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DIN EN ISO 52016-1

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Supersedes: see below

Energy performance of buildings – Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads – Part 1: Calculation procedures (ISO 52016-1:2017); English version EN ISO 52016-1:2017, English translation of DIN EN ISO 52016-1:2018-04

Energetische Bewertung von Gebäuden –
Energiebedarf für Heizung und Kühlung, Innentemperaturen sowie fühlbare und latente Heizlasten –
Teil 1: Berechnungsverfahren (ISO 52016-1:2017);
Englische Fassung EN ISO 52016-1:2017,
Englische Übersetzung von DIN EN ISO 52016-1:2018-04

Performance énergétiques des bâtiments –
Besoins d'énergie pour le chauffage et le refroidissement, les températures intérieures et les chaleurs sensible et latente –
Partie 1: Méthodes de calcul (ISO 52016-1:2017);
Version anglaise EN ISO 52016-1:2017,
Traduction anglaise de DIN EN ISO 52016-1:2018-04

Together with DIN EN ISO 52017-1:2018-04, supersedes DIN EN 15255:2007-11, DIN EN 15265:2007-11, DIN EN ISO 13791:2012-08 and DIN EN ISO 13792:2012-08;
supersedes DIN EN ISO 13790:2008-09

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A comma is used as the decimal marker.

National foreword

This document (EN ISO 52016-1:2017) has been prepared by Technical Committee ISO/TC 163 "Thermal performance and energy use in the built environment" in collaboration with Technical Committee CEN/TC 89 "Thermal performance of buildings and building components" (Secretariat: SIS, Sweden).

The responsible German body involved in its preparation was *DIN-Normenausschuss Bauwesen* (DIN Standards Committee Building and Civil Engineering), Joint Working Committee NA 005-12-01 GA "NABau/FNL/NHRS: Energy efficiency of buildings (national mirror committee for CEN/TC 371, CEN/TC 371/WG 1, ISO/TC 163/WG 3, ISO/TC 163/WG 4, ISO/TC 163/SC 2/WG 15)".

The DIN documents corresponding to the international documents referred to in this document are as follows:

ISO 6946	DIN EN ISO 6946
ISO 7345	DIN EN ISO 7345
ISO 9488	DIN EN ISO 9488
ISO 10077-1	DIN EN ISO 10077-1
ISO 13370	DIN EN ISO 13370
ISO 13786	DIN EN ISO 13786
ISO 13789	DIN EN ISO 13789
ISO 13790	DIN EN ISO 13790
ISO 13791	DIN EN ISO 13791
ISO 13792	DIN EN ISO 13792
ISO 15927-2	DIN EN ISO 15927-2
ISO 15927-4	DIN EN ISO 15927-4
ISO 15927-5	DIN EN ISO 15927-5
ISO 52000-1	DIN EN ISO 52000-1
ISO 52010-1	DIN EN ISO 52010-1
ISO 52017-1	DIN EN ISO 52017-1
ISO 52022-3	DIN EN ISO 52022-3

This standard is part of the standards series DIN EN ISO 52000 and has been prepared under the EPBD mandate M/480.

DIN EN ISO 52016-1 is an International Standard and CEN ISO/TR 52016-2 is the accompanying Technical Report to this standard containing further informative content for assessing the energy performance of a building.

In Germany, the Directive on the energy performance of buildings (2010/31/EU) of the European Parliament and the European Council is primarily implemented by national energy conservation legislation. National energy conservation legislation refers to dated national and European Standards and national prestandards that have been specified for implementation in Germany.

In Germany, the application of this standard in connection with national energy conservation legislation is defined by provisions in this legislation.

Provisions of German energy conservation legislation cannot be systematically fully and identically implemented with the set of standards under the EPBD mandate M/480 and the therein referenced International and European Standards. When applying the standards of the mandate, accordance with German energy conservation legislation cannot be achieved, whether in terms of the procedure, the result, or assessment of the result. National Annex NA is intended to give assistance by showing relationships between provisions in German energy conservation legislation and corresponding, comparable or similar provisions in the set of standards, including the International and European Standards referenced therein.

Currently, the set of standards of the EPBD mandate M/480 is not applicable for the purposes of German energy conservation legislation, even if references to national provisions in the respective national annexes are taken into consideration.

In addition to the normative references listed in subclause 6.5.8.3, characteristic values for window, door and curtain walling elements may be taken from the following sources: hEN, European harmonized product standards; *ETA*, European Technical Assessments, specifications of the *VVTB* of the German *Länder* (VVTB, German Administrative Regulation for Technical Building Regulations [*Verwaltungsvorschrift Technische Baubestimmungen*]); DIN 4108-4; abZ, General Building Inspectorate Approvals (*Allgemeine bauaufsichtliche Zulassung*), or General Type Certifications (*Allgemeine Bauartgenehmigung*); ZiE, approvals for particular cases issued by the Supreme Building Authority of the relevant German *Land* (*Zustimmung im Einzelfall der obersten Baubehörde des Bundeslandes*), or design certifications for particular cases (*Einzelfall-Bauartgenehmigung*).

The calculated “effective” heat capacity according to DIN EN ISO 13786:2018-04 is unsuitable for the calculation or validation of performance and indoor temperatures by means of thermal building simulation. For this reason, the methods of this standard are not applicable for the hourly or transient calculation or validation of performance and room temperatures.

EN ISO 52016-1:2017 contains errors that have been corrected in the German translation. The corrections made have been marked by and explained in national footnotes.

Amendments

This standard differs from DIN EN 15255:2007-11, DIN EN 15265:2007-11, DIN EN ISO 13790:2008-09, DIN EN ISO 13791:2012-08 and DIN EN ISO 13792:2012-08 as follows:

a) the title of the standard has been modified;

b) normative references have been updated;

c) this standard has been included in the set of EPB standards, as specified in the overarching EPB standard (EN 15603), whereby calculation elements that are covered or to be covered by other standards have been removed (e.g., the general rules for zoning [partitioning] of the building are now at overarching level (EPB module M1-8); the conditions of use have now been included in a separate standard (module M1-6);

d) major editiorial changes based on the detailed technical rules for all EPB standards have been made, including moving all informative annexes to a separate accompanying Technical Report (ISO/TR 52016-2);

e) the monthly calculation method has been revised and the seasonal method has been removed;

f) the simple hourly calculation method has been replaced by a more direct and transparent method, with no need to add input data.

Previous editions

DIN EN 832: 1998-12, 2003-06
DIN EN ISO 13790: 2004-09, 2008-09
DIN EN ISO 13791: 2005-02, 2012-08
DIN EN ISO 13792: 2005-06, 2012-08
DIN EN 15255: 2007-11
DIN EN 15265: 2007-11

National Annex NA
(normative)

Input and method selection data sheet — Template

NA.1 General

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Currently, the set of standards of the EPBD mandate M/480 is not applicable for the purposes of German energy conservation legislation, even if references to national provisions in the respective national annexes NA are taken into consideration.

In addition to the normative references listed in subclause 6.5.8.3, characteristic values for window, door and curtain walling elements may be taken from the following sources: hEN, European harmonized product standards; *ETA*, European Technical Assessments, specification of the *VVTB* of the German *Länder* (VVTB, German Administrative Regulation for Technical Building Regulations [*Verwaltungsvorschrift Technische Baubestimmungen*]); DIN 4108-4; abZ, General Building Inspectorate Approvals (*Allgemeine bauaufsichtliche Zulassung*), or General Type Certifications(*Allgemeine Bauartgenehmigung*); ZiE, approvals for particular cases issued by the Supreme Building Authority of the relevant German *Land* (*Zustimmung im Einzelfall der obersten Baubehörde des Bundeslandes*), or design certifications for particular cases (*Einzelfall-Bauartgenehmigung*).

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NA.2 References

References identified by a module code number are given in Table NA.1.

Table NA.1 — References

Reference	**Reference document**[a]	
	Number	**Title**
M1-4	DIN EN ISO 52003-1	*Energy performance of buildings — Indicators, requirements, ratings and certificates — Part 1: General aspects and application to the overall energy performance*
M1-6	DIN V 18599-10	*Energy efficiency of buildings — Calculation of the net, final and primary energy demand for heating, cooling, ventilation, domestic hot water and lighting — Part 10: Boundary conditions of use, climatic data*
M1-8	DIN EN ISO 52000-1	*Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures*
M1-13	DIN V 18599-10	*Energy efficiency of buildings — Calculation of the net, final and primary energy demand for heating, cooling, ventilation, domestic hot water and lighting — Part 10: Boundary conditions of use, climatic data*
M2-4	DIN EN ISO 52018-1	*Energy performance of buildings — Indicators for partial EPB requirements related to thermal energy balance and fabric features — Part 1: Overview of options*
M2-5.1	DIN EN ISO 13789	*Thermal performance of buildings — Transmission and ventilation heat transfer coefficients — Calculation method*
M2-5.2	DIN EN ISO 13370	*Thermal performance of buildings — Heat transfer via the ground — Calculation methods*
M2-5.3	DIN EN ISO 6946	*Building components and building elements — Thermal resistance and thermal transmittance — Calculation methods*
M2-5.4	DIN EN ISO 10211	*Thermal bridges in building construction — Heat flows and surface temperatures — Detailed calculations*
M2-5.5	DIN 4108 Supplement 2	*Thermal insulation and energy economy in buildings — Thermal bridges — Examples for planning and performance*
M2-5.6	DIN EN ISO 10077-1	*Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General*
M2-5.7	DIN EN ISO 10077-2	*Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 2: Numerical method for frames*
M2-8		See 3 in Table C.1
M3-1	DIN EN 15316-1	*Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 1: General and energy performance expression, Module M3-1, M3-4, M3-9, M8-1, M8-4*
M3-4[b]	DIN EN 15316-1	See M3-1

Reference	Reference document[a]	
	Number	**Title**
M3-5	DIN EN 15316-2	*Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Part 2: Space emission systems (heating and cooling), Module M3-5, M4-5*
M4-1	DIN EN 16798-9	*Energy performance of buildings — Ventilation for buildings — Part 9: Calculation methods for energy requirements of cooling systems (Modules M4-1, M4-4, M4-9)*
M4-4[b]	DIN EN 16798-9	See M4-1
M4-5	DIN EN 15316-2	See M3-5
M5-1	DIN EN 16798-3	*Energy performance of buildings — Ventilation for buildings — Part 3: For non-residential buildings — Performance requirements for ventilation and room-conditioning systems (Modules M5-1, M5-4)*
M5-5	DIN EN 16798-7	*Energy performance of buildings — Ventilation for buildings — Part 7: Calculation methods for the determination of air flow rates in buildings including infiltration (Modules M5-5)*
M5-6	DIN EN 16798-5-1 DIN EN 16798-5-2	*Energy performance of buildings — Ventilation for buildings — Part 5-1: Calculation methods for energy requirements of ventilation and air conditioning systems (Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8) — Method 1: Distribution and generation* *Energy performance of buildings — Ventilation for buildings — Part 5-2: Calculation methods for energy requirements of ventilation systems (Modules M5-6, M5-8, M6-5, M7-5, M7-8) — Method 2: Distribution and generation*
M6-1	DIN EN 16798-3	See M5-1
M6-4[b]	DIN EN 16798-3	See M5-1
M6-5	DIN EN 16798-5-1 DIN EN 16798-5-2	See M5-6
M7-1	DIN EN 16798-3	See M5-1
M7-4[b]	DIN EN 16798-3	See M5-1
M7-5	DIN EN 16798-5-1 DIN EN 16798-5-2	See M5-6
M9-1	DIN EN 15193-1	*Energy performance of buildings — Energy requirements for lighting — Part 1: Specifications, Module M9*
M10-1	DIN EN 15232-1	*Energy Performance of Buildings — Part 1: Impact of Building Automation, Controls and Building Management — Modules M10-4, 5, 6, 7, 8, 9, 10*

[a] If a reference comprises more than one document, the references can be differentiated.

[b] Informative

NA.3 Selection of main method

Table NA.2 — Choice between hourly or monthly calculation method (see subclause 5.2)

Type of object and/or application	All applications	— [b]
Description	Choice[a]	—
Only hourly method allowed	No	—
Only monthly method allowed	Yes	—
Both methods are allowed	No	—

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between type of object, type of building or space, type of application or type of assessment. Use the list of identifiers from ISO 52000-1:2017, Tables A.2 to A.7 (normative template, with informative default choices in Tables B.2 to B.7).

NA.4 Zoning

Table NA.3 — Thermal zoning rules (see 6.4.2.12)

	Application: .....[a]	
Description	**Apply the described method?**	**If "No": Alternative method** If the described method is not used, describe details of the alternative method or give reference to source document.
Zoning step 1. Assessment of thermal envelope	Yes	Not applicable
Zoning step 2. Grouping according to space category	Yes	Not applicable
Zoning step 3. Grouping in case of large openings	Yes	Not applicable
Zoning step 4. Split to have same combination of services	Yes	Not applicable
Zoning step 5. Further grouping according to similar thermal conditions of use	Yes	Not applicable
Zoning step 6. Split according to specific system or subsystem properties	Yes	Not applicable
Zoning step 7. (Further) split to have sufficient homogeneity in thermal balance	Yes	Not applicable
Zoning step 8. (Further) grouping of thermally unconditioned zones	Yes	Not applicable
Zoning step 9. Simplification in case of small thermal zones	Yes	Not applicable
Zoning step 10. Simplification in case of very small thermal zones	Yes	Not applicable

[a] Add more columns to differentiate per application, if needed.

Table NA.4 — Options of thermally unconditioned zone types and default values (see subclause 6.4.5)

Situation	**Default value of $b_{ztu;m}$ in case of a thermally unconditioned zone, type: external**[a]
	DIN V 18599-2:2016-10, Tables 5 and 6
Internal thermally unconditioned zone type allowed?	
Choice	Yes
If Yes: (optionally) specify default values for the adjustment factor (free text)	
Situation	**Default value of $b_{ztu;m}$ in case of a thermally unconditioned zone, type: external** [a]
	No standard values intended
[a] Add more rows if needed.	

Table NA.5 — Default contribution of ventilation in external construction of a thermally unconditioned zone (see subclause 6.4.5.4)

Application	All applications[a]	— [b]
Description	**Choice**	—
Default allowed?	Yes	—
If Yes:		—
Coefficient for default contribution of ventilation, $c_{ztu;ve}$	0,5	—
[a] Add more columns if needed.		

Table NA.6 — Choice of spatial temperature averaging in residential buildings (see subclause 6.4.6)

Description		**Choice**[a]
Application of the given formula for spatial temperature averaging		Yes
If No		
No application of the given formula for spatial temperature averaging	It is assumed that the same temperature set-point for heating applies also to partly or moderately thermally conditioned residential spaces.	Not applicable
	Calculate the fully and partly or moderately thermally conditioned residential spaces as separate, thermally uncoupled thermal zones.	Not applicable
	Calculate the fully and partly or moderately thermally conditioned residential spaces as separate, thermally coupled thermal zones.	Not applicable
In case of application of the formula		**Value**
$f_{mod;t}$		0,8
$f_{mod;sp}$		0,5
$H_{int;spec}$ (W/K)		2,0
[a] Only one Yes possible.		

Table NA.7 — Choice between calculations with thermally coupled or uncoupled thermal zones (see subclause 6.4.7)

Application	**All applications**[b]	—
Description	**Choice**[a]	—
Thermally uncoupled calculations	Yes	—
Thermally coupled calculations	No	—
Both methods are allowed	No	—

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.). Note the link with the choice in Table A.9.

Table NA.8 — Default thermal coupling properties in case of thermally coupled zones (see subclause 6.4.7)

		Choice	
Heat transfer part	**Quantity**	**Default value**	**Unit**
Transmission heat transfer between zones *z* and *y*	Not applicable	Not applicable	—
Ventilation heat transfer from zone *z* to zone *y*	Not applicable	Not applicable	—
Ventilation heat transfer from zone *z* to zone *y*	Not applicable	Not applicable	—

NA.5 Hourly calculation procedures

Table NA.9 — Factor for consideration of internal heat gains in design heat load calculation (see subclause 6.5.4.5.2)

Application	All applications[a]	…..[a]
Description	**Choice**	**Choice**
Value for factor $f_{H;ig}$	Not applicable	Not applicable

[a] Add more rows if needed.

Table NA.10 — Alternative choices in modelling (see subclauses 6.5.5.2, 6.5.6.3.1 and 6.5.7.1)

Description	Choice	If choice is No, describe or give reference to the applied alternative method
Use the method in subclause 6.5.5.2 to calculate the actual temperatures and loads	Not applicable	Not applicable
Use method in subclause 6.5.6.3.1 for the calculation of the thermal (longwave) radiation exchange	Not applicable	Not applicable
Use method in subclause 6.5.7.1 for the conversion of physical properties of building elements into properties per layer (node)	Not applicable	Not applicable
NOTE In case of one or more “No”, the procedures are validated using the validation cases in subclause 7.2, as described in that subclause.		

Table NA.11 — Convective fractions (see subclause 6.5.6.2)

$f_{int;c}$ [a]	$f_{sol;c}$	$f_{H;c}$	$f_{C;c}$
0,40 for all source types	Not applicable	Not applicable	Not applicable
[a] Can be differentiated per source type.			

Table NA.12 — Specification of internal partitions (see subclause 6.5.6.3.1)

	Choice
Internal partitions need to be specified?	Not applicable
If By default: specify the default thermal characteristics	
Default characteristics	**Specification**[a]
Not applicable	Not applicable
—	—
[a] Add more rows if needed.	

