and cumbersome, especially if the standards are implemented or referenced in national or regional building codes.

Therefore each EPB standard is accompanied by an informative Technical Report, like this one, where all informative content is collected, to ensure a clear separation between normative and informative contents (see CEN/TS 16629 [2]):

— to avoid flooding and confusing the actual normative part with informative content;

— to reduce the page count of the actual standard; and

— to facilitate understanding of the set of EPB standards.

This was also one of the main recommendations from the European CENSE project [34] that laid the foundation for the preparation of the set of EPB standards.

This document

This document accompanies ISO 52016-1 and ISO 52017-1, which form part of a set of standards related to the evaluation of the energy performance of buildings (EPB).

The role and the positioning of the accompanying standards in the set of EPB standards is defined in the Introduction to the standards.

Brief articles on the subject can be found in [50] to [51].

Accompanying spreadsheets

An extensive spreadsheet was produced on ISO 52016-1, covering both the hourly and the monthly calculation method. Examples of the calculation sheet can be found in this document. This spreadsheet (including possible updated version) is available at www.epb.center.

No spreadsheet was produced on ISO 52017-1, because this EPB standard (with reference hourly thermal balance calculation procedures) is not directly used for calculations.

History of this Technical Report and the accompanying standards

The first series of standards on thermal and hygrothermal properties of building components and elements were prepared by ISO Technical Committee 163 in the 1980s, as a result of growing global concern on future fuel shortages and inadequate health and comfort levels in buildings. During the following decades these first standards were revised and new standards were added, to cope with new developments and additional needs. From the 1990s on, many of these standards were developed in close collaboration with CEN (see furtheron).

As part of the Mandate 343 of the EC to CEN to support the EPBD (2003)[26], the series of standards were scrutinized to see which changes would be needed for the purpose of supporting the EPBD [25]. This resulted in new versions of a number of standards, most of them published in 2007. The standards were further revised in the 2010s as part of Mandate 480 of the EC to CEN [28], to support the EPBD recast [29].

More extensive background information and history of the set of EPB standards is given in the Introduction to ISO/TR 52000-2[4], the Technical Report accompanying the overarching EPB standard and in recent ISO papers ([47],[48],[49]).

Application area of ISO 52016-1**:**

ISO 52016-1 presents a coherent set of calculation methods at different levels of detail, for the (sensible) energy needs for the space heating and cooling and (latent) energy needs (de-)humidification of a building and/or internal temperatures and heating and/or cooling loads.

The effect of specific system properties can also be taken into account, such as the maximum heating or cooling power, and the impact of specific system control provisions. This leads to **system-specific energy loads and needs**, in addition to the **basic energy loads and needs**.

ISO 52016-1 contains both hourly and monthly calculation procedures. These are closely linked: they use as much as possible the same input data and assumptions. And the hourly method produces as additional output the key monthly quantities needed to generate parameters for the monthly calculation method. This means that a number of (nationally) representative cases can be run with the hourly method and from the key monthly quantities the monthly correlation factors can be derived

ISO 52016-1 has been developed for buildings that are, or are assumed to be, heated and/or cooled for the thermal comfort of people, but can be used for other types of building or other types of use (e.g. industrial, agricultural, swimming pool), as long as appropriate input data are chosen and the impact of special physical conditions on the accuracy is taken into consideration.

NOTE 1 For instance, it can be used when a special model is needed but is missing.

Depending on the purpose of the calculation, it can be decided nationally to provide specific calculation rules for thermal zones that are dominated by process heat (e.g. indoor swimming pool, computer/server room or kitchen in a restaurant).

NOTE 2 For instance, in the case of a building energy certificate and/or building permit, e.g. by ignoring the process heat or using default process heat for certain processes (e.g. shops: freezers, lighting in shop window).

Design heating and cooling load

Upon request of CEN/TC 156, the method to calculate the design heating and cooling and latent heat load from prEN 16798-11:2015[21], prepared by CEN/TC 156, has been integrated in ISO 52016-1.