Table NA.13 — Distribution of mass of opaque and ground floor elements (see subclause 6.5.7.2)

Class	Specification of the class
Class I (mass concentrated at internal side)	Not applicable
Class E (mass concentrated at external side)	Not applicable
Class IE (mass divided over internal and external side)	Not applicable
Class D (mass equally distributed)	Not applicable

Table NA.14 — Specific heat capacity of mass of opaque and ground floor elements (see subclause 6.5.7.2)

Class	$\kappa_{m;op}$ J/(m²·K)	Specification of the class
Very light	50 000	Not applicable
Light	75 000	Not applicable
Medium	110 000	Not applicable
Heavy	175 000	Not applicable
Very heavy	250 000	Not applicable

Table NA.15 — Solar absorption coefficient of external opaque surfaces (see subclause 6.5.7.2)

	Choice
Differentiation in solar absorption coefficient?	Not applicable
If Yes: specify the procedure to classify the three categories (free text)	
Category	**Specification**
Category 1 α_{sol} = **0,3** **(light colour)**	Not applicable
Category 2 α_{sol} = **0,6** **(intermediate colour)**	Not applicable
Category 3 α_{sol} = **0,9** **(dark colour)**	Not applicable
	Choice
If No: choose the default category	Not applicable

Table NA.16 — Coefficient to limit assumed temperature in adjacent thermally unconditioned zone (see subclause 6.5.9)

Application	**All applications**	**.....[a]**
	$c_{ztu,h;max}$	$c_{ztu,h;max}$
Value	Not applicable	Not applicable

[a] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table NA.17 — Specific heat capacity of air and furniture (see subclause 6.5.11)

$\kappa_{m;int}$ J/(m²·K)
Not applicable

Table NA.18 — View factor to the sky (see subclause 6.5.13.3)

	Unshaded horizontal roof	Unshaded vertical wall
F_{sky}	Not applicable	Not applicable

Table NA.19 — Difference between external air temperature and sky temperature (see subclause 6.5.13.3)

Climatic region[a]	Subpolar regions	Tropics	Intermediate zones
$\Delta_{\theta sky;t}$ (K)	Not applicable	Not applicable	Not applicable
[a] Add more columns if needed to differentiate between climatic regions.			

Table NA.20 — Choice of method for moisture absorption and desorption in materials (see subclause 6.5.14.1)

Application	All applications	…..[a]
Description	**Choice**	**Choice**
Moisture absorption and desorption calculated?	Not applicable	Not applicable
If No:	Not applicable	Not applicable
If Yes: give reference to method	Not applicable	Not applicable
[a] Add more columns if needed.		

Table NA.21 — Choice of glazing area or frame area fraction (see subclause 2.1)

Description	Choice[a]
For each window: free choice between glazing area or fixed frame fraction	Not applicable
For all windows the same choice: either glazing area or fixed frame fraction	Not applicable
For all windows: only glazing area allowed	Not applicable
For all windows: only fixed frame fraction	Not applicable
In case of frame fraction:	F_{fr}
Frame fraction fixed value	Not applicable
[a] Only one Yes per column possible.	

Table NA.22 — Factors related to the solar energy transmittance (see subclause E.2.2.1)

Correction and weighting factor for *g*-value non-scattering and scattering transparent glazing and blinds:		
F_w	a_g	alt_g
Not applicable	Not applicable	Not applicable

Default values of the total solar energy transmittance at normal incidence, g_n, for typical types of glazing[a]	
Type	g_n
Single glazing	Not applicable
Double glazing	Not applicable
Double glazing with selective low-emissivity coating	Not applicable
Triple glazing	Not applicable
Triple glazing with two selective low-emissivity coatings	Not applicable
Double window	Not applicable

Default values of the reduction factor, for typical types of blinds[b]				
Blind type	**Optical properties of blind**		**Reduction factor with**	
	absorption	**transmission**	**blind inside**	**blind outside**
White blinds	0,1	Not applicable	Not applicable	Not applicable
White curtains	0,1	Not applicable	Not applicable	Not applicable
Coloured textiles	0,3	Not applicable	Not applicable	Not applicable
Aluminium-coated textiles	0,2	Not applicable	Not applicable	Not applicable

a Assuming a clean surface and normal, untainted and non-scattering glazing.

b Add more rows or columns if needed.

Table NA.23 — Rules for operation of shutters (see subclause G.2.2.1.2)

Application	**All applications**	**....[a]**
Control level	**Rules**	**Rules**
0 Manual operation	Closed: after sunset, if occupied Open: after sunrise, if occupied, but not during sleeping hours	Not applicable
1 Motorized operation with manual control	Identical	Not applicable
2 Motorized operation with automatic control	Closed: after sunset Open: after sunrise	Not applicable
3 Combined light/blind/HVAC control	Identical[b]	Not applicable

[a] Add more columns if needed.
[b] Conservative rule; a level 3 combined control is not covered in this table.

Table NA.24 — Rules for operation of solar shading devices (see subclause G.2.2.1.2)

Application	**All applications**	**....[a]**
Control level	**Rules**	**Rules**
0 Manual operation	Closed: if solar irradiance > 300 W/m^2 Open: if solar irradiance < 200 W/m^2	Not applicable
1 Motorized operation with manual control	Identical	Not applicable
2 Motorized operation with automatic control	Closed: if solar irradiance > 200 W/m^2 Open: if solar irradiance < 200 W/m^2 and ≥ 2 hours passed since closing	Not applicable
3 Combined light/blind/HVAC control	Identical[b]	Not applicable

[a] Add more columns if needed.
[b] Conservative rule; a level 3 combined control is not covered in this table.

Table NA.25 — Choices between options and methods for calculation of shading by external objects (see Clause F.1)

Application[b]	All applications			Not applicable		
Description	**Choice**			**Choice**		
Calculation of the effect of shading by distant objects included in this document?	Not applicable			Not applicable		
When calculating solar shading on building elements: which types of distant shading objects (not on-site) may or shall be taken into account or ignored?	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
NOTE: For instance landscape (such as hills or dikes), vegetation (such as trees), other constructions (such as buildings)	Not applicable	Not applicable	—	Not applica-ble	Not applica-ble	Not applica-ble
When calculating solar shading on opaque building elements such as roofs or facades: which types of on-site shading objects can or shall be ignored?	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
NOTE: For instance rebates, overhangs or other shading objects from the own building(s) on-site	—	—	Not applicable	Not applica-ble	Not applica-ble	Not applica-ble
When calculating solar shading on transparent building elements: NOTE: For instance window rebates, overhangs and side fins	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	Window rebates, overhangs and side fins if depth larger than 20% of window height resp. width	Other window rebates, overhangs and side fins	—	Not applica-ble	Not applica-ble	Not applica-ble
Specific subdivision rules for the calculation of solar shading on building elements	Not applicable			Not applicable		
Choice between the two methods for the solar shading calculation:	Choice[a]			Choice[a]		
Method 1, Shading of direct radiation	Not applicable			Not applicable		
Method 2, Shading of direct and diffuse radiation	Not applicable			Not applicable		
In case of method 2: give reference to calculation procedure	Not applicable			Not applicable		

a Only one Yes per column possible.

b Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table NA.26 — Number of skyline segments, $n_{sh;segm}$ for input solar shading objects (see subclause F.3.3)

Application[b]	All applications	....
Description	Value of $n_{sh;segm}$[a]	Value of $n_{sh;segm}$[a]
Maximum number of segments over 360 degrees	Not applicable	
Fixed width (= 360 / $n_{sh;segm}$)[c]	Not applicable	

[a] Practical range, informative.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

[c] If not fixed, the width of each segment can be adapted to the width of the shading object, with limitation of maximum number of segments $n_{sh;segm}$.

NA.6 Monthly calculation procedures

Table NA.27 — Monthly ventilation heat transfer coefficient (see subclause 6.6.6.2)

Application	**All applications**	**....**[b]
Description	Choice[a]	Choice[a]
Method A	Yes	Not applicable
Method B[c]	No	Not applicable
Both methods[c]	No	Not applicable

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

[c] Method B is only allowed outside the CEN area.

Table NA.28 — Dynamics correction factor for ventilation (see subclause 6.6.6.2)

Dynamics correction factor for monthly mean air flow	**Value**
$f_{ve;dyn;k}$	1,0

Table NA.29 — Solar absorption coefficient of external opaque surfaces (see subclause 6.6.8.2)

	Choice
Differentiation in solar absorption coefficient?	No
If Yes: specify the procedure to classify the three categories (free text)	
Category	**Specification**
Category 1 α_{sol} = **0,3** **(light colour)**	Not applicable
Category 2 α_{sol} = **0,6** **(intermediate colour)**	Not applicable
Category 3 α_{sol} = **0,9** **(dark colour)**	Not applicable
	Choice
If No: choose the default category	2

Table NA.30 — View factor to the sky (see subclause 6.6.8.3)

	Unshaded horizontal roof	**Unshaded vertical wall**
F_{sky}	1,0	0,5

Table NA.31 — Difference between external air temperature and sky temperature (see subclause 6.6.8.3)

Climatic region[a]	**Subpolar regions**	**Tropics**	**Intermediate zones**
$\Delta\theta_{sky;m}$ (K)	Not applicable	Not applicable	11 (fixed value)

a Add more columns if needed to differentiate between climatic regions.

Table NA.32 — Choice between detailed or simple method to determine the internal effective heat capacity (monthly method; see subclause 6.6.9)

Application	All applications[b]	
Description	**Choice**[a]	**Choice**[a]
Only detailed method allowed	No	—
Only simple method allowed	No	—
Both methods allowed	Yes	—

a Only one Yes per column possible.

b Add more columns if needed to differentiate between applications (e.g. construction types or building categories).

Table NA.33 — Simple method to determine the internal effective heat capacity. Specification of the classes (see subclause 6.6.9)

Class	Specification of the class
Very light	Construction type is dominated by very light constructions as specified in Table B.14
Light	Construction type is dominated by light constructions as specified in Table B.14
Medium	Construction type is dominated by medium constructions as specified in Table B.14
Heavy	Construction type is dominated by heavy constructions as specified in Table B.14
Very heavy	Construction type is dominated by very heavy constructions as specified in Table B.14

Table NA.34 — Values of the reference numerical parameter $a_{H,0}$ and the reference time constant $\tau_{H,0}$ for the gain utilization factor (see subclause 6.6.10.2)

$a_{H,0}$	$\tau_{H,0}$ h
1,0	16

Table NA.35 — Values of the reference numerical parameter $a_{C,0}$ and the reference time constant $\tau_{C,0}$ for the loss utilization factor (see subclause 6.6.10.3)

$a_{C,0}$	$\tau_{C,0}$ h
1,0	16

Table NA.36 — Choice between methods A and B for heating intermittency (see subclause 6.6.11.3)

Application	All applications[b]	
Description	**Choice[a]**	**Choice[a]**
Only Method A	Yes	—
Only Method B	No	—
Both methods are allowed	No	—

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table NA.37 — Choice between methods A and B for cooling intermittency (see subclause 6.6.11.4)

Application	**All applications**[b]	
Description	**Choice**[a]	—
Only Method A	Yes	—
Only Method B	No	—
Both methods are allowed	No	—
If Method A applies		
Correlation factor for method A for intermittent cooling		**Value**
$b_{C;red}$		0,3

[a] Only one Yes per column possible.
[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table NA.38 — Choice between methods A and B for overheating indicator (see subclause 6.6.12)

Application	....[b]	....[b]
Description	**Choice**[a]	**Choice**[a]
Method A	Yes	Not applicable
Method B	No	Not applicable
If Method B applies		
Provide details or reference to details	Not applicable	

[a] Only one Yes per column possible.
[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table NA.39 — The monthly fraction of energy need for humidification (see subclause 6.6.14)

	Monthly fraction of energy need for humidification $f_{HU;m}$		
Formula?	Yes		
If Yes, give formula	for each month m: $f_{HU;m} = Q_{H;nd;m}/Q_{H;nd;an}$ where $Q_{H;nd;m/an}$ is the monthly / annual energy need for heating, as determined in subclause 6.5.4.1, in kWh		
If No, give fraction for each month (total = 1)	**Monthly fraction of energy need for humidification** $f_{HU;m}$		
January	Not applicable	July	Not applicable
February	Not applicable	August	Not applicable
March	Not applicable	September	Not applicable
April	Not applicable	October	Not applicable
May	Not applicable	November	Not applicable
June	Not applicable	December	Not applicable

Table NA.40 — Efficiency of latent heat recovery (see subclause 6.6.14)

Type of heat recovery unit	Efficiency of latent heat recovery $\eta_{HU;rvd}$
Provisions specifically made for transporting moisture from exhaust to supply air (such as a heat recovery wheel with moisture absorbing surface)	0,55
Other provisions	0
— [a]	—
— [a]	—

[a] Add more rows if needed to differentiate between types.

Table NA.41 — Annually accumulated amount of moisture to be supplied per kg dry air supply (see subclause 6.6.14)

Space category[a] No.	Usage	Annually accumulated amount of moisture to be supplied per kg dry air supply $\Delta x \cdot t_{a;sup}$ (kg h/kg)
1	Individual office	2,9
2	Group office (two to six workplaces)	2,9
3	Open-plan office (from seven workplaces)	2,9
4	Meeting, conference, seminar	2,9
5	Hall	2,9
6	Retail / department store	3,8
7	Retail / department store (food department with refrigerated products)	3,8
8	Classroom (school), common room (kindergarten)	1,5
9	Lecture hall, auditorium	1,6
11	Hotel room	4,2
17	Miscellaneous common rooms	2,9
23	Audience area (theatres and event constructions)	1,1
24	Foyer (theatres and event constructions)	1,1
25	Stage (theatres and event constructions)	2,6
26	Fair / congress	1,4
27	Exhibition spaces and museum with conservational requirements	4,7
28	Library - Reading room	3,8
29	Library - Open access area	3,8

Space category[a]		Annually accumulated amount of moisture to be supplied per kg dry air supply $\Delta x \cdot t_{a;sup}$ (kg h/kg)
No.	Usage	
30	Library - Stack and depository	3,8
36	Laboratory	2,9
37	Examination and treatment rooms	2,9
38	Special care areas	9,2
40	Medical and therapeutic practices	2,6
ANMERKUNG For residential buildings, no humidification is intended.		
[a] The listed categories correspond to the usage and its numbering according to DIN V 18599-10:2016-10, Table 5.		

Table NA.42 — Choice of glazing area or frame area fraction (see subclause E.2.1)

Description	Choice[a]
For each window: free choice between glazing area or fixed frame fraction	Yes
For all windows of the same choice: either glazing area or fixed frame fraction	No
For all windows: only glazing area allowed	No
For all windows: only fixed frame fraction	No
In case of frame fraction:	F_{fr}
Frame fraction fixed value	0,30
[a] Only one Yes per column possible.	

Table NA.43 — Factors related to the solar energy transmittance (see subclause E.2.2.1)

Correction and weighting factor for g-value non-scattering and scattering transparent glazing and blinds:		
F_w	a_g	alt_g °
0,90	0,75	45

Default values of the total solar energy transmittance at normal incidence, g_n, for typical types of glazing[a]

Type	g_n
Single glazing	0,87
Double glazing	0,78
Double glazing with selective low-emissivity coating	0,60
Triple glazing	Not applicable
Triple glazing with two selective low-emissivity coatings	0,53
Double window	0,75

Default values of the reduction factor, for typical types of blinds[a]																				
Glass type	Characteristic values, without solar shading				with external solar shading										with internal solar shading						
					Blind outside (10° position)		Blind inside (45° position)		Vertical awning		Shutter (completely closed)		Shutter (to three quarters closed)		Blind inside (10° position)		Blind inside (45° position)		Textile blind		Film
					White	Dark grey	White	Dark grey	White	Medium grey	White	Dark grey	White	Dark grey	White	Dark grey	White	Dark grey	White	Aluminized	White
	U_g	$g_{\perp}$	t_e	t_v	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}	F_{mind}
Single glazing	5,8	0,87	0,85	0,90	0,14	0,23	0,21	0,24	0,33	0,26	0,26	0,28	0,44	0,46	0,50	0,74	0,52	0,75	0,48	0,53	0,44
Double glazing with air filling, without coating	2,9	0,78	0,73	0,82	0,12	0,19	0,20	0,20	0,33	0,24	0,26	0,25	0,44	0,44	0,57	0,81	0,59	0,82	0,54	0,61	0,51
Triple glazing with air filling, without coating	2,0	0,70	0,63	0,75	0,12	0,17	0,19	0,18	0,33	0,23	0,26	0,24	0,44	0,43	0,62	0,84	0,64	0,85	0,59	0,66	0,56
Double thermal insulation glazing with argon filling, one coating	1,7	0,72	0,60	0,74	0,11	0,15	0,18	0,16	0,32	0,21	0,25	0,22	0,44	0,41	0,61	0,85	0,63	0,86	0,58	0,65	0,55
	1,4	0,67	0,58	0,78	0,11	0,15	0,18	0,15	0,32	0,21	0,25	0,21	0,44	0,41	0,64	0,86	0,66	0,87	0,61	0,68	0,59
	1,1	0,64	0,58	0,82	0,10	0,13	0,17	0,14	0,32	0,20	0,25	0,20	0,44	0,40	0,66	0,87	0,68	0,88	0,63	0,70	0,61
	1,0	0,53	0,45	0,70	0,11	0,14	0,18	0,15	0,33	0,21	0,26	0,21	0,45	0,41	0,72	0,89	0,73	0,90	0,69	0,75	0,67
Triple thermal insulation glazing with argon filling, two coatings	0,8	0,60	0,50	0,72	0,10	0,11	0,17	0,12	0,31	0,19	0,25	0,18	0,43	0,38	0,68	0,89	0,70	0,90	0,65	0,72	0,63
	0,7	0,53	0,46	0,74	0,10	0,11	0,17	0,12	0,32	0,19	0,25	0,18	0,44	0,39	0,72	0,90	0,74	0,91	0,69	0,75	0,68
Double solar shading glazing with argon filling, one coating	1,3	0,48	0,44	0,59	0,13	0,19	0,21	0,20	0,36	0,25	0,28	0,26	0,46	0,44	0,74	0,89	0,75	0,90	0,72	0,76	0,70
	1,2	0,37	0,34	0,67	0,15	0,23	0,23	0,24	0,39	0,28	0,31	0,30	0,48	0,47	0,80	0,91	0,81	0,92	0,78	0,82	0,77
	1,2	0,25	0,21	0,40	0,20	0,34	0,30	0,35	0,47	0,37	0,37	0,41	0,53	0,56	0,86	0,93	0,87	0,93	0,85	0,87	0,84
	1,1	0,36	0,33	0,66	0,15	0,22	0,23	0,23	0,39	0,28	0,31	0,29	0,48	0,47	0,80	0,92	0,81	0,92	0,79	0,82	0,78
	1,1	0,27	0,24	0,50	0,18	0,29	0,27	0,30	0,44	0,34	0,35	0,37	0,51	0,52	0,85	0,93	0,86	0,93	0,84	0,86	0,83
Triple sun shading glazing with argon filling, two coatings	0,7	0,34	0,29	0,63	0,12	0,17	0,20	0,18	0,36	0,24	0,28	0,24	0,46	0,43	0,82	0,93	0,83	0,93	0,80	0,84	0,79
	0,7	0,24	0,21	0,45	0,15	0,23	0,24	0,24	0,41	0,29	0,32	0,31	0,49	0,48	0,87	0,94	0,88	0,95	0,86	0,88	0,85
	0,7	0,16	0,13	0,27	0,20	0,34	0,31	0,36	0,49	0,39	0,39	0,42	0,54	0,57	0,91	0,96	0,91	0,96	0,91	0,92	0,90
Double thermal insulation glazing with argon filling, one coating Switchable	1,1	0,41	0,36	0,55	F_{mind} = 0,49																
Triple thermal insulation glazing with argon filling, two coatings Switchable	0,7	0,36	0,31	0,51	HF_{mind} = 0,47																

[a] Assuming a clean surface and normal, untainted and non-scattering glazing.

Table NA.44 — — Movable shutter reduction factor, $f_{sht;with}$ (see subclause G.2.2.2.2)

Month	$f_{sht;with}$ [a]
1	0,39
2	0,39
3	0,42
4	0,46
5	0,44
6	0,46
7	0,00
8	0,00
9	0,44
10	0,43
11	0,39
12	0,38
Annually	0,4

[a] Values according to DIN V 18599-2:2016-10, Table G.3 (scenario 10 pm to 7 am).

Table NA.45 Movable solar shading reduction factor $f_{sh;with}$ (see subclause G.2.2.2.2) for manually or time-controlled solar shading

Inclination	Period	$f_{sh;with}$ [a]				
		North	NE/NW	East/West	SE/SW	South
Perpendi-cular 90°	Winter	0,00	0,00	0,34	0,63	0,71
	Summer	0,00	0,13	0,39	0,56	0,67
60°	Winter	0,00	0,01	0,36	0,63	0,69
	Summer	0,03	0,33	0,54	0,68	0,76
45°	Winter	0,00	0,02	0,34	0,59	0,66
	Summer	0,30	0,46	0,61	0,72	0,78
30°	Winter	0,00	0,05	0,32	0,53	0,60
	Summer	0,55	0,60	0,67	0,74	0,78
		All directions				
Horizontal 0°	Winter	0,24				
	Summer	0,74				

[a] Values according to DIN V 18599-2:2016-10, Table A.4 (scenario 10 pm to 7 am).
The summer covers the months April to September. The winter covers the months October to March.

Table NA.46 — Movable solar shading reduction factor $f_{sh;with}$ (see subclause G.2.2.2.2) for radiation-controlled solar shading

Inclination	Period	$f_{sh;with}$ [a]				
		North	NE/NW	East/West	SE/SW	South
Perpendi-cular 90°	Winter	0,00	0,03	0,45	0,71	0,77
	Summer	0,10	0,49	0,70	0,77	0,79
60°	Winter	0,00	0,05	0,48	0,70	0,75
	Summer	0,43	0,69	0,81	0,86	0,88
45°	Winter	0,01	0,08	0,47	0,67	0,72
	Summer	0,64	0,77	0,84	0,88	0,90
30°	Winter	0,05	0,14	0,45	0,62	0,67
	Summer	0,80	0,83	0,87	0,89	0,90
		All directions				
Horizontal 0°	Winter	0,42				
	Summer	0,89				

[a] Values according to DIN V 18599-2:2016-10, Table A.5 (scenario 10 pm to 7 am).
The summer covers the months April to September. The winter covers the months October to March.

Table NA.47 — Choices between options and methods for calculation of shading by external objects (see Clause F.1)

Application[b]	All applications			Not applicable		
Description	**Choice**			**Choice**		
Calculation of the effect of shading by distant objects included in this document?	Yes			n.a.		
When calculating solar shading on building elements: which types of distant shading objects (not on-site) may or shall be taken into account or ignored?	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
NOTE: For instance landscape (such as hills or dikes), vegetation (such as trees), other constructions (such as buildings)	Landscape (such as hills or dikes), other constructions (such as buildings)	Vegetation (such as trees)	—	n.a.	n.a.	n.a.
When calculating solar shading on opaque building elements such as roofs or facades: which types of on-site shading objects can or shall be ignored?	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
NOTE: For instance rebates, overhangs or other shading objects from the own building(s) on-site	—	—	Rebates, overhangs or other shading objects from the own building(s) on-site	n.a.	n.a.	n.a.

<table>
<tr><th>Application[b]</th><th colspan="3">All applications</th><th colspan="3">Not applicable</th></tr>
<tr><th>Description</th><th colspan="3">Choice</th><th colspan="3">Choice</th></tr>
<tr><td rowspan="2">When calculating solar shading on transparent building elements:
NOTE: For instance window rebates, overhangs and side fins</td><td>Shall be taken into account:</td><td>May be taken into account:</td><td>Shall be ignored:</td><td>Shall be taken into account:</td><td>May be taken into account:</td><td>Shall be ignored:</td></tr>
<tr><td>Window rebates, overhangs and side fins if depth larger than 20% of window height or width</td><td>Other window rebates, overhangs and side fins</td><td>—</td><td>n.a.</td><td>n.a.</td><td>n.a.</td></tr>
<tr><td>Specific subdivision rules for the calculation of solar shading on building elements</td><td colspan="3">none</td><td colspan="3">n.a.</td></tr>
<tr><td>Choice between the two methods for the solar shading calculation:</td><td colspan="3">Choice [a]</td><td colspan="3">Choice [a]</td></tr>
<tr><td>Method 1, Shading of direct radiation</td><td colspan="3">Yes</td><td colspan="3">n.a.</td></tr>
<tr><td>Method 2, Shading of direct and diffuse radiation</td><td colspan="3">No</td><td colspan="3">n.a.</td></tr>
<tr><td>In case of method 2: give reference to calculation procedure</td><td colspan="3">n.a.</td><td colspan="3">n.a.</td></tr>
<tr><td colspan="7">a Only one Yes per column possible.
b Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).</td></tr>
</table>

Table NA.48 — Parameters for monthly solar shading due to overhangs (see subclause F.3.5.1.2)

<table>
<tr><th colspan="2">Period:</th><td colspan="4">Summer: June to September</td></tr>
<tr><th colspan="2">Orientation</th><th rowspan="2">A_1</th><th rowspan="2">B_1</th><th rowspan="2">A_2</th><th rowspan="2">B_2</th></tr>
<tr><th>Northern hemisphere</th><th>Southern hemisphere</th></tr>
<tr><td>S</td><td>N</td><td>-3,023</td><td>0,045</td><td>1,285</td><td>-0,006</td></tr>
<tr><td>SE-SW</td><td>NE-NW</td><td>-1,255</td><td>0,015</td><td>0,905</td><td>-0,008</td></tr>
<tr><td>E-W</td><td>E-W</td><td>-0,684</td><td>0,005</td><td>0,610</td><td>-0,004</td></tr>
<tr><td>NE-NW</td><td>SE-SW</td><td>-0,654</td><td>0,006</td><td>0,616</td><td>-0,006</td></tr>
<tr><td>N</td><td>S</td><td>-0,726</td><td>0,007</td><td>0,616</td><td>-0,007</td></tr>
</table>

Table NA.49 — Parameters for monthly solar shading due to fins (see subclause F.3.5.1.2)

Period:		Summer: June to September			
Orientation		A_1	B_1	A_2	B_2
Northern hemisphere	Southern hemisphere				
S	N	-1,175	0,012	0,860	-0,008
SE-SW	NE-NW	-0,799	0,009	0,684	-0,006
E-W	E-W	0,118	-0,014	0,005	0,010
NE-NW	SE-SW	0,155	-0,041	-0,680	0,009
N	S	-0,275	0,133	-0,641	-0,039

Table NA.50 — Parameters for monthly solar shading by obstacles; more detailed method (see subclauses F.3.1.2 and F.3.5.2.2)

Location:	40° north latitude								
Period:	Winter: October to May								
Orientation	Weight $w_{obst;m;i}$ per sector				Solar altitude, $\alpha_{sol;m;i}$ per sector				Fraction direct solar irradiation $f_{sol;dir;m}$
	1	2	3	4	1	2	3	4	
N	0	0	0	0	—	—	—	—	0
NE	0	0	0	1,00	—	—	—	7,6	0,10
E	0	0	0,31	0,69	—	—	9,0	20,8	0,50
SE	0	0,14	0,58	0,28	—	9,2	22,2	24,0	0,70
S	0,06	0,40	0,47	0,07	9,4	22,8	22,6	9,7	0,75
SW	0,22	0,63	0,15	0	24,2	22,0	9,6	—	0,70
W	0,70	0,30	0	0	20,6	9,5	—	—	0,50
NW	1,00	0	0	0	8,7	—	—	—	0,10

Table NA.51 — Parameters for monthly solar shading by obstacles; more detailed method (see subclauses F.3.1.2 and F.3.5.2.2)

Location:	40° north latitude								
Period:	Summer: June to September								
Orientation	**Weight**, $w_{obst;m;i}$ **per sector**				**Solar altitude**, $\alpha_{sol;m;i}$ **per sector**				**Fraction direct solar irradiation** $f_{sol;dir;m}$
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	
N	0	0	0	1,00	—	—	—	17,4	0,10
NE	0	0	0,62	0,38	—	—	20,9	50,2	0,30
E	0	0,48	0,48	0,04	—	21,8	52,5	74,4	0,45
SE	0,33	0,53	0,10	0,03	23,2	54,0	74,4	74,4	0,55
S	0,30	0,20	0,21	0,29	60,5	74,4	74,4	60,7	0,50
SW	0,03	0,11	0,52	0,34	74,4	74,4	54,2	23,1	0,55
W	0,04	0,47	0,49	0	74,4	52,7	21,8	—	0,45
NW	0,37	0,63	0	0	50,3	20,9	—	—	0,30

National Annex NB
(informative)

Bibliography

DIN EN ISO 6946, *Building components and building elements — Thermal resistance and thermal transmittance — Calculation method*

DIN EN ISO 7345, *Thermal insulation — Physical quantities and definitions*

DIN EN ISO 9488, *Solar energy — Vocabulary*

DIN EN ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General*

DIN EN ISO 13370, *Thermal performance of buildings — Heat transfer via the ground — Calculation methods*

DIN EN ISO 13786, *Thermal performance of buildings — Dynamic thermal characteristics — Calculation methods*

DIN EN ISO 13789, *Thermal performance of buildings — Transmission and ventilation heat transfer coefficients — Calculation methods*

DIN EN ISO 13790, *Energy performance of buildings — Calculation of energy use for space heating and cooling*

DIN EN ISO 13791, *Thermal performance of buildings — Calculation of internal temperatures of a room in summer without mechanical cooling — General criteria and validation procedures*

DIN EN ISO 13792, *Thermal performance of buildings — Calculation of internal temperatures of a room in summer without mechanical cooling — Simplified methods*

DIN EN ISO 15927-2, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 2: Hourly data for design cooling load*

DIN EN ISO 15927-4, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 4: Hourly data for assessing the annual energy use for heating and cooling*

DIN EN ISO 15927-5, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 5: Data for design heat load for space heating*

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

DIN EN ISO 52010-1, *Energy performance of buildings — External climatic conditions — Part 1: Conversion of climatic data for energy calculations*

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

DIN EN ISO 52022-3, *Energy performance of buildings — Thermal, solar and daylight properties of building components and elements — Part 3: Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing*

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NORME EUROPÉENNE
EUROPÄISCHE NORM

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Supersedes EN 15255:2007, EN 15265:2007, EN ISO 13790:2008, EN ISO 13791:2012, EN ISO 13792:2012

English Version

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

Performance énergétiques des bâtiments - Besoins d'énergie pour le chauffage et le refroidissement, les températures intérieures et les chaleurs sensible et latente - Partie 1: Méthodes de calcul (ISO 52016-1:2017)

Energetische Bewertung von Gebäuden - Energiebedarf für Heizung und Kühlung, Innentemperaturen sowie fühlbare und latente Heizlasten - Teil 1: Berechnungsverfahren (ISO 52016-1:2017)

This European Standard was approved by CEN on 27 February 2017.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the CEN-CENELEC Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the CEN-CENELEC Management Centre has the same status as the official versions.

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EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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European foreword

This document (EN ISO 52016-1:2017) has been prepared by Technical Committee ISO/TC 163 "Thermal performance and energy use in the built environment" in collaboration with Technical Committee CEN/TC 89 “Thermal performance of buildings and building components” the secretariat of which is held by SIS.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by January 2018 and conflicting national standards shall be withdrawn at the latest by January 2018.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

This document is part of the set of standards on the energy performance of buildings (the set of EPB standards) and has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/480, see reference [EF1] below), and supports essential requirements of EU Directive 2010/31/EC on the energy performance of buildings (EPBD, [EF2]).

In case this standard is used in the context of national or regional legal requirements, mandatory choices may be given at national or regional level for such specific applications, in particular for the application within the context of EU Directives transposed into national legal requirements.

Further target groups are users of the voluntary common European Union certification scheme for the energy performance of non-residential buildings (EPBD art.11.9) and any other regional (e.g. Pan European) parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

This International Standard cancels and replaces EN ISO 13790 that was developed during the first EPBD mandate (M/343) and was published in 2008.

This document supersedes EN 15255:2007, EN 15265:2007, EN ISO 13790:2008, EN ISO 13791:2012, EN ISO 13792:2012.

According to the CEN-CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

References:

[EF1] Mandate M/480, Mandate to CEN, CENELEC and ETSI for the elaboration and adoption of standards for a methodology calculating the integrated energy performance of buildings and promoting the energy efficiency of buildings, in accordance with the terms set in the recast of the Directive on the energy performance of buildings (2010/31/EU) of 14th December 2010

[EF2] EPBD, Recast of the Directive on the energy performance of buildings (2010/31/EU) of 14th December 2010

[EF3] EN 15265:2007, Energy performance of buildings — Calculation of energy needs for space heating and cooling using dynamic methods — General criteria and validation procedures

[EF4] EN 15255:2007, Thermal performance of buildings Sensible room cooling load calculation - General criteria and validation procedures

Endorsement notice

The text of ISO 52016-1:2017 has been approved by CEN as EN ISO 52016-1:2017 without any modification.

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 collaboration 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

This document is part of a series aimed at the international harmonization of the methodology for assessing the energy performance of buildings. Throughout, this series is referred to as a “set of EPB standards”.

All EPB standards follow specific rules to ensure overall consistency, unambiguity and transparency.

All EPB standards provide a certain flexibility with regard to the methods, the required input data and references to other EPB standards, by the introduction of a normative template in Annex A and Annex B with informative default choices.

For the correct use of this document, a normative template is given in Annex A to specify these choices. Informative default choices are provided in Annex B.

The main target groups for this document are architects, engineers and regulators.

Use by or for regulators: In case the document is used in the context of national or regional legal requirements, mandatory choices may be given at national or regional level for such specific applications. These choices (either the informative default choices from Annex B or choices adapted to national/regional needs, but in any case following the template of Annex A) can be made available as national annex or as separate (e.g. legal) document (national data sheet).

NOTE 1 So in this case:

— the regulators will specify the choices;

— the individual user will apply the document to assess the energy performance of a building, and thereby use the choices made by the regulators.

Topics addressed in this document can be subject to public regulation. Public regulation on the same topics can override the default values in Annex B. Public regulation on the same topics can even, for certain applications, override the use of this document. Legal requirements and choices are in general not published in standards but in legal documents. In order to avoid double publications and difficult updating of double documents, a national annex may refer to the legal texts where national choices have been made by public authorities. Different national annexes or national data sheets are possible, for different applications.

It is expected, if the default values, choices and references to other EPB standards in Annex B are not followed due to national regulations, policy or traditions, that:

— national or regional authorities prepare data sheets containing the choices and national or regional values, according to the model in Annex A. In this case a national annex (e.g. NA) is recommended, containing a reference to these data sheets;

— or, by default, the national standards body will consider the possibility to add or include a national annex in agreement with the template of Annex A, in accordance to the legal documents that give national or regional values and choices.

Further target groups are parties wanting to motivate their assumptions by classifying the building energy performance for a dedicated building stock.