ISO 52016-1 includes specification of the method and the boundary conditions for the calculation of the design heating and cooling load, including latent load, as a basis for the dimensioning of equipment on zone level and on central level for cooling and dehumidification. It specifies also the methods and conditions for the calculation of the humidification load.

The method given for the design heat load is intended especially for the cases where the cooling load calculation needs to be done (for instance when cooling is necessary) and/or an hourly calculation is used for the energy needs calculation. The principle idea is that there is only one method needed for load and energy calculations for heating and cooling in case of an hourly calculation interval.

A simplified steady state calculation method for the design heat load is given in EN 12831-1[22].

Link between the two standards, ISO 52017-1 and ISO 52016-1

In short, ISO 52017-1 contains a generic (reference) hourly calculation method for building (zone). This method is based on and replaces that in ISO 13791. This document contains no specific assumptions, boundary conditions, specific simplifications or input data that are not needed to apply the generic calculation method. Compared with ISO 13791, the heat flows describing the energy needs for heating and cooling are added to increase the application range. This document does not include validation cases (unlike ISO 13791). For validation, specific assumptions and input data would need to be given that only apply to the validation cases. To keep a clear distinction between the generic method and a specific application, verification and validation cases are adopted in ISO 52016-1.

ISO 52016-1 replaces the information in ISO 13790:2008[5]. It contains a (new) hourly calculation method and a monthly calculation method. The hourly calculation method is a specific application of the generic method provided in ISO 52017-1. ISO 52016-1 further contains specific boundary conditions, specific simplifications and input data for the application: calculation of energy needs for heating and cooling. Amended simplifications and input data are provided for the application to calculate the design heating and design cooling load and (e.g. summer) internal temperatures.

In this way the generic calculation method (ISO 52017-1) is clearly separated from the specific application with all specific assumptions, simplifications and specific input data (ISO 52016-1). Due to these changes, ISO 52016-1 together with ISO 52017-1 also replace ISO 13792.

The hourly method in ISO 52016-1 produces as additional output the key parameters needed to generate parameters for the monthly calculation method. This means that a number of (nationally) representative cases can be run with the hourly method and from the output, the key monthly parameters for the different cases, the monthly correlation factors can be derived.

See flowchart in Figure 1.

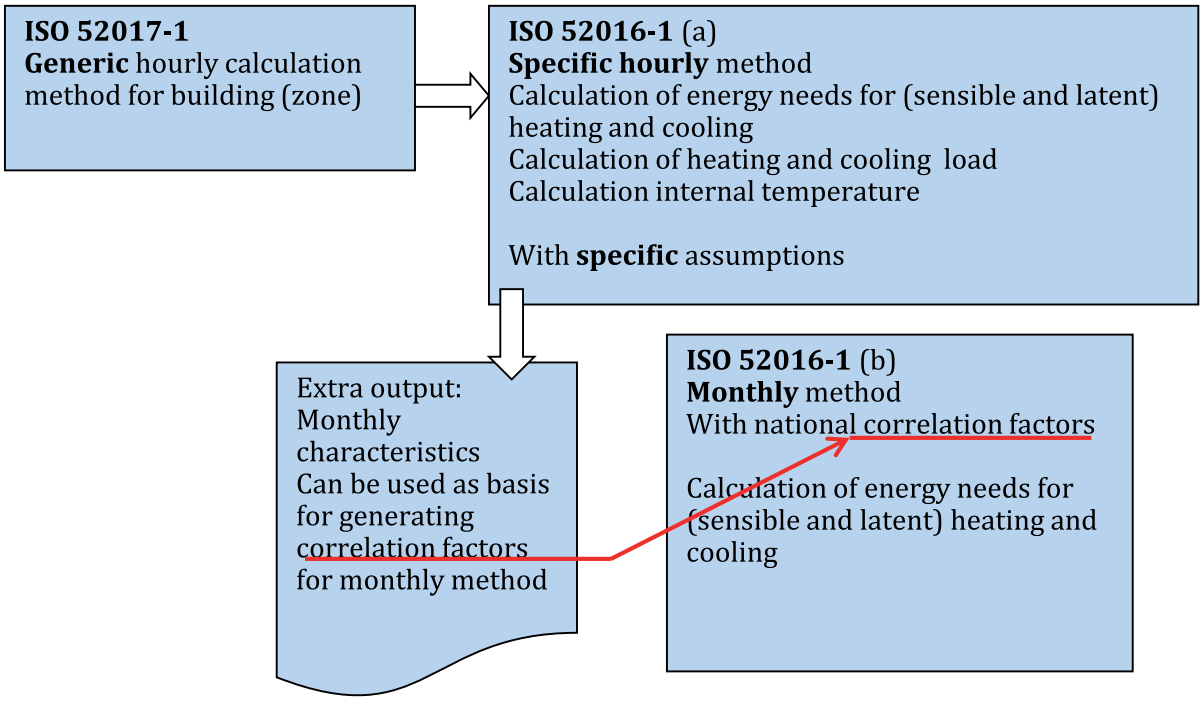

Figure 1 — Relationship between ISO 52016-1 and ISO 52017-1

Input-output relations between the two standards and other standards of the set of EPB standards

As explained above, ISO 52017-1 plays a role as a reference calculation method. For instance as reference method for ISO 52016-1.

For the input-output relations with the other EN and ISO standards in the set of EPB standards, only ISO 52016-1 is relevant.

There are many inputs from and many interactions with many other EPB standards. More details are given in the core of this document.

See flowchart in Figure 2.