More information is provided in the Technical Report accompanying this document (ISO/TR 52016-2[1]).

The subset of EPB documents prepared under the responsibility of ISO/TC 163/SC 2 (*Thermal performance and energy use in the built environment, Calculation methods*) cover inter alia:

— calculation procedures on the overall energy use and energy performance of buildings;

— calculation procedures on the internal temperature in buildings (e.g. in case of no space heating or cooling);

— indicators for partial EPB requirements related to thermal energy balance and fabric features; and

— calculation methods covering the performance and thermal, hygrothermal, solar and visual characteristics of specific parts of the building and specific building elements and components, such as opaque envelope elements, ground floor, windows and facades.

ISO/TC 163/SC 2 cooperates with other TCs for the details on e.g. appliances, technical building systems and indoor environment.

This document presents a coherent set of calculation methods at different levels of detail, for the energy needs involved in the space heating and cooling and for (de-)humidification of a building and/or for the internal temperatures and (sensible or latent) heat loads, including the influence from technical buildings systems, control aspects and boundary conditions where relevant for the calculation.

The result of the design loads is also of possible use for the checking of the appropriate sizing of the equipment at the occasion of inspections.

References are made to other International Standards or to national documents for input data and detailed calculation procedures not provided by this document.

This document supersedes ISO 13790:2008. The main differences are:

— integration in the set of EPB standards, as specified in the overarching EPB standard (ISO 52000-1). Including removal of calculation elements that are covered or to be covered in other standards (for instance, the general rules for zoning (partitioning) of the building is now at overarching level (EPB module M1-8); the conditions of use are now assumed to be in a separate standard (module M1-6);

— major editorial changes based on the detailed technical rules for all EPB standards. Including moving all informative annexes to a separate accompanying Technical Report (ISO/TR 52016-2[1]);

— revision of the monthly calculation method and removal of the seasonal method;

— replacement of the simple hourly calculation method by a more direct and transparent method, with no need to add input data;

— integration of the calculation of the design heating and cooling load, including latent heat load, initially prepared as prEN 16798-11:2015 by CEN/TC 156.

Relevant editorial changes have been made based on the detailed technical rules for all EPB standards, including moving all informative annexes, if not covered elsewhere, to a separate accompanying Technical Report (ISO/TR 52016-2[1]).

Together with ISO 52017-1 this document also supersedes ISO 13791:2012[3] and ISO 13792:2012[4].

Table 1 shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1.

NOTE 2 In ISO/TR 52000-2[7] the same table can be found, with, for each module, the numbers of the relevant EPB standards and accompanying technical reports that are published or in preparation.

NOTE 3 The modules represent EPB standards, although one EPB standard could cover more than one module and one module could be covered by more than one EPB standard, for instance a simplified and a detailed method respectively. See also Clause 2 and Tables A.1 and B.1.

Table 1 — Position of this document (in casu M2-2, M2-3, M2-6, M3-3, M4-3, M6-3, M7-3), within the modular structure of the set of EPB standards

	Overarching		**Building (as such)**		**Technical Building Systems**									
Sub module	Descrip-tions		Descrip-tions		Descrip-tions	Heat-ing	Cool-ing	Venti-lation	Humid-ifica-tion	Dehu-midifi-cation	Do-mes-tic hot water	Light ing	Build ing auto mation and control	PV, wind, ..
sub1		M1		M2		M3	M4	M5	M6	M7	M8	M9	M10	M11
1	General		General		General									
2	Common terms and definitions; symbols, units and subscripts		Building energy needs	52016-1	Needs								a	
3	Applica-tions		(Free) Indoor conditions without systems	52016-1	Maximum load and power	52016-1	52016-1		52016-1	52016-1				
4	Ways to express energy per-formance		Ways to express energy per-formance		Ways to express energy per-formance									
5	Building catego-ries and building boundaries		Heat trans-fer by trans-mission		Emission and control									
6	Building occupan-cy and operating conditions		Heat trans-fer by infil-tration and ventilation	52016-1	Distribu-tion and control									
7	Aggregation of energy services and energy carriers		Internal heat gains		Storage and control									
8	Building zoning		Solar heat gains		Generation and control									
9	Calculated energy per-formance		Building dynamics (thermal mass)		Load dispatch-ing and operating conditions									
10	Measured energy per-formance		Measured energy per-formance		Measured energy per-formance									
11	Inspection		Inspection		Inspection									
12	Ways to express indoor comfort				BMS									
13	External en-vironment conditions													
14	Economic calculation													

NOTE The shaded modules are not applicable.

1 Scope

This document specifies calculation methods for the assessment of:

a) the (sensible) energy need for heating and cooling, based on hourly or monthly calculations;

b) the latent energy need for (de-)humidification, based on hourly or monthly calculations;

c) the internal temperature, based on hourly calculations;

d) the sensible heating and cooling load, based on hourly calculations;

e) the moisture and latent heat load for (de-)humidification, based on hourly calculations;

f) the design sensible heating or cooling load and design latent heat load using an hourly calculation interval;

g) the conditions of the supply air to provide the necessary humidification and dehumidification.

The calculation methods can be used for residential or non-residential buildings, or a part of it, referred to as "the building" or the "assessed object".

This document also contains specifications for the assessment of thermal zones in the building or in the part of a building. The calculations are performed per thermal zone. In the calculations, the thermal zones can be assumed to be thermally coupled or not.

The calculation methods have been developed for the calculation of the basic energy loads and needs, without interaction with specific technical building systems, and for the calculation of the system specific energy loads and needs, including the interaction with specific systems. The hourly calculation procedures can also be used as basis for calculations with more extensive system control options.

This document is applicable to buildings at the design stage, to new buildings after construction and to existing buildings in the use phase.

NOTE Table 1 in the Introduction shows the relative position of this document within the set of EPB standards in the context of the modular structure as set out in ISO 52000-1.

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 7345, *Thermal insulation — Physical quantities and definitions*

ISO 9050, *Glass in building — Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors*

ISO 10077-1, *Thermal performance of windows, doors and shutters — Calculation of thermal transmittance — Part 1: General*

ISO 10292, *Glass in building — Calculation of steady-state U values (thermal transmittance) of multiple glazing*

ISO 13789:2017, *Thermal performance of buildings — Transmission and ventilation heat transfer coefficients — Calculation method*

ISO 15099, *Thermal performance of windows, doors and shading devices — Detailed calculations*

ISO 15927-2, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 2: Hourly data for design cooling load*

ISO 15927-4, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 4: Hourly data for assessing the annual energy use for heating and cooling*

ISO 15927-5, *Hygrothermal performance of buildings — Calculation and presentation of climatic data — Part 5: Data for design heat load for space heating*

ISO 52000-1:2017, *Energy performance of buildings — Overarching EPB assessment – Part 1: General framework and procedures*

EN 410, *Glass in building — Determination of luminous and solar characteristics of glazing*

EN 673, *Glass in building — Determination of thermal transmittance (U value) — Calculation method*

EN 12831-1, *Energy performance of buildings - Method for calculation of the design heat load - Part 1: Space heating load, Module M3-3*

NOTE Default references to EPB standards other than ISO 52000-1 are identified by the EPB module code number and given in Annex A (normative template in Table A.1) and Annex B (informative default choice in Table B.1).

EXAMPLE EPB module code number: M5–5, or M5–5.1 (if module M5–5 is subdivided), or M5–5/1 (if reference to a specific clause of the standard covering M5–5).

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 7345, in ISO 52000-1 and the following apply.

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

3.1 Building

3.1.1
assessed object
building, part of a building or portfolio of buildings that is the object of the energy performance assessment

Note 1 to entry: The assessed object comprises all spaces and technical systems which may contribute to or influence the energy performance assessment.

Note 2 to entry: The assessed object may include one or several building units, if these are not individually object of the energy performance assessment.

Note 3 to entry: A distinction may be made between e.g. a designed building, new building after construction, existing building in the use phase and existing building after major renovation.

[SOURCE: ISO 52000-1:2017, 3.1.1]

3.1.2
building
construction as a whole, including the fabric and all technical building systems, where energy may be used to condition the indoor environment, to provide domestic hot water and illumination and other services related to the use of the building

Note 1 to entry: The term refers to the physical building as a whole or to all parts thereof that at least include the spaces and technical building systems that are relevant for the energy performance assessment.

Note 2 to entry: Parts of a building can be physically detached, but are on the same building site. For example: a canteen or a guard house or one or more classrooms of a school in a detached part of a building; or an essential space in a dwelling (e.g. bedroom).

[SOURCE: ISO 52000-1:2017, 3.1.2]

3.1.3
building category
unit category
classification of buildings and/or building units related to their main use or their special status, for the purpose of enabling differentiation of the energy performance assessment procedures and/or energy performance requirements

EXAMPLE Buildings officially protected as part of a designated environment or because of their special architectural or historical merit, buildings used as places of worship and for religious activities, residential buildings, (a) single-family houses of different types;(b) apartment blocks;(c) offices;(d) educational buildings;(e) hospitals;(f) hotels and restaurants;(g) sports facilities;(h) wholesale and retail trade services buildings;(i) data centers; (j) other types of energy-consuming buildings.

Note 1 to entry: Building regulation often make a distinction between building categories.

Note 2 to entry: The building category, for instance, may determine if energy performance assessment is mandatory (e.g. not for religious or historic buildings) and which are the minimum energy performance requirements (e.g. for new buildings); in some countries measured energy performance of a building is prescribed for specific categories of buildings (e.g. apartment buildings, large public buildings), etc. Another type of categorization is the distinction between new and existing and renovated buildings.

Note 3 to entry: Many buildings or building units of a given (use) category contain spaces of different (use) categories; for instance an office building may contain a restaurant; see 3.1.20 definition of space category.

Note 4 to entry: The allocation of a building category may also have a strong impact on other parts of the building regulations, for instance on safety (e.g. emergency exits, strength of floor) or indoor environmental quality (e.g. minimum ventilation rates)

[SOURCE: ISO 52000-1:2017, 3.1.3]

3.1.4
building element
integral component of the technical building systems or of the fabric of a building

[SOURCE: ISO 52000-1:2017, 3.1.4]

3.1.5
building fabric
all physical elements of a building, excluding technical building systems

EXAMPLE Roofs, walls, floors, doors, gates and internal partitions.

Note 1 to entry: It includes elements both inside and outside of the thermal envelope, including the thermal envelope itself.

Note 2 to entry: The fabric determines the thermal transmission, the thermal envelope airtightness and (nearly all of) the thermal mass of the building (apart from the thermal mass of furniture and technical building systems). The fabric also makes the building wind and water tight. The building fabric is sometimes described as the building as such, i.e. the building without any technical building system.

[SOURCE: ISO 52000-1:2017, 3.1.5]

3.1.6
building portfolio
set of buildings and common technical building systems whose energy performance is determined taking into account their mutual interactions

Note 1 to entry: An example of common equipment is an energy generation system (PV panels, wind turbine, cogen unit, boiler etc.) serving the building portfolio

[SOURCE: ISO 52000-1:2017, 3.1.6]

3.1.7
building thermal zone
thermal zone
internal environment with assumed sufficiently uniform thermal conditions to enable a thermal balance calculation according to the procedures in the standard under EPB module M2-2

Note 1 to entry: The EPB standard under module M2–2 is this document.

[SOURCE: ISO 52000-1:2017, 3.1.6, modified - Note 1 to entry modified to “this document”]

3.1.8
building unit
section, floor or apartment within a building which is designed or altered to be used separately from the rest of the building

EXAMPLE A shop in a shopping mall, an apartment in an apartment building or a rentable office space in an office building.

Note 1 to entry: The building unit can be the assessed object.

[SOURCE: ISO 52000-1:2017, 3.1.8]

3.1.9
conditioned space
room or enclosure that is covered by one or more of the EPB services

3.1.10
cooled space
room or enclosure, which for the purposes of a calculation is assumed to be cooled to a given temperature set-point or set-points

[SOURCE: ISO 52000-1:2017, 3.1.9]

3.1.11
elementary space
space
room, part of a room or group of adjacent rooms that belongs to one thermal zone and one service area of each service, used to administer the boundaries of the thermal zones and service areas and to administer the exchange of data between the service areas and thermal zones

[SOURCE: ISO 52000-1:2017, 3.1.10]

3.1.12
external dimension
dimension measured on the exterior of a building

Note 1 to entry: See ISO 13789:2017, Figure 1.

[SOURCE: ISO 13789:2017, 3.13]

3.1.13
heated space
room or enclosure, which for the purposes of a calculation is assumed to be heated to a given temperature set-point or set-points

[SOURCE: ISO 52000-1:2017, 3.1.11]

3.1.14
internal dimension
dimension measured from wall to wall and floor to ceiling inside a room of a building

Note 1 to entry: See ISO 13789:2017, Figure 1.

[SOURCE: ISO 13789:2017, 3.11]

3.1.15
overall internal dimension
dimension measured on the interior of a building, ignoring internal partitions

Note 1 to entry: See ISO 13789:2017, Figure 1.

[SOURCE: ISO 13789:2017, 3.12]

3.1.16
projected area of solar collecting elements
area of the projection of the surface of the element on to a plane parallel to the transparent or translucent part of the element

Note 1 to entry: In the case of non-flat elements, this refers to the area of the imaginary of the smallest plane connecting the perimeter of the element.

EXAMPLE Windows.

3.1.17
projected area of frame elements
area of the projection of the frame element on to a plane parallel to the glazing or panel that is held by the frame

EXAMPLE Window frames.

3.1.18
reference floor area
floor area used as a reference size

Note 1 to entry: See definition of reference size.

[SOURCE: ISO 52000-1:2017, 3.1.12]

3.1.19
reference size
relevant metric to normalize the overall or partial energy performance and energy performance requirements to the size of the building or part of a building and for the comparison against benchmarks

[SOURCE: ISO 52000-1:2017, 3.1.13]

3.1.20
space category
classification of building spaces related to a specific set of use conditions

EXAMPLE Office space, restaurant space, entrance hall, toilet, living space, assembly hall, shop, residential bed room, indoor car park, heated indoor stair case, unheated indoor stair case, etc.

Note 1 to entry: The space category is relevant for the calculation of the energy performance assessment and for defining the reference size.

[SOURCE: ISO 52000-1:2017, 3.1.14]

3.1.21
thermal envelope area
total area of all elements of a building that enclose thermally conditioned spaces through which thermal energy is transferred, directly or indirectly, to or from the external environment

Note 1 to entry: The thermal envelope area depends on whether internal, overall internal or external dimensions are being used.

Note 2 to entry: The thermal envelope area does not include the area to adjacent buildings; see ISO 13789.

Note 3 to entry: The thermal envelope area may play a role in the ways to express the overall and partial energy performance and energy performance requirements and comparison against benchmarks.

[SOURCE: ISO 13789:2017, 3.9, modified, Notes 2 and 3 to entry added]

3.1.22
thermally conditioned space
heated and/or cooled space

[SOURCE: ISO 52000-1:2017, 3.1.16]

3.1.23
thermally unconditioned space
room or enclosure that is not part of a thermally conditioned space

[SOURCE: ISO 52000-1:2017, 3.1.17]

3.1.26
useful floor area
<for EPB assessment> area of the floor of a building needed as parameter to quantify specific conditions of use that are expressed per unit of floor area and for the application of the simplifications and the zoning and (re-)allocation rules

[SOURCE: ISO 52000-1:2017, 3.1.18]

3.2 Indoor and outdoor conditions

3.2.1
condition of use
requirement and/or restriction for the use of a building space category, related to the services for the energy performance assessment and/or the boundary conditions

EXAMPLE Heating set-point, cooling set-point, minimum amount of ventilation related to air quality, net domestic hot water needs (e.g. per m^2 floor area or per person), lighting levels, internal heat gains, etc. ; including the distribution over time (operation). Where relevant, the numbers are based on the number of occupants per m^2 per type of building space.

[SOURCE: ISO 52000-1:2017, 3.2.1]

3.2.2
external temperature
temperature of outdoor air

[SOURCE: ISO 52000-1:2017, 3.2.3]

3.2.3
intermittent heating or cooling
heating or cooling pattern where normal heating or cooling periods alternate with periods of reduced or no heating or cooling

3.2.4
internal temperature
operative temperature
weighted average of the air temperature and the mean radiant temperature at the centre of the thermal zone

Note 1 to entry: Internal temperature is the approximate operative temperature according to ISO 7726.

Note 2 to entry: Operative temperature is the term used in this document.

Note 3 to entry: ISO 52017-1 uses a more generic definition.

[SOURCE: for internal temperature: ISO 52000-1:2017, 3.2.4, modified, Notes 2 and 3 to entry added]

3.2.5
internal air temperature
temperature of the air in the internal environment

3.2.6
mean radiant temperature
uniform surface temperature of the internal environment in which an occupant would exchange the same amount of radiant heat as in the actual non-uniform enclosure

3.2.7
set-back temperature
minimum internal temperature to be maintained during reduced heating periods, or maximum internal temperature to be maintained during reduced cooling periods

3.2.8
set-point (of the internal) temperature
internal (minimum intended) operative temperature for the calculation of the energy load or need for heating, or internal (maximum intended) temperature for the calculation of the energy load or need for cooling

Note 1 to entry: The values and duration (pattern) are specified in the standard under EPB module M1-6. For monthly and seasonal methods, the value of the set-point can include adjustment for intermittency, as specified in 6.6.11. For system-specific calculations the values may be adjusted due to system control features.

3.2.9
solar irradiance
power density of radiation incident on a surface, i.e. the quotient of the radiant flux incident on the surface and the area of that surface, or the rate at which radiant energy is incident on a surface, per unit area of that surface

[SOURCE: ISO 52000-1:2017, 3.2.6]

3.2.10
solar irradiation
incident solar heat per area over a given period

Note 1 to entry: Incident energy per unit area of a surface, found by integration of solar irradiance over a specified time interval, often an hour or a day (ISO 9488).

[SOURCE: ISO 52000-1:2017, 3.2.7]

3.3 Technical building systems

3.3.1
building service
service provided by the technical building systems and by appliances to provide the indoor environment conditions, domestic hot water, illumination levels and other services related to the use of the building

[SOURCE: ISO 52000-1:2017, 3.3.3] [N1)]

3.3.2
building service area (service area)
part of a building consisting of one or more elementary spaces served by a specific technical building system or sub-system

Note 1 to entry: Building service area for a specific heating system circuit, for a specific cooling system circuit, for a specific domestic hot water distribution system, for a specific ventilation system, for a specific air conditioning system, for a specific lighting (artificial light or daylight) configuration.

[SOURCE: ISO 52000-1:2017, 3.3.4]

3.3.3
other building service
service supplied by energy-consuming appliances

[SOURCE: ISO 52000-1:2017, 3.2.5]

3.3.4
recoverable system thermal loss
part of a system thermal loss which can be recovered to lower either the energy need for heating or cooling or the energy use of the heating or cooling system

Note 1 to entry: This depends on the calculation approach chosen to calculate the recovered gains and losses (detailed or simplified approach; see ISO 52000-1:2017, 11.3).

Note 2 to entry: In this document, if not directly taken into account as a reduction to the system losses, the recoverable system thermal losses are calculated as part of the internal heat gains. It may be decided at national level to report the recoverable system thermal losses separately from the other internal heat gains.

[SOURCE: ISO 52000-1:2017, 3.3.9; modified, Note 1 to entry editorially revised, Note 2 to entry added.]

3.3.5
recovered system thermal loss
part of a recoverable system thermal loss which has been recovered to lower either the energy need for heating or cooling or the energy use of the heating or cooling system

Note 1 to entry: This depends on the calculation approach chosen to calculate the recovered gains and losses (detailed or simplified approach; see ISO 52000-1:2017, 11.3).

[SOURCE: ISO 52000-1:2017, 3.3.10; modified, Note 1 to entry editorially revised]

N1) National footnote: In ISO 52000-1:2017, it reads "acceptable indoor environment conditions [...] [and] acceptable illumination levels".

3.3.6
system thermal loss
thermal loss from a technical building system for heating, cooling, domestic hot water, humidification, dehumidification or ventilation that does not contribute to the useful output of the system

Note 1 to entry: A system loss can become an internal heat gain for the building if it is recoverable.

Note 2 to entry: Thermal energy recovered directly in the sub-system is not considered as a system thermal loss but as heat recovery and directly treated in the related system standard under EPB module M3 to M8.

Note 3 to entry: Heat dissipated by the lighting system or by other services (e.g. appliances of computer equipment) is not part of the system thermal losses, but part of the internal heat gains.

[SOURCE: ISO 52000-1:2017, 3.3.11]

3.3.7
technical building sub-system
part of a technical building system that performs a specific function (e.g. heat generation, heat distribution, heat emission)

[SOURCE: ISO 52000-1:2017, 3.3.12]

3.3.8
technical building system
technical equipment for heating, cooling, ventilation, humidification, dehumidification, domestic hot water, lighting, building automation and control and electricity production

Note 1 to entry: A technical building system can refer to one or to several building services (e.g. heating, heating and domestic hot water).

Note 2 to entry: A technical building system is composed of different sub-systems.

Note 3 to entry: Electricity production can include cogeneration, wind power and photovoltaic systems.

[SOURCE: ISO 52000-1:2017, 3.3.13]

3.4 Energy

3.4.1
dehumidification
process of removing water vapour from air

[SOURCE: ISO 52000-1:2017, 3.4.5]

3.4.2
design load
maximum hourly mean value of the load, occurring during a design climate period under design use conditions

3.4.3
energy need for heating or cooling
heat to be delivered to, or extracted from, a thermally conditioned space to maintain the intended space temperature conditions during a given period of time

[SOURCE: ISO 52000-1:2017, 3.4.13]

3.4.4
energy need for humidification or dehumidification
latent heat in the water vapour to be delivered to or extracted from a thermally conditioned space by a technical building system to maintain a specified minimum or maximum humidity within the space

[SOURCE: ISO 52000-1:2017, 3.4.14]

3.4.5
energy use for lighting
electrical energy input to a lighting system

[SOURCE: ISO 52000-1:2017, 3.4.16]

3.4.6
energy use for other services
energy input to appliances providing services not included in the EPB services

Note 1 to entry: See definition of EPB services.

EXAMPLE Elevators, escalators, home appliances, TV, computers, etc. (if not covered under EPB services)

[SOURCE: ISO 52000-1:2017, 3.4.17]

3.4.7
energy use for space heating or cooling or domestic hot water
energy input to the heating, cooling or domestic hot water system to satisfy the energy need for heating, cooling (including dehumidification) or domestic hot water respectively

[SOURCE: ISO 52000-1:2017, 3.4.18]

3.4.8
energy use for ventilation
electric energy input to a ventilation system for air transport and heat recovery

[SOURCE: ISO 52000-1:2017, 3.4.19]

3.4.9
humidification
process of adding water vapour to air to increase humidity

[SOURCE: ISO 52000-1:2017, 3.4.22]

3.4.10
humidification or dehumidification moisture load
hourly mean value of the water vapour mass flow to be supplied to, or extracted from the internal environment to maintain a specified minimum or maximum humidity within the space

3.4.11
latent heating or cooling load
hourly mean value of the latent heat in the water vapour to be supplied to or extracted from the internal environment to maintain the intended space air moisture conditions

3.4.12
lighting
process of providing illumination

[SOURCE: ISO 52000-1:2017, 3.4.23]

3.4.13
(sensible) heating or cooling load
hourly mean value of the heating or cooling heat flow rate supplied to or extracted from the internal environment to maintain the intended space temperature conditions

3.4.14
space cooling
process of extracting heat from a building space with the aim of reaching and maintaining a given maximum space temperature

[SOURCE: ISO 52000-1:2017, 3.4.30]

3.4.15
space heating
process of heat supply to a building space with the aim of reaching and maintaining a given minimum space temperature

[SOURCE: ISO 52000-1:2017, 3.4.31]

3.4.16
ventilation
process of supplying or removing air by natural of mechanical means to or from a space or building

[SOURCE: ISO 52000-1:2017, 3.4.33]

3.4.17
ventilation-heat recovery
heat recovered from exhaust air to reduce the ventilation heat transfer

3.5 Energy performance

3.5.1
energy performance
overall energy performance
<of an assessed object> calculated or measured amount of (weighted) energy needed to meet the energy demand associated with a typical use of the assessed object, which includes energy used for specific services (EPB services)

Note 1 to entry: See definition of EPB services and definition of assessed object.

Note 2 to entry: Also called overall energy performance, to distinguish from partial energy performance.

[SOURCE: ISO 52000-1:2017, 3.5.7]

3.5.2
EPB service
building service included in the assessment of the energy performance

Note 1 to entry: See definition of building service. Which services are included is a national or regional choice, specified in ISO 52000-1:2017, Annexes A and B.

EXAMPLE Energy used for heating, cooling, ventilation, humidification, dehumidification, domestic hot water and lighting.

[SOURCE: ISO 52000-1:2017, 3.5.13]

3.5.3
EPB standard
standard that complies with the requirements given in ISO 52000-1, CEN/TS 16628[5] and CEN/TS 16629[6]

Note 1 to entry: These three basic EPB documents were developed under a mandate given to CEN by the European Commission and the European Free Trade Association (Mandate M/480), and support essential requirements of EU Directive 2010/31/EU on the energy performance of buildings (EPBD). Several EPB standards and related documents are developed or revised under the same mandate.

[SOURCE: ISO 52000-1:2017, 3.5.14]

3.6 Energy calculation

3.6.1
calculation period
period of time over which a calculation is performed

Note 1 to entry: The calculation period can be divided into a number of calculation intervals.

Note 2 to entry: The calculation period is usually a whole year for domestic hot water and ventilation, and a season for cooling and heating.

Note 3 to entry: The length of the calculation period [e.g. heating or cooling season] may be a result of the calculation or may be imposed for specific applications

[SOURCE: ISO 52000-1:2017, 3.6.4]

3.6.2
calculation interval
calculation time interval
discrete time interval for the calculation of the energy performance

EXAMPLE One hour, one month, one heating and/or cooling season, one year, operating modes and bins.

[SOURCE: ISO 52000-1:2017, 3.6.3; modified - alternative term added]

3.6.3
calculation with coupled zones
multi-zone calculation with thermal coupling between zones, taking into account any heat transfer by thermal transmission and/or by ventilation and/or by air infiltration between zones

3.6.4
calculation with uncoupled zones
multi-zone calculation without thermal coupling between zones, not taking into account any heat transfer by thermal transmission or by ventilation or by air infiltration between zones

3.6.5
gain utilization factor
factor reducing the total monthly heat gains in the monthly calculation method, to obtain the resulting reduction of the building energy need for heating

3.6.6
heat-balance ratio
monthly heat gains divided by the monthly heat transfer

3.6.7
heat gain
heat generated within, or entering into, the thermally conditioned space from heat sources other than energy intentionally utilized for heating, cooling or domestic hot water preparation

Note 1 to entry: Internal heat gains and solar heat gains. Sinks that extract heat from the building, are examples of heat gains, with a negative sign.

Note 2 to entry: For summer conditions heat gains with a positive sign constitute extra heat load on the space.

[SOURCE: ISO 52000-1:2017, 3.6.5]

3.6.8
heating or cooling season
period of the year during which a significant amount of energy for heating or cooling is needed

Note 1 to entry: The season lengths are used to determine the operation period of technical systems.

[SOURCE: ISO 52000-1:2017, 3.6.6]

3.6.9
heat transfer coefficient
heat flow rate divided by the temperature difference between two environments; specifically used for heat transfer coefficient by transmission or ventilation

Note 1 to entry: In contrast with a heat gain, the driving force for heat transfer is the difference between the temperature in the considered space and the temperature of the environment at the other side (in the case of transmission) or the supply air temperature (in the case of ventilation).

3.6.10
internal heat gain
heat provided within the building by occupants (sensible metabolic heat) and by appliances such as domestic appliances, office equipment, etc., other than energy intentionally provided for heating, cooling or hot water preparation

Note 1 to entry: In this document, if not directly taken into account as a reduction to the system thermal losses, the recoverable system thermal losses are included as part of the internal heat gains. It may be decided at national level to report the recoverable system thermal losses separately.

Note 2 to entry: Included are heat from (warm) or to (cold) process sources that are not controlled for the purpose of heating or cooling or domestic hot-water preparation. The heat extracted from the building, from the indoor environment to cold sources (sinks), is included as gain with a negative sign.

[SOURCE: ISO 52000-1:2017, 3.6.7; modified, Notes 1 and 2 to entry adapted]

3.6.11
loss utilization factor
factor reducing the total monthly heat transfer in the monthly calculation method, to obtain the resulting reduction of the energy need for cooling

Note 1 to entry: The traditional term “loss”, which originally referred to the heating mode only, is retained for the utilization factor for losses; if the losses are “negative”, there is no utilization.

3.6.12
solar heat gain
heat provided by solar radiation entering, directly or indirectly (after absorption in building elements), into the building through windows, opaque walls and roofs, or passive solar devices such as sunspaces, transparent insulation and solar walls

Note 1 to entry: Active solar devices such as solar collectors are considered as part of the technical building system.

[SOURCE: ISO 52000-1:2017, 3.6.10]

3.6.13
transmission heat transfer coefficient
heat flow rate due to thermal transmission through the fabric of a building, divided by the difference between the environment temperatures on either side of the construction

Note 1 to entry: By convention, the sign is positive if the heat flow is going out of the space considered (heat loss).

3.6.14
unoccupied period
period of several days or weeks without heating or cooling

EXAMPLE Due to holidays

3.6.15
useful heat gain
part of internal and solar heat gains that contribute to reducing the energy need for heating

[SOURCE: ISO 52000-1:2017, 3.6.11]

3.6.16
ventilation heat transfer coefficient
heat flow rate due to air entering an enclosed space, either by infiltration or ventilation, divided by the difference between the internal air temperature and the supply air temperature

Note 1 to entry: The sign of the coefficient is always positive. By convention, the sign of the heat flow is positive if the supply air temperature is lower than the internal air temperature (heat loss).

4 Symbols, subscripts and abbreviations

4.1 Symbols

For the purposes of this document, the symbols given in ISO 52000-1 and the following apply.

Symbol	Name of quantity	Unit
A	area	m^2
a_{sol}	solar absorption coefficient	—
a	numerical parameter in utilization factor	—
b	temperature reduction factor	—
C	heat capacity	J/K
c	specific heat capacity	J/(kg·K)
D	depth	m
d	thickness	m
F or f	factor, fraction	—
G	moisture flow	kg/s
g	total solar energy transmittance	—
H	height	m
H	heat transfer coefficient	W/K
H_{sol}	(accumulated, monthly) solar irradiation	kWh/m^2
h	surface coefficient of heat transfer	$W/(m^2·K)$
h	(partial) height	m
h	latent heat	J/kg
I_{sol}	solar irradiance	W/m^2
L, l	length	m
N	number of items (integer only)	—
Q	quantity of heat	kWh[a]
q	heat flow density	W/m^2
q_V	air volume flow rate	m^3/h
R	thermal resistance	$m^2·K/W$
S	space	
T	thermodynamic temperature	K
T	accumulated over- or undertemperature	K·h
t	time	s
U	thermal transmittance	$W/(m^2·K)$
V	volume	m^3
W	width	m
w	(partial) width	m

[a] Hours (h) are used as the unit of time instead of seconds when aggregating heat or energy flow (W) to quantity of heat or energy (kWh).

w	weighting factor	-
x	moisture content or mixing ratio	kg/kg dry air
Z	heat transfer parameter for solar walls	$W/(m^2·K)$
Z	zone	
α_{sol}	solar altitude angle	°
β	tilt angle	°
γ	azimuth angle	°
γ	heat-balance ratio	—
δ	(solar) declination	°
ε	long-wave emissivity of the surface	—
η	efficiency, utilization factor	—
θ	Celsius temperature	°C
φ	relative humidity	%
φ	latitude	°
φ_{sol}	solar azimuth angle	°
κ	areal heat capacity	$J/(m^2·K)$
ν	humidity by volume	kg/m^3
ρ	density	kg/m^3
σ	Stefan-Boltzmann constant	$W/(m^2·K^4)$
τ	time constant	s [a]
Φ	heat flow rate, heat load, power	W
Ψ	linear thermal transmittance	W/(m·K)

[a] Hours (h) are used as the unit of time instead of seconds when aggregating heat or energy flow (W) to quantity of heat or energy (kWh).

4.2 Subscripts

For the purposes of this document, the subscripts given in ISO 52000-1:2017, Clause 4, Annex C and the following apply.

NOTE Relevant subscripts already given in ISO 52000-1 are included if necessary for the understanding of this document.

Subscript	Term	Subscript	Term	Subscript	Term
a	air	ht	heat transfer	re	radiative external (~r;e)
A	appliances[a]	HVAC	heating, ventilation, air conditioning	red	reduced
adj	adjusted	i	internal	ri	radiative internal (~r;i)
ahu	air handling unit	i,j,k,z	indexes	s	surface
alt	altitude	int	internal or indoor[c]	se	surface external
an	annual	interm	intermittent	set	set-point
C	cooling[a]	iu	from thermally conditioned internal) to thermally unconditioned zone	sh	shading

[a] Type of energy use (energy service)

[b] The subscript “e” is used for the term “external”, in contrast with “internal”. But if there is a risk of confusion between “external” to (for instance) a construction in general and “external”, meaning outdoor environment, then the term “outdoor” is recommended for the latter.

[c] The subscript “int” is used for the term “internal”, in contrast with “external”. But if there is a risk of confusion between “internal” in a construction and “internal” in a building or thermal zone, then the term “indoor” is recommended for the latter.

Subscript	Term	Subscript	Term	Subscript	Term
c	structure, construction element	L	lighting[a]	sht	shutter
c	convection, convective	ld	load	sol	solar
calc	calculation	lim	limited	spec	specific
ce	convective external (~c;e)	lr	long-wave radiation	ss	subsystem
ci	convective internal (~c;i)	ls	loss	stc	thermally conditioned space
cont	continuous	m	monthly	sup	supply
cu	from thermally conditioned to thermally unconditioned zone	m	mass related conductance or capacitance	sys	system
cw	curtain walling	mn	mean	T	thermal[a]
d	door	n	normal to surface	t	time
day	daily	nd	need	tel	transparent element
DHU	dehumidification[a]	nlim	unlimited	tot	total
dif	diffuse	noc	unoccupied period	tr	transmission (heat transfer)
dir	direct	obst	obstacles	u	unconditioned
e	external or outdoor[b]	oc	occupants	UC	undersizing cooling system
eff	effective	occ	occupied period	ue	from unconditioned to external environment
el	element	oel	opaque element	UH	undersizing heating system
fin, finl, finr, fins	(side) fin (left, right, both)	OH	overheating	use	useful
fl	floor	op	operative	vi	virtual
fr	frame	op	opaque	ve	ventilation (heat transfer)
gr	ground	ovh	overhang	W	hot water (as energy service)[a]
gl	glazing, glazed element	pl	layer	w	window
gn	gains	proc	processes	we	water evaporation
H	heating[a]	p	projected	zt	thermal zone
h	hourly	pl	plane, layer	ztc	thermally conditioned zone
hru	heat recovery unit	r	radiation, radiative	ztu	thermally unconditioned zone
HU	humidification[a]				

[a] Type of energy use (energy service)

[b] The subscript “e” is used for the term “external”, in contrast with “internal”. But if there is a risk of confusion between “external” to (for instance) a construction in general and “external”, meaning outdoor environment, then the term “outdoor” is recommended for the latter.

[c] The subscript “int” is used for the term “internal”, in contrast with “external”. But if there is a risk of confusion between “internal” in a construction and “internal” in a building or thermal zone, then the term “indoor” is recommended for the latter.

NOTE In this document subscripts that are indexed (counting 1, 2, ...) can be found written in two ways:

— the comprehensive way: by adding an index (e.g. *i*) to the subscript, separated by a comma and written in italic. For instance “w,*i*”, for a variable related to a window, for window element *i*;

— the short way: as the subscript itself written in italic.

For instance: “*m*” is the monthly value of a variable, for the month *m*;

— this is short for “m,*i*”: the monthly value of a variable, for the month *i*.

Similarly, if there is no risk of confusion, it is also possible to write: "*wi*" instead of "w,*i*".

4.3 Abbreviations

For the purposes of this document, the abbreviations given in ISO 52000-1:2017, Clause 4 and Annex C and the following apply.

H	hourly calculation method
M	monthly calculation method
ZT	thermal zone

5 Description of the methods

5.1 Output of the method

This document covers the calculation of the energy need for heating and cooling and the internal temperature.

The method covers also the calculation of the design load for cooling, heating, humidification and dehumidification for a thermal zone and for a sub system.

For all calculations, the time interval is hourly.

Alternatively, for the calculation of the energy need for heating and cooling a monthly time interval can also be chosen.

Throughout this document, where indicated in the text, Table C.1 shall be used to identify alternative regional references in line with ISO Global Relevance Policy.

5.2 General description of the method

5.2.1 Hourly calculation procedures

The hourly calculation procedures in this document are derived from the reference calculation procedures as given in ISO 52017-1.

ISO 52017-1 provides a generic hourly calculation procedure, with only a minimum number of assumptions needed to define the energy balance equations, with no specific application, no specific solution technique and no specific input data.

The underlying document is an application of the method provided in ISO 52017-1. In function of the application, specific assumptions, simplifications, solution techniques and input data restrictions are provided in the underlying document.

NOTE 1 See ISO/TR 52016-2[1] for a more extensive explanation and justification.

With the hourly calculation method the thermal balance of the building or building thermal zone is made up at an hourly time interval.

The main goal of the hourly calculation method is to be able to take into account the influence of hourly and daily variations in weather, operation (solar blinds, thermostats, needs, occupation, accumulation, etc.) and their dynamic interactions for heating and cooling. The extra input for the user compared to the monthly calculation method is kept to a minimum.

In the hourly calculation method given in this document each construction element is modelled separately. This leads to transparency on the boundary conditions at either side of the constructions.

NOTE 2 For instance: heat transfer through the ground floor does not have to be lumped together with heat transfer through walls. Heat transfer through lightweight constructions does not have to be lumped together with heat transfer through heavy weight constructions. There is a clear distinction between air and mean radiation internal temperature, etc. These are important advantages compared to the simple hourly method in ISO 13790:2008.

The hourly climatic data are given in the relevant standard under EPB module M1-13 and the hourly and daily patterns of the conditions of use (operating schedules) are given in the relevant standard under EPB module M1-6. The hourly method produces also key monthly data that are essential for a quick understanding of the main processes involved and as a means to derive correction and adjustment factors for the monthly method.

The hourly calculation of the internal temperature, the energy need for heating and cooling and the calculation of the design heating and cooling load all use the same hourly internal temperature calculation. Although aim and outcome of these calculations are different, the calculation methods are identical and use the same inputs as far as possible.

Specific assumptions of the calculations may differ: for the calculation of design loads, the conditions of use and of climate of a design period apply.

For the calculation of design loads, distinction is made between a basic cooling/heating load calculation and a system specific cooling/heating load calculation.

For the basic cooling/heating load and energy need calculation, a continuous operation and no power restrictions for the cooling/heating system is assumed, and the emission is assumed to occur purely convective.

For the system specific cooling/heating load and energy need calculation, a limited operation time may be assumed, the available power of the system may be limited, the recoverable losses may be further specified and a convective fraction according to the system intended to be installed can be used.

5.2.2 Monthly calculation procedures

With the monthly calculation method the thermal balance of the building or building thermal zone is made up at a monthly time interval. The dynamic effects are taken into account by correction and adjustment factors.

These correction and adjustment factors can be developed on the basis of series of calculations using the hourly calculation procedures.

Because conditions of use and assumptions (e.g. on the amount of ventilation) may be different during days with heating needs and days with cooling needs, two independent calculations are done for each month: first the calculation of the energy need for heating, using the assumed conditions for heating and secondly the calculation of the energy need for cooling, using the assumed conditions for cooling.

NOTE 1 E.g. at national or regional level, to produce national or regional correction and adjustment factors replacing the informative default values from Annex B if needed.

NOTE 2 See more explanation, including justification and discussion of the limitations in the accompanying Technical Report, ISO/TR 52016-2[1].

5.2.3 Input data and assumptions for hourly and monthly method

The monthly calculation of the energy need for heating and cooling is based on the same assumptions and boundary conditions as the hourly calculation of the energy need for heating and cooling. Also the same inputs are used as far as possible, although averaged on monthly basis and where relevant corrected to approximate the impact of dynamic effects and dynamic interactions (e.g. recoverable heat or cold from the technical building systems, control actions) that are not covered by the monthly time interval.

However, some input data are specific for either the hourly or the monthly calculation method of the energy need for heating and cooling. These differences are distinguished in this document in the tabulated overview of 6.3.

5.2.4 Choices between methods

5.2.4.1 Choice between hourly and monthly calculation method

Table A.2 provides the normative template for the choice between the hourly or monthly calculation method, with an informative default choice in Table B.2.

5.2.4.2 Choice between basic or system specific load calculation

The basic cooling/heating load calculation is used, when no specifications of the system intended to be installed are known or in simple cases when the usability of the system intended to be installed shall be evaluated. Simple cases are air heating and cooling systems or standard convector heaters and coolers.

The system specific cooling/heating load calculation is used in cases where the type and design of the system is advanced and the effects of a specific operation shall be evaluated.

For some systems like building component embedded systems the use of a system specific method may be compulsory, since the use of a basic load calculation may be misleading.

On the other hand, a system specific calculation may lead to too optimistic calculation results with regard of the calculated energy use, if the system is undersized and not capable to provide the assumed standard conditions of use.

6 Calculation method

6.1 Output data

6.1.1 General data on the assessed object and application

This document contains choices between different methods, input data or references. Several of these choices depend on the type of objects and/or type of building, and/or type of application and/or type of assessment.

General data on the assessed object and application are listed in Table 2.

Table 2 — Output data of this method; general data on the assessed object

Description	Symbol	Intended destination module [b]	Comment [a]	See clause [b]
Number of thermal zones	$Z_{\text{th;i}}$	all	numbering of the thermal zones and which	H + M 6.4.2
List of spaces per thermal zone	$Z_{\text{th;i}} = S_k + S_l + S_m + \ldots$	all	by space numbers	H + M: 6.4.2

[a] Informative

[b] H: hourly calculation procedures, M: monthly calculation procedures

Other general data on the assessed object and application are listed as input in 6.3.2. These data may also be needed as output for subsequent calculations, for instance in relevant system standards under EPB modules M3 to M7.

6.1.2 Calculated data

The geometrical output data are listed in Table 3.

The output data from the calculations are listed in Tables 4 to 10.

When relevant, the output data are given per thermal zone.

When relevant, the total output for the assessed object is obtained by the sum of the values over all thermal zones.

When relevant, the average output for the assessed object (building or part of the building) is obtained by averaging the values for all thermal zones, weighted according to the subdivision and recombination rules for thermal zones, as specified in ISO 52000-1:2017, 10.5.

The calculation method comprises different options. Therefore not all the output data are available in each case.

Table 3 — Output data: geometrical data, per thermal zone

Description	Symbol	Unit	Validity interval[a]	Intended destination module[b]	Varying[c]	See clause[d]
Useful floor area per thermal zone	$A_{use;zt}$	m^2	0 to ∞	All	NO	H + M: 6.4.3
Air volume per thermal zone	$V_{int;a;zt}$	m^3	0 to ∞	All	NO	H + M: 6.4.3

[a] Practical range, informative

[b] Informative

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Be aware that the same variable as output can be the result of different assumptions (e.g. basic needs, system specific needs, absence of systems, design conditions, etc.

Table 4 — Output data: sensible heating and cooling loads and needs and internal temperatures

Description	Symbol	Unit	Validity interval[a]	Intended destination module[b]	Varying[c]	See clause[d]
Sensible energy need for heating, per thermally conditioned zone, per year	$Q_{H;nd;ztc;an}$	kWh	0 to ∞	M2-4, M3-4	Yes	H: 6.5.4.2 M: 6.6.4.2
Sensible energy need for cooling, per thermally conditioned zone, per year	$Q_{C;nd;ztc;an}$	kWh	0 to ∞	M2-4, M4-4	Yes	H: 6.5.4.2 M: 6.6.4.3
Sensible energy need for heating, per thermally conditioned zone, per month	$Q_{H;nd;ztc;m}$	kWh	0 to ∞	M3-5	Yes	H: 6.5.4.2 M: 6.6.4.2
Sensible energy need for cooling, per thermally conditioned zone, per month	$Q_{C;nd;ztc;m}$	kWh	0 to ∞	M4-5	Yes	H: 6.5.4.2 M: 6.6.4.3
Internal operative temperature, per thermally conditioned zone, per month	$\theta_{int;op;ztc;m}$	°C	0 to 50	M1-4, M3-5, M4-5, M5-5, M8-5, M3 to M8	Yes	H: 6.5.5.3 e M: 6.6.11.6
Internal temperature, per thermally unconditioned zone, per month	$\theta_{ztu;m}$	°C	-20 to 50	M3 to M8	Yes	H: 6.4.5.3 e M: 6.4.5.3
(Sensible) hourly heating load, per thermally conditioned zone, per hour	$\Phi_{H;ld;ztc;t}$	W	0 to ∞	M3-5	Yes	H: 6.5.5.2 M: n. a.
(Sensible) hourly cooling load, per thermally conditioned zone	$\Phi_{C;ld;ztc;t}$	W	0 to ∞	M4-5	Yes	H: 6.5.5.2 M: n. a.
Internal operative temperature, per thermally conditioned zone, per hour	$\theta_{int;op;ztc;t}$	°C	0 to 50	M1-4, M3-5, M4-5, M5-5, M8-5	Yes	H: 6.5.5.3 M: n. a.
Internal mean radiant temperature, per thermally conditioned zone, per hour	$\theta_{int;r;mn;ztc;t}$	°C	0 to 50	same	Yes	H: 6.5.5.3 M: n. a.
Indoor air temperature, per thermally conditioned zone, per hour	$\theta_{int;a;ztc;t}$	°C	0 to 50	same	Yes	H: 6.5.5.4 M: n. a.
Internal temperature, per thermally unconditioned zone, per hour	$\theta_{ztu;t}$	°C	-20 to 50	M3 to M8	Yes	H: 6.4.5.3 e M: n.a.

[a] Practical range, informative

[b] Informative

[c] "Varying": value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

e Average of hourly values

Table 5 — Output data: Latent energy loads and needs and internal moisture content

Description	Symbol	Unit	Validity interval[a]	Intended destination module[b]	Varying[c]	See clause[d]
Humidification needs, per thermally conditioned zone, per year	$Q_{HU;nd;zt;an}$	kWh	0 to ∞	M2-4, M6-4	Yes	H: 6.5.4.3 M: 6.6.14
Dehumidification needs, per thermally conditioned zone, per year	$Q_{DHU;nd;zt;an}$	kWh	0 to ∞	M2-4, M7-4	Yes	H: 6.5.4.3 M: 6.6.14
Humidification needs, per thermally conditioned zone, per month	$Q_{HU;nd;zt;m}$	kWh	0 to ∞	(M6-5)	Yes	H: 6.5.4.3 M: 6.6.14
Dehumidification needs, per thermally conditioned zone, per month	$Q_{DHU;nd;zt;m}$	kWh	0 to ∞	(M7-5)	Yes	H: 6.5.4.3 M: 6.6.14
Humidification moisture load, per thermally conditioned zone, per hour	$G_{HU;ld;ztc;t}$	kg/s	0 to ∞	M6-5	Yes	H: 6.5.14 M: n. a.
Dehumidification moisture (removal) load, per thermally conditioned zone, per hour	$G_{DHU;ld;ztc;t}$	kg/s	0 to ∞	M7-5	Yes	H: 6.5.14 M: n. a.
Latent heat load for humidification (humidification load) , per thermally conditioned zone, per hour	$\Phi_{HU;ld;zt;t}$	W	0 to ∞	M4-5 (combined with sensible heat load)	Yes	H: 6.5.14 M: n. a.
Latent heat load for dehumidification (dehumidification load) , per thermally conditioned zone, per hour	$\Phi_{DHU;ld;zt;t}$	W	0 to ∞	M4-5 (combined with sensible heat load)	Yes	H: 6.5.14 M: n. a.
Required moisture content for central humidification of the mechanical supply air, per thermally conditioned zone , per hour	$x_{a;sup;HU;req;ztc;t}$	kg/kg dry air	0 to 0,050	M5-6	Yes	H: 6.5.14 M: n. a.
Required moisture content for central dehumidification of the mechanical supply air , per thermally conditioned zone, per hour	$x_{a;sup;DHU;req;ztc;t}$	kg/kg dry air	0 to 0,050	M5-6	Yes	H: 6.5.14 M: n. a.
Indoor moisture content , per thermally conditioned zone, per hour	$x_{int;a;ztc;t}$	kg/kg dry air	0 to 0,050	M5-6	Yes	H: 6.5.14 M: n. a.

[a] Practical range, informative

[b] Informative

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 6 — Output data: dynamic control

Description	Symbol	Unit	Validity interval[a]	Intended destination module[b]	Varying[c]	See clause[d]
Dynamic control output						
Actual hourly on/off pattern window shutters over the year	..	-	..	-	Yes	H: Annex G
Actual hourly on/off pattern solar shading provisions over the year	..	-	..	M9	Yes	H: Annex G

[a] Practical range, informative

[b] Informative

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 7 — Output data: design (sensible and latent) heating and cooling load calculation

Description	Symbol	Unit	Validity interval[a]	Intended destination module[b]	Varying[c]	See clause[d]
Design sensible heating load, per year	$\Phi_{\text{H;ld;des;}ztc\text{;an}}$	W	0 to ∞	(M4)	Yes	H: 6.5.4.5 M: n. a.
Design sensible cooling load, per year	$\Phi_{\text{C;ld;des;}ztc\text{;an}}$	W	0 to ∞	(M5)	Yes	H: 6.5.4.5 M: n. a.
Design humidification moisture load, per year	$G_{\text{HU;ld;des;}ztc\text{;an}}$	kg/s	0 to ∞	(M6)	Yes	H: 6.5.4.5 M: n. a.
Design dehumidification moisture load, per year	$G_{\text{DHU;ld;des;}ztc\text{an}}$	kg/s	0 to ∞	(M7)	Yes	H: 6.5.4.5 M: n. a.
Design latent heat load for humidification, per year	$\Phi_{\text{HU;ld;des;}ztc\text{;an}}$	W	0 to ∞	(M6)	Yes	H: 6.5.4.5 M: n. a.
Design latent heat load for dehumidification, per year	$\Phi_{\text{DHU;ld;des;zt;anc}}$	W	0 to ∞	(M7)	Yes	H: 6.5.4.5 M: n. a.
Design increase of the supply air moisture content, compared to the moisture content of external air, for humidification, per year	$\Delta x_{\text{a;-sup;HU;ld;des;}z\text{-}tc\text{;an}}$	kg / kg dry air	0 to 20	(M6)	No	H: 6.5.4.5 M: n.a.
Design decrease of the supply air moisture content, compared to the moisture content of external air, for dehumidification, per year	$\Delta x_{\text{a;sup;D-HU;ld;des;}ztc\text{;an}}$	kg / kg dry air	0 to 20	(M7)	No	H: 6.5.4.5 M: n.a.

[a] Practical range, informative

[b] Informative

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 8 — Output data: Hourly calculation procedures, indicators for system undersizing

Description	Symbol	Unit	Validity interval[a]	Intended destination module[b]	Varying[c]	See clause[d]
Annual amount of undersizing of the heating system for different thresholds $\Phi_{UH;ld;thres,I}$	$Q_{UH;thres,i,ztc;an}$	kWh	0 to ∞	M1-4, M2-4	No	H: 6.5.15 M: 6.6.4.
Annual amount of undersizing of the cooling system for different thresholds $\Phi_{UC;ld;thres,I}$	$Q_{UC;thres,i,ztc;an}$	kWh	0 to ∞	M1-4, M2-4	No	H: 6.5.15 M: 6.6.4.
Annual accumulated undertemperature ("underheating") for different temperature differences $\Delta\theta_{UH;thres,i}$	$T_{UH;thres,i,ztc;an}$	K·h	0 to ∞	M1-4, M2-4	No	H: 6.5.15 M: 6.6.4
Annual accumulated overtemperature for different temperature differences $\Delta\theta_{OH;thres,i}$	$T_{OH;thres,i,ztc;an}$	K·h	0 to ∞	M1-4, M2-4	No	H: 6.5.15 M: 6.6.4

[a] Practical range, informative

[b] Informative

[c] "Varying": value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 9 — Output data: hourly calculation procedures, key monthly data

Description	Symbol	Unit	Validity interval[a]	Intended destination module[b]	Varying[c]	See clause[d]
Monthly heat balance ratio, heating	$\gamma_{H;gn;ztc;m}$	-	-∞ to ∞	(M2-2)	Yes	H: 6.5.15
Monthly heat balance ratio, cooling	$\gamma_{C;ht;ztc;m}$	-	-∞ to ∞	(M2-2)	Yes	H: 6.5.15
Monthly utilization factor, heating	$\eta_{H;gn;ztc;m}$	-	-1 to 1	(M2-2)	Yes	H: 6.5.15
Monthly utilization factor, cooling	$\eta_{C;ht;ztc;m}$	-	-1 to 1	(M2-2)	Yes	H: 6.5.15

[a] Practical range, informative

[b] Informative

[c] "Varying": value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

NOTE These output data are intended to be used for a quick understanding of the main processes involved and as a means to derive correction and adjustment factors for the monthly method

Table 10 — Output data: design loads per subsystem

Description	Symbol	Unit	Validity interval[a]	Intended destination module[b]	Varying[c]	See clause[d]
(annual) design sensible heating load in the subsystem	$\Phi_{H;ld;des;ss;an}$	W	0 to ∞	(M3-5)	Yes	H: 6.5.4.5 M: n. a.
(annual) design sensible cooling load in the subsystem	$\Phi_{C;ld;desint;a;ss;an}$	W	0 to ∞	(M4-5)	Yes	H: 6.5.4.5 M: n. a.

a Practical range, informative

b Informative

c “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

d H: hourly calculation procedures, M: monthly calculation procedures

6.2 Calculation time intervals and calculation period

The methods described in paragraph 6.5 are suitable for an hourly time interval. The methods described in 6.6 have a monthly time interval.

The calculation period is a full year, except for the application for peak indoor temperatures and design loads, which are calculated over a short representative period.

The length of the heating or cooling or (de-)humidification season is defined by the operation time of the respective technical systems. This has to be taken into account in the system specific calculations. It may differ from the time resulting from the basic energy needs calculation. See 6.5.2 and 6.6.2.

6.3 Input data

6.3.1 Source of data; general

In this document the input data is given for the calculation of the energy load and need for heating and cooling, the calculation of the internal temperature and the calculation of the design heating and cooling load.

This document comprises different options. Therefore not all the input data are necessary in each case.

The source of data for the calculation procedure in this document may depend on the (supposed) availability of input data. For instance, in case of existing buildings with limited information on the products and/or on the composition of building element assemblies, the level and type of input data might differ from new buildings. The selection which source applies may be done at national or regional level when the set of EPB standards is used in the context of national or regional building regulations. Where relevant, Annex A provides the template for the choices, values and references, with informative default choices, values and references in Annex B.

ISO 52000-1:2017, Clause 9, contains the rules for the distribution of heat flows in case of differences in the division of the various types of zones.

EXAMPLE From a thermal zone to the lighting zones and vice versa.

6.3.2 General data on the assessed object and application

This document contains choices between different methods, input data and/or references. Several of these choices depend on the type of object, type of building or space, type of application or type of assessment.

Consequently, for the correct use of this document and for the overall consistency of the energy performance assessment, the general data about the assessed object in Table 11, obtained from ISO 52000-1:2017, 6.3.2, are needed as input to this document:

Table 11 — General data on the assessed object and application

Description	Identifier	Unit	Source
Object type (more than one choice possible)	EPB_OBJECT_TYPE	n/a	ISO 52000-1
Building category	BLDNGCAT_TYPE	n/a	ISO 52000-1
Space category for each space or group of spaces (if different from building category)	SPACECAT_TYPE	n/a	ISO 52000-1
Application type	EPB_APPLIC_TYPE	n/a	ISO 52000-1
Assessment type	EPB_ASSESS_TYPE	n/a	ISO 52000-1
Calculation case	CASE_IDENTIFIER	n/a	ISO 52000-1

NOTE ISO 52000-1:2017, Tables A.2 to A.7 (normative template, with informative default lists in Tables B.2 to B.7) contain limited lists of possible types. These lists are respected in all subsequent EPB standards. National or regional lists can be specified in a national data sheet replacing Tables B.2 to B.7, in line with the template of ISO 52000-1:2017, Tables A.2 to A.7.

6.3.3 Geometrical characteristics

The required geometrical data are listed in Table 12.

Table 12 — Geometrical data list

Name	Symbol	Unit	Validity interval[a]	Origin[b]	Varying[c]	Calculation method[d]
Geometrical data						
Useful floor area per elementary space	$A_{\text{use};sp}$	m^2	0 to ∞	Local	No	H+M
Air volume per elementary space	$V_{\text{int;a};sp}$	m^3	0 to ∞	Local	No	H+M

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

The geometrical input data for building elements are listed as part of the thermophysical parameters in 6.3.4.

NOTE The chosen metric for the geometrical data (area, length) can have an effect on the thermophysical properties (per unit of area or length).

6.3.4 Thermophysical parameters of the building and building elements

The required technical data on the level of the thermal zones are listed in Table 13.

Table 14 contains the input data list related to the building elements.

Input data list related to external solar shading are listed in Table 15.

This document comprises different options. Therefore not all the data in these tables are necessary in each case.

NOTE 1 If data are a mix of thermophysical data and boundary conditions (such as the virtual ground temperature), they are also listed in these tables.

NOTE 2 When there is a choice, the default choice given in Annex B is used as basis.

Table 13 — Thermal zone related input data list

Name	Symbol	Unit	Validity interval[a]	Origin[b]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Value of areal thermal capacity of air and furniture per thermally conditioned zone	$\kappa_{m;int}$	J/(m²·K)	Identifier	Local or default (Table A.17)	No	H	-
Class of the internal heat capacity per thermally conditioned zone	-	-	Identifier	Local	No	M	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 14 — Building element related input data list

Name	Symbol	Unit	Validity interval[a]	Origin[b]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Hourly calculation procedures:							
Thermal resistance, per opaque building element	$R_{c;k}$	(m²·K)/W	0 to 10	M2-5.1	No	H	R_c
Effective thermal resistance, per building element in thermal contact with the ground, including slab-on-ground floors, suspended floors and basements (including the effect of the ground)	$R_{c;fl;eff;k}$	(m²·K)/W	0 to 10	M2-5.1	No	H	$R_{f;eff}$
Thermal resistance of a 0,5 m thick ground layer, per building element in thermal contact with the ground	$R_{gr;k}$	(m²·K)/W	0 to 10	M2-5.1	No	H	R_g
Thermal capacity of a 0,5 m thick ground layer, per building element in thermal contact with the ground	$\kappa_{gr;k}$	J/(m²·K)	≥ 0	M2-5.1	No	H	κ_g
Thermal resistance of a virtual ground layer, per building element in thermal contact with the ground	$R_{gr;vi;k}$	(m²·K)/W	0 to 10	M2-5.1	No	H	$R_{g;v}$

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 14 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Virtual ground temperature, per building element in thermal contact with the ground, per month	$\theta_{\text{gr;vi};k;m}$	°C	-50 to +50	M2-5.1	No	H	$\theta_{\text{g;ve};m}$
Convective heat transfer coefficient internal surface, per construction element	$h_{\text{ci};k}$	W/(m^2·K)	0 to 50	M2-5.1	No	H	h_{ci}
Long-wave radiative heat transfer coefficient internal surface, per construction element	$h_{\text{ri};k}$	W/(m^2·K)	0 to 50	M2-5.1	No	H	h_{ri}
Class for the distribution of the mass, per opaque building element	-	-	Identifier	Local	No	H	-
Class for the areal heat capacity, per opaque element	-	-	Identifier	Local	No	H	-
Monthly calculation procedures:							
Thermal transmittance, per opaque element	$U_{\text{c;op};k}$	W/(m^2·K)	0 to 10	M2-5.1	No	M	U_c
Ground transmission heat transfer coefficient for building elements in thermal contact with the ground, including slab-on-ground floors, suspended floors and basements, per thermal zone and month, based on the annual temperature difference	$H_{\text{gr;an};ztc;m}$	W/K	0 to ∞	M2-5.1	Yes	M	$H_{\text{g;an};m}$
Average overall heat transfer coefficient for transmission through the ground floor, adjusted for the seasonal temperature difference, for the heating season, per thermal zone	$H_{\text{gr;H;adj};ztc}$	W/K	0 to ∞	M2-5.1	No	M	$H_{\text{g;H;adj}}$
Average overall heat transfer coefficient for transmission through the ground floor, adjusted for the seasonal temperature difference, for the cooling season, per thermal zone	$H_{\text{gr;C;adj};ztc}$	W/K	0 to ∞	M2-5.1	No	M	$H_{\text{g;C;adj}}$
Hourly and monthly calculation procedures:							

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 14 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Area, per construction element; in case of protruded components also the projected area	$A_{\mathrm{el};k}$	m^2	0 to ∞	M2-5.1	No	H+M	A_e
Convective heat transfer coefficient external surface, per construction element	$h_{\mathrm{ce};k}$	$W/(m^2{\cdot}K)$	0 to 50	M2-5.1	No	H+M	h_{ce}
Long-wave radiative heat transfer coefficient external surface, per construction element	$h_{\mathrm{re};k}$	$W/(m^2{\cdot}K)$	0 to 50	M2-5.1	No	H+M	h_{re}
Thermal transmittance, per window	$U_{\mathrm{w};k}$	$W/(m^2{\cdot}K)$	0 to 10	M2-5.1	No	H+M	U_w
Thermal transmittance, per window with closed shutter	$U_{\mathrm{wsht};k}$	$W/(m^2{\cdot}K)$	0 to 10	M2-5.1	No	H+M	U_{ws}
Thermal transmittance, per door	$U_{\mathrm{d};k}$	$W/(m^2{\cdot}K)$	0 to 10	M2-5.1	No	H+M	U_d
Thermal transmittance, per curtain wall	$U_{\mathrm{cw};k}$	$W/(m^2{\cdot}K)$	0 to 10	M2-5.1	No	H+M	U_{cw}
Glazed area, per window element	$A_{\mathrm{gl};k}$	m^2	0 to ∞	M2-5.1	No	H+M	A_g
Linear thermal transmittance, per linear thermal bridge	$\Psi_{\mathrm{tb};k}$	W/(m·K)	0 to 10	M2-5.1	No	H+M	Ψ
Length, per linear thermal bridge	$l_{\mathrm{tb};k}$	m	0 to ∞	M2-5.1	No	H+M	l
Overall heat transfer coefficient for the thermal bridges, per thermal zone	$H_{\mathrm{tr;tb};zt}$	W/K	0 to ∞	M2-5.1	Yes	H+M	H_{tb}
Heat transfer coefficient between thermally conditioned zone and thermally unconditioned zone, per month	$H_{\mathrm{ztc},j;ztu;m}$	W/K	0 to ∞	M2-5.1	Yes	H+M	H_{iu}
Heat transfer coefficient between thermally unconditioned zone *ztu* and external environment, per month	$H_{\mathrm{ztu;e};m}$	W/K	0 to ∞	M2-5.1	Yes	H+M	H_{ue}
Heat transfer coefficient between thermally unconditioned zone *ztu* and external environment by transmission, per month	$H_{\mathrm{tr};ztu;e;m}$	W/K	0 to ∞	M2-5.1	Yes	H+M	$H_{\mathrm{tr;ue}}$
Tilt angle, per external building element (from horizontal, measured upwards facing)	$\beta_{\mathrm{ic};k}$	°	0 to 180	Local	No	H+M	

a Practical range, informative

b For instance EPB module or (e.g. product) standard or “local” (type, geometry)

c “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

d H: hourly calculation procedures, M: monthly calculation procedures

Table 14 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Orientation angle per external building element, (expressed as the geographical azimuth angle of the horizontal projection of the inclined surface normal; convention: angle from South, eastwards positive, westwards negative)	$\gamma_{\text{ic};k}$	°	-180 to +180	Local	No	H+M	
Class for the solar absorption coefficient of the external surface, per opaque element	$a_{\text{sol};k}$	-	0 to 1	Local or default (Table A.15 (H) or Table A.29 (M))	No	H+M	
Total solar energy transmittance at normal incidence, for the transparent part, per transparent building element with non-scattering glazing	$g_{\text{gl;n};k}$	-	0 to 1	M2-8 ([3] of Table C.1)	No	H+M	g_{n}
Total solar energy transmittance at 45 degrees (x=45) incidence and diffuse (x = dif) radiation, for the transparent part, per transparent building element with scattering glazing or blinds	$g_{\text{gl};x;k}$	-	0 to 1	M2-8 ISO 15099(or see Subject 4 in Table C.1)	No	H+M	g_{t}
Total solar energy transmittance including solar protection device of the transparent part, per transparent building element	$g_{\text{gl;sh};k}$	-	0 to 1	M2-8 ISO 52022-3 or ISO 15099(or see Subject 5 in Table C.1)	No	H+M	g_t
Calculation method based on thermally coupled thermal zones							
Heat transfer coefficient by transmission between zones *z* and *y*	$H_{\text{tr},zy}$	W/K	0 to ∞	M2-2	No	H+M	
Ventilation heat transfer coefficient from zone *z* to zone *y*	$H_{\text{ve},z\text{->}y}$	W/K	0 to ∞	M2-2	No	H+M	
Ventilation heat transfer coefficient from zone *y* to zone *z*	$H_{\text{ve},y\text{->}z}$	W/K	0 to ∞	M2-2	No	H+M	
Dynamic transparent building elements							
Thermal transmittance, per dynamic window or façade, per state	$U_{\text{dyn};k;i}$	W/(m²·K)	0 to 10	M2-5 (see Annex G)	Yes	H+M	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 14 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Total solar energy transmittance, per dynamic window or façade, per state *i*	$g_{dyn;k;i}$	-	0 to 1	M2-8 (see Annex G)	Yes	H+M	
Solar transmittance, per dynamic window or façade, per state	$\tau_{sol;\,dyn;k;i}$	-	0 to 1	M2-8 (see Annex G)	Yes	H+M	
Visual transmittance, per dynamic window or façade, per state	$\tau_{vis;\,dyn;k;i}$	-	0 to 1	M2-8 (see Annex G)	Yes	H+M	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

Table 15 — Input data list related to external solar shading

Name	Symbol	Unit	Validity interval[a]	Origin[b]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Latitude of the weather station	φ_w	°	-90 to +90	M1-13	No	M	
Base height, per shaded surface, from ground level	$H0_{;ic;k}$	m	≥ 0	Local	No	H+M	
Height, per shaded surface, from bottom to top; if tilted: vertical projection[e]	$H_{ic;k}$	m	> 0	Local	No	H+M	
Width, per shaded surface	$W_{ic;k}$	m	≥ 0	Local	No	H+M	
Tilt angle, per external building element (from horizontal, measured upwards facing) [e]	$\beta_{ic;k}$	°	0 to 180	Local	No	H+M	
Orientation angle per external building element, (expressed as the geographical azimuth angle of the horizontal projection of the inclined surface normal; convention: angle from South, eastwards positive, westwards negative) [e]	$\gamma_{ic;k}$	°	-180 to +180	Local	No	H+M	
Depth of a (simple) overhang (or similar shading object)	$D_{k;ovh,q}$	m	≥ 0	Local	No	H+M	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

[e] Could already have been covered as input data per (opaque or transparent) building element

Table 15 *(continued)*

Name	**Symbol**	**Unit**	**Validity interval**[a]	**Origin**[b]	**Varying**[c]	**Calculation method**[d]	**Symbol in origin (if different)**
Vertical distance between the edge of the façade element and a (simple) overhang (or similar shading object)	$L_{k;\text{ovh},q}$	m	≥ 0	Local	No	H+M	
Depth of a (simple) right side fin (or similar shading object)	$D_{k;\text{finr},r}$	m	≥ 0	Local	No	H+M	
Horizontal distance between the edge of the façade element and a (simple) right side fin (or similar shading object)	$L_{k;\text{finr},r}$	m	≥ 0	Local	No	H+M	
Depth of a (simple) left side fin (or similar shading object)	$D_{k;\text{finl},l}$	m	≥ 0	Local	No	H+M	
Horizontal distance between the edge of the façade element and a (simple) left side fin (or similar shading object)	$L_{k;\text{finl},l}$	m	≥ 0	Local	No	H+M	
Height from ground level, per shading obstacle in a skyline segment	$Hk;\text{obst};p;i$	m	≥ 0	Local	No	H+M	
Horizontal distance between the shaded surface *k* and the shading object (obstacle) in a skyline segment, per shading object, measured between their central points	$Lk;\text{obst};p;i$	m	≥ 0	Local	No	H+M	
Lowest height, from ground level, per shading overhang in a skyline segment, from ground level	$Hk;\text{ovh};q;i$	m	≥ 0	Local	No	H+M	
Horizontal distance between the shaded surface *k* and the overhang in a skyline segment, per shading object, measured between their central points	$Lk;\text{ovh};q;i$	m	≥ 0	Local	No	H+M	
Position, per skyline segment, indicated by the upper boundary of the geographical azimuth angle (convention: angle from South, eastwards positive, westwards negative)	$\gamma_{\text{sh;obst;max};i}$	°	-180 to + 180	Local	No	H+M	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

[e] Could already have been covered as input data per (opaque or transparent) building element

6.3.5 Operating and boundary conditions

Required operating and boundary conditions data for this calculation procedure are listed in Tables 16-19.

Specific adaptations may be needed in case of hourly calculation of the internal temperature under design summer conditions (see 6.5.4.4) or hourly calculation of design heating, cooling or latent heat loads (see 6.5.4.5).

This document comprises different options. Therefore not all the data in these tables are necessary in each case.

NOTE When there is a choice, the default choice given in Annex B is used as basis.

Table 16 — Input data related to conditions of use and technical building systems

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Hourly calculation procedures[e]:							
Temperature set-point for heating, per thermally conditioned zone, per hour, taking into account intermittent heating (day, night, weekend) and unoccupied periods, if applicable	$\theta_{int;set;H;ztc;t}$	°C	0 to 50	M1-6	Yes	H	
Temperature set-point for cooling, per thermally conditioned zone, per hour, taking into account intermittent cooling (e.g. weekend) and unoccupied periods, if applicable	$\theta_{int;set;C;ztc;t}$	°C	0 to 50	M1-6	Yes	H	
Available heating power, per thermally conditioned zone, per hour	$\Phi_{H;avail;ztc;t}$	W	0 to ∞	M3-1	Yes	H	
Available cooling power, per thermally conditioned zone, per hour	$\Phi_{C;avail;ztc;t}$	W	0 to ∞	M4-1	Yes	H	$Q_{C;out;zt,j}$
Convective fraction of the heating system per thermally conditioned zone (if system specific)	$f_{H,c\ ztc}$	-	0 to 1	(M3-5 or M3 system description) or default (Table A.11)	No	H	
Convective fraction of the cooling system per thermally conditioned zone (if system specific)	$f_{C,c\ ztc}$	-	0 to 1	(M4-5 or M4 system description) or default (Table A.11)	No	H	

a Practical range, informative

b For instance EPB module or (e.g. product) standard or “local” (type, geometry)

c “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

d H: hourly calculation procedures, M: monthly calculation procedures

e Some of the conditions of use can be adapted by system specific input

Table 16 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calcula-tion method[d]	Symbol in origin (if different)
Set-point relative humidity for humidification, per thermally conditioned zone, per hour	$\varphi_{\text{int;set;HU};ztc;t}$	%	0 to 100	M1-6	Yes	H	
Set-point relative humidity for dehumidification, per thermally conditioned zone, per hour	$\varphi_{\text{int;set;DHU};ztc;t}$	%	0 to 100	M1-6	Yes	H	
Volume flow rate for each air flow element *k* entering a thermal zone, per hour	$q_{\text{V,k;t}}$	m^3/s	0 to ∞	M5-5	Yes	H	$q_{\text{V;arg;in}}$ $q_{\text{V;comb;in}}$ $q_{\text{V;lea;in}}$ $q_{\text{V;pdu;in}}$ $q_{\text{V;vent;in}}$
Supply temperature for each ventilation system air flow element *k* entering a zone, per hour	$\theta_{\text{sup};k;t}$	°C	0 to 50	M5-5	Yes	H	
Supply air moisture content for air flow element *k* entering a thermal zone, per hour	$x_{\text{a;sup;k};t}$	kg/kg dry air	0 to 1	M5-5	Yes	H	
Actual system specific moisture content of the mechanical supply air entering a zone, in case of central (de-)humidification of the mechanical ventilation, per thermally conditioned zone, per hour	$x_{\text{a;sup;ss};zt;t}$	kg/kg dry air	0 to ∞	M5-6	Yes	H	
Actual system specific moisture supply by the local system for humidification, per thermally conditioned zone, per hour	$G_{\text{HU;ss};ztc;t}$	kg/s	0 to ∞	M6-5	Yes	H	
Actual system specific moisture removal by the local system for dehumidification, per thermally conditioned zone. per hour	$G_{\text{DHU;ss};ztc;t}$	kg/s	0 to ∞	M7-5	Yes	H	
Monthly calculation procedures[e]:							

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

[e] Some of the conditions of use can be adapted by system specific input

Table 16 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
The normal ('thermal comfort level') heating temperature set-point per thermally conditioned zone	$\theta_{\mathrm{int;set;H;}ztc}$	°C	0 to 50	M1-6	No	M	
The reduced ('economy level') heating temperature set-point of the zone (day, night and/or weekend)	$\theta_{\mathrm{int;set;H;low;}ztc}$	°C	0 to 50	M1-6	No	M	
The duration of the period with reduced heating set-point (day, night and/or weekend)	$\Delta t_{\mathrm{H;red;y;}ztc}$	h	0 to 48	M1-6	No	M	
The number of repetitions in a week of heating reduction period (day, night and/or weekend)	$n_{\mathrm{rep;H;red;y;}ztc}$	-	0 to 7	M1-6	No	M	
The normal ('thermal comfort level') cooling temperature set-point per thermally conditioned zone	$\theta_{\mathrm{int;set;C;}ztc}$	°C	0 to 50	M1-6	No	M	
The number of hours during the weekend with reduced temperature set-point for cooling or interruption	$\Delta t_{\mathrm{C;red;wknd;}ztc}$	-	0 to 48	M1-6	No	M	
The fraction of the month which is the unoccupied (heating/cooling) period	$f_{\mathrm{H/C;nocc;}ztc;m}$	-	0 to 1	Local	Yes	M	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or "local" (type, geometry)

[c] "Varying": value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

[e] Some of the conditions of use can be adapted by system specific input

Table 16 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Monthly time-average airflow rate of air flow element, *k* entering the thermal zone, for heating/cooling, for each month	$q_{V;k;H/C;m}$	m³/s	0 to ∞	M5-5	Yes	M	
Monthly mean supply temperature for each ventilation system air flow element, for heating/cooling, entering a zone, for each month	$\theta_{sup;k;H/C;m}$	°C	0 to 50	M5-2	Yes	M	
The fraction of sensible energy need to be added for dehumidification, per type of cooling system	$f_{DHU;C;ss}$	-	0 to 1	M7-5	No	M	

a Practical range, informative

b For instance EPB module or (e.g. product) standard or “local” (type, geometry)

c “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

d H: hourly calculation procedures, M: monthly calculation procedures

e Some of the conditions of use can be adapted by system specific input

Table 17 — Climatic input data

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Hourly calculation procedures:							
External (outdoor) air temperature at each hour	$\theta_{e;a;t}$	°C	-50 to +50	M1-13	Yes	H	θ_a
Moisture content or mixing ratio of the external air per hour	$x_{a;e;t}$	kg/kg dry air	0 to ∞	M1-13	Yes	H	x
Direct part (including circumsolar) of the solar irradiance, per building element, per hour	$I_{sol;dir;tot;k;t}$	W/m²	0 to ∞	M1-13	Yes	H	$I_{dir;tot}$

a Practical range, informative

b For instance EPB module or (e.g. product) standard or “local” (type, geometry)

c “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

d H: hourly calculation procedures, M: monthly calculation procedures

e Some of the conditions of use can be adapted by system specific input

Table 17 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Diffuse part (excluding circumsolar; including ground reflection) of the solar irradiance, per building element, per hour	$I_{sol;dif;tot;k;t}$	W/m^2	0 to ∞0 to ∞	M1-13	Yes	H	$I_{dif;tot}$
Solar altitude angle, from horizontal, per hour	$\alpha_{sol;t}$	°	0 to 90	M1-13	Yes	H	
Solar azimuth angle, per hour (Convention in this document: angle from South, eastwards positive, westwards negative)	$\varphi_{sol;t}$	°	-180 to +180	M1-13	Yes	H	
Monthly calculation procedures:							
Duration, per month	Δt_m	h	672 to 744	M1-13	Yes	M	-
Mean external (outdoor) air temperature, per month	$\theta_{e;a;m}$	°C	-50 to +50	M1-13	Yes	M	$\theta_{a;m}$
Mean external (outdoor) air temperature, per year	$\theta_{e;a;an}$	°C	-50 to +50	M1-13	No	M	$\theta_{a;an}$
Total solar irradiation per building element, per month	$H_{sol;k;m}$	kWh/m^2	0 to ∞	M1-13	Yes	M	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or “local” (type, geometry)

[c] “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

[e] Some of the conditions of use can be adapted by system specific input

Table 18 — Internal heat gains including recoverable heat losses and moisture production

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Hourly calculation procedures:							
Specific internal heat flow rate due to occupants, per thermal zone, per hour	$q_{\text{int;oc;}zt;t}$	W/m²	0 to ∞	M1-6	Yes	H	
Specific internal heat flow rate due to appliances, per thermal zone, per hour	$q_{\text{int;A;}zt;t}$	W/m²	0 to ∞	M1-6	Yes	H	
Specific internal heat flow rate due to lighting, per thermal zone, per hour	$q_{\text{int;L;}zt;t}$	W/m²	0 to ∞	M9-1	Yes	H	
Specific internal heat flow rate due to hot and mains water and sewage systems, per thermal zone, per hour	$q_{\text{int;WA;}zt;t}$	W/m²	0 to ∞	M3-1 and M8-1	Yes	H	Incl. in M3-1
Specific internal heat flow rate due to HVAC, per thermal zone, per hour	$q_{\text{int;HVAC;}zt;t}$	W/m²	0 to ∞	M3-1, M4-1 and M5-1	Yes	H	$Q_{\text{HZ;ls;rbl}}$ $Q_{\text{C;sto;ls;tot;rbl}}$ $Q_{\text{V;ls;dis;rbl;zt;i}}$ $Q_{\text{V;ls;gen;rbl}}$
Specific internal heat flow rate due to processes and goods, per thermal zone, per hour	$q_{\text{int;proc;}zt;t}$	W/m²	0 to ∞	M1-6	Yes	H	
Moisture production in the zone, per thermally conditioned zone, per hour	$G_{\text{int;}ztc;t}$	kg/s	0 to ∞	M1-6	Yes	H	
Monthly calculation procedures:							
Specific internal heat gain due to occupants, for heating/cooling, per thermal zone, per month	$Q_{\text{H/C;spec;int;oc;}zt;m}$	W/m²	0 to ∞	M1-6	Yes	M	
Specific internal heat gain due to appliances, for heating/cooling, per thermal zone, per month	$Q_{\text{H/C;spec;int;A;}zt;m}$	W/m²	0 to ∞	M1-6	Yes	M	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or "local" (type, geometry)

[c] "Varying": value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

[e] Some of the conditions of use can be adapted by system specific input

Table 18 *(continued)*

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Specific internal heat gain due to lighting, for heating/cooling, per thermal zone, per month	$Q_{H/C;spec;int;L;zt;m}$	W/m²	0 to ∞	M9-1	Yes	M	
Specific internal heat gain due to hot and mains water and sewage systems, for heating/cooling, per thermal zone, per month	$Q_{H/C;spec;int;WA;zt;m}$	W/m²	0 to ∞	M3-1 and M8-1	Yes	M	Incl. in M3-1
Specific internal heat gain due to HVAC, for heating/cooling, per thermal zone, per month	$Q_{H/C;spec;int;HVAC;zt;m}$	W/m²	0 to ∞	M3-1, M4-1 and M5-1	Yes	M	$Q_{HZ;ls;rbl}$ $Q_{C;sto;ls;tot;rbl}$ $Q_{V;ls;dis;rbl;zt;i}$ $Q_{V;ls;gen;rbl}$
Specific internal heat gain due to processes and goods, for heating/cooling , per thermal zone, per month	$Q_{H/C;spec;int;proc;zt;m}$	W/m²	0 to ∞	M1-6	Yes	M	

a Practical range, informative

b For instance EPB module or (e.g. product) standard or “local” (type, geometry)

c “Varying”: value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

d H: hourly calculation procedures, M: monthly calculation procedures

e Some of the conditions of use can be adapted by system specific input

Table 19 — Operating and boundary conditions related to dynamic building elements

Name	Symbol	Unit	Validity interval[a]	Origin[b,e]	Varying[c]	Calculation method[d]	Symbol in origin (if different)
Hourly calculation procedures:							
Criteria for switching of shutters	..	-	0 to 1	(M1-6, M10-1) or default (Table A.23)	Yes	H	
Criteria for switching of solar blinds	..	-	0 to 1	(M1-6, M10-1) or default (Table A.24)	Yes	H	

[a] Practical range, informative

[b] For instance EPB module or (e.g. product) standard or "local" (type, geometry)

[c] "Varying": value can vary over time: different values per time interval, for instance: hourly values or monthly values (not constant values over the year)

[d] H: hourly calculation procedures, M: monthly calculation procedures

[e] Some of the conditions of use can be adapted by system specific input

6.3.6 Constants and physical data

Constants and physical data are listed in Table 20.

Table 20 — Constants and physical data

Name	Symbol	Unit	Value	Calculation method[a]
Atmospheric pressure	p_{atm}	Pa	101 325	H+M
Specific heat of air at constant pressure	c_a	J/(kg·K)	1 006	H+M
Air density at 20 °C	ρ_a	kg/m³	1,204[b]	H+M
Latent heat of vaporization of water	h_{we}	J/kg	$2\,466 \times 10^3$	H+M
Stefan-Boltzmann constant	σ	W/(m²·K⁴)	$5{,}67 \times 10^{-8}$	H+M

Monthly mean solar declination, δ_m (degrees):

Month	Value (degrees)	Month	Value (degrees)
January	-20,8	July	21,1
February	-13,3	August	13,3
March	-2,4	September	2,0
April	9,5	October	-9,8
May	18,8	November	-19,1
June	23,1	December	-23,1

[a] H: hourly calculation procedures M: monthly calculation procedures

[b] The air density is adjusted for altitude h (in m) above sea level as follows:

$$\rho_a = \rho_{a;sea} \cdot \left(1 - \frac{0{,}00651 \cdot h}{288}\right)^{4{,}255}$$

The air density is by definition at 20 °C, to avoid a useless conversion to the density at the actual temperature of the air (flow); for the thermal balance it is the air mass (flow) that counts and not the volume (flow).

6.3.7 Input data from Annex A (Annex B)

Annex A contains the normative template for choices in references, methods and input data. Informative default choices in references, methods and input data are given in Annex B, respecting the template of Annex A.

All these choices and input data are indispensable for the application of this document.

6.4 Zoning of the assessed object

6.4.1 General

An overview of all relevant terms and basic rules for zoning, including thermal zones and service areas, is found in ISO 52000-1:2017, Clauses 3, 9 and 10.

For the calculations according to this document, the assessed object (building or part of a building) is considered either as a single thermal zone, or divided into more than one thermal zone. The procedures for the grouping and differentiation into thermal zones are given in 6.4.2.

The rules for zoning with respect to domestic hot water needs and technical building system related service areas are provided in the relevant system standards under EPB modules M3 – M9.

The thermal zoning may need to be adjusted in case of design load calculations, see 6.4.2.13.

NOTE The required zoning for design load calculations could not be the same as for the energy needs calculation. The multiple use of the input structure could, however, influence the zoning, e.g. by using a finer (room by room) zoning for the energy needs calculation, enabling a load calculation based on the same input.

The size of each thermal zone (useful floor area and air volume) is specified in 6.4.3.

In 6.4.4 the rules for the allocation of the amount of heat exchanged between a thermal zone and a system related service area are described.

The thermal balance of adjacent thermally unconditioned zones is as a rule modelled in a simplified way, see 6.4.5. There are two methods, depending whether the thermal transmission is calculated on the internal partition or on the external construction.

If a thermally unconditioned zone has a strong effect on the overall calculation, it can be considered in the calculation as a thermally conditioned zone with zero heating and cooling power. This leads to a more accurate assessment of the impact of the thermally unconditioned zone. See 6.4.2.3.

Finally, it is decided whether the thermally conditioned zones are calculated with or without thermal coupling. See 6.4.7.

6.4.2 Thermal zoning procedures

6.4.2.1 General

The zoning procedures in this document are given in this clause and cover the rules for the specification of thermal zones. These rules are in accordance with the general procedures described in ISO 52000-1:2017, Clause 10.

NOTE 1 These are essential for the understanding of the specification of thermal zones.

For the calculations according to this document, the assessed object (building or part of a building) is considered either as a single thermal zone, or divided into more than one thermal zone.

In a stepwise approach spaces are combined or split to form thermal zones. The stepwise approach enables to choose alternative procedures for one or more of the steps. The details of this stepwise approach are given in the next subclauses.

The following steps are distinguished:

1. For each space the space category is specified, taking into account the overall energy performance assessment procedures of ISO 52000-1:2017, Clause 9.
2. All adjacent spaces belonging to the same space category are grouped into one thermal zone.
3. In case of large openings between spaces, the spaces are combined into one thermal zone.
4. A thermal zone is split in such a way that a thermal zone contains only spaces that share the same combination of relevant services.
5. Adjacent thermally conditioned zones may be combined if the thermal conditions of use are the same or similar.
6. In case of system specific calculations (see 6.5.4.1 and 6.6.4.1), a thermal zone may need to be split up, due to rules (if any) in the relevant system standards, aiming at certain homogeneity in the system or subsystem within a thermal zone.
7. A thermal zone is to be split in such a way that a thermal zone is to some degree homogeneous in the thermal balance. The criteria are more stringent if cooling is involved.
8. Adjacent thermally unconditioned zones may be combined.
9. A small thermal zone may be (re-)combined with an adjacent thermal zone if it has the same set of services, but different conditions of use.
10. A very small thermal zone may be (re-)combined with an adjacent thermal zone even if it has a different set of services.

NOTE 2 See ISO/TR 52016-2[1] for a more extensive explanation and justification.

At each step, a choice is allowed for an alternative method. The procedure is described in 6.4.2.12.

6.4.2.2 Zoning step 1: Assessment of space categories

For each space, the space category is specified