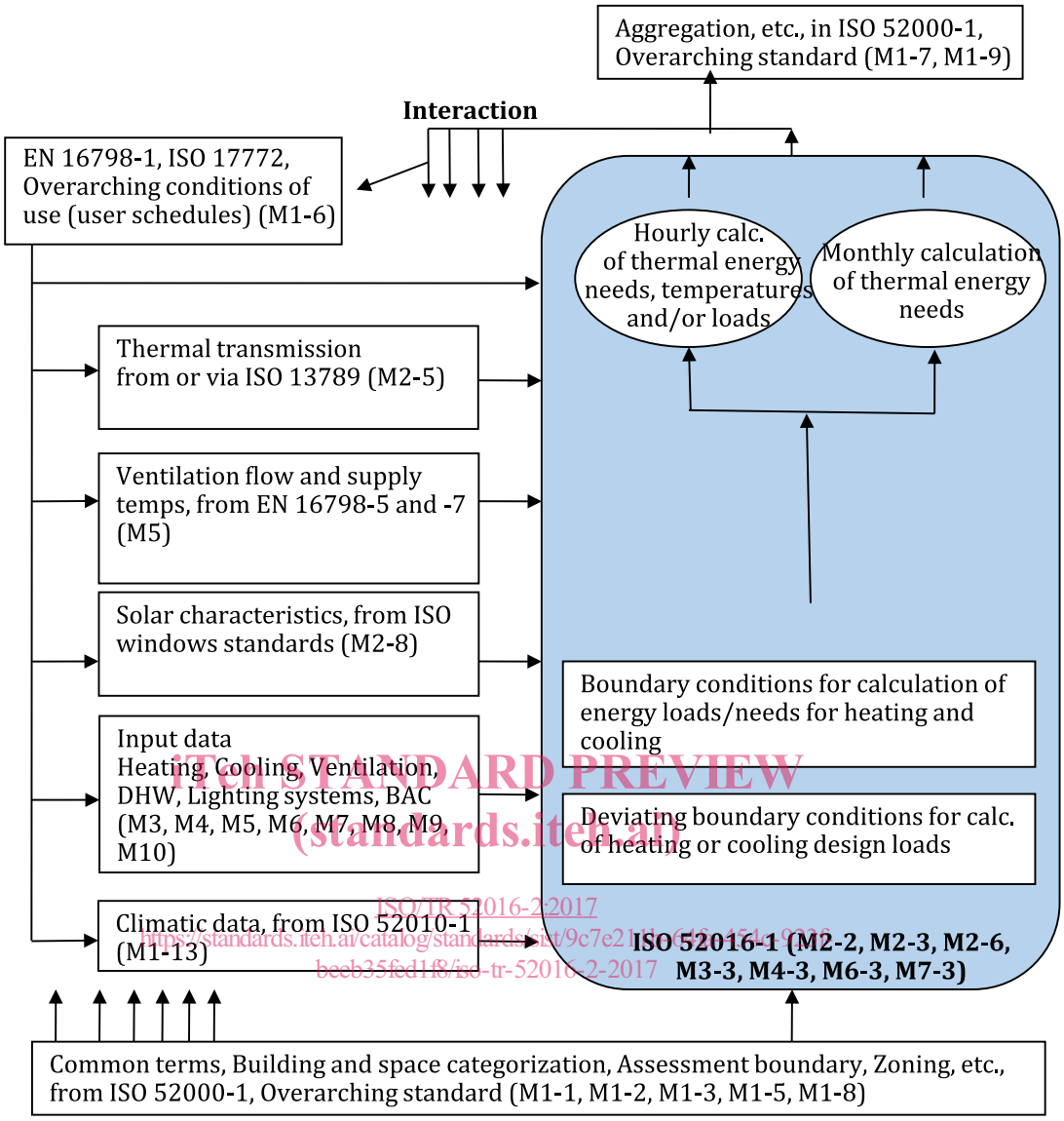

Figure 2 — Relationship between ISO 52016-1 and other EPB standards

NOTE 3 The list of referenced standards can be found in ISO 52016-1:2017, Table B.1.

Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads —

Part 2:
Explanation and justification of ISO 52016-1 and ISO 52017-1

1 Scope

This document contains information to support the correct understanding and use of ISO 52016-1 and ISO 52017-1.

These documents give calculation methods for the assessment of:

— the (sensible and latent) energy load and need for heating and cooling, based on hourly calculations;

— the (sensible and latent) energy need for heating and cooling, based on monthly calculations (ISO 52016-1);

— the internal temperature, based on hourly calculations; and

— the design (sensible and latent) heating and cooling load, based on hourly calculations.

This document does not contain any normative provisions.

NOTE A description of the rationale behind the reorganization of the cluster of strongly related and partly overlapping ISO and CEN standards is given in Annex H.

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.

More information on the use of EPB module numbers, in all EPB standards, for normative references to other EPB standards is given in ISO/TR 52000-2[4].

ISO 52016-1:2017, *Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Part 1: Calculation procedures*

ISO 52017-1, *Energy performance of buildings — Sensible and latent heat loads and internal temperatures — Part 1: Generic calculation procedures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 52016-1 and ISO 52017-1 apply.

This clause provides an explanation of some of the terms and definitions given in ISO 52016-1:2017, Clause 3 and ISO 52017-1: 2017, Clause 3.

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

— IEC Electropedia: available at http://www.electropedia.org/

— ISO Online browsing platform: available at http://www.iso.org/obp

NOTE 1 Explanations on the terms and definitions that are copied from ISO 52000-1 are given in ISO/TR 52000-2. For instance on the difference between useful floor area and reference floor area. But also, more general explanations, on the difference between a definition of a term (given in Clause 3) and a specification of a term (procedure to assess the term).

NOTE 2 For terms that are sensitive to national or regional policy, building tradition or legal context, the EPB standards contain a definition, but leave the specification to be provided at national or regional level, if possible using Annex A (normative template) and Annex B (informative default choice).

NOTE 3 The term "load" is used in (sensible) heating or cooling load, latent heating or cooling load and humidification or dehumidification moisture load. It is defined, for hourly calculations, as the hourly mean value of the heat or mass flow rate supplied to or extracted from the internal environment to maintain the intended space temperature or moisture conditions. The unit is Watt (J/s, for heat) or kg (for moisture; sometimes more specifically called kg_{H2O}/s). See 6.5.14 for an explanation of the calculation of the moisture load versus latent heat load for (de-)humidification in the application of ISO 52016-1. The load under design conditions, conditions that are assumed for the design (sizing) of the system, is called "design load".

NOTE 4 The term "power" is used for the heat flow rate that is available from the system to cover the load. If the power is insufficient to cover the load, the system is called "undersized" and the operative temperature or air moisture level in the internal environment exceeds the limit of the set-point in question.

NOTE 5 The term "need" is used for the heat to be delivered to, or extracted from the internal environment to maintain the intended space temperature or moisture conditions during a given period of time. This period is typically a month or a year. The unit is kWh (for heat) or kg_{H2O} (for moisture). See also 6.5.3 on the distinction between "basic need" versus "system specific need" calculations.

4 Symbols, subscripts and abbreviations

4.1 Symbols

For the purposes of this document, the symbols given in ISO 52016-1 and ISO 52017-1 and the following apply.

More information on key EPB symbols is given in ISO/TR 52000-2.

Symbol	Quantity	Unit
ω	ratio of the total solar radiation	-

4.2 Subscripts

For the purposes of this document, the subscripts given in ISO 52016-1 and ISO 52017-1 and the following apply.

More information on key EPB subscripts is given in ISO/TR 52000-2.

Subscript	Term	Subscript	Term
al	air layer	sw	solar wall
hem	hemispherical	t	transparent element
ref	reflected	te	external thermal transmittance

NOTE ISO 52016-1 needs input data from many technology fields. In the exceptional cases that subscripts in ISO 52016-1 are different from subscripts in other EPB standards that produce output needed as input to ISO 52016-1, these differences are reported in a special column in the tables with the overview of input data in 6.3. This can occur when the source documents use subscripts that are crucial for that specific technology field, but conflict with subscripts that are crucial for another specific technology field.

EXAMPLE Subscript g for glazing and for ground.

4.3 Abbreviations

For the purposes of this document, the abbreviations given in ISO 52016-1 and ISO 52017-1 apply.

More information on key EPB abbreviations is given in ISO/TR 52000-2.

5 Brief description of the method(s) and routing

5.1 Output of the method

5.1.1 Reference hourly method in ISO 52017-1

ISO 52017-1 is a generic reference hourly calculation method to calculate the thermal balance in a building or building zone. The main output quantities are the indoor air and indoor mean radiant temperature and (derived from these two) the operative temperature. The energy need for heating or cooling can also be produced as output, at given heating and/or cooling set points for the operative temperature. However, the actual conditions and temperature control specifications depend on the application. ISO 52016-1 contains such a specific hourly calculation method.

ISO 52017-1 also contains a moisture balance formula to calculate the moisture balance in a building or building zone. The main output quantities are the moisture content of the internal air, the moisture load and the latent energy load and need. Again in a generic way, because the actual moisture and latent heat load depends on the specific application. This is covered in ISO 52016-1.

5.1.2 Hourly method in ISO 52016-1

ISO 52016-1 contains a specific hourly method to calculate the energy loads and needs for heating and cooling and the hourly indoor temperature (air, mean radiant and operative). It also contains a specific hourly method to calculate the moisture and latent energy loads and needs for humidification and dehumidification and the hourly indoor air moisture content (humidity). The assumptions and simplifications have been chosen in such a way that sufficient accuracy is obtained (e.g. in relation to the reliability of input data and boundary conditions), with a minimum of required input data. The input data to be gathered by the user of the calculation procedures is equal or equivalent to the input data for the simplified monthly calculation method.

5.1.3 Monthly method in ISO 52016-1

ISO 52016-1 contains also a specific monthly method to calculate the (monthly) energy needs for heating and cooling, plus a specific simple monthly method to calculate the (monthly) energy needs for (de-)humidification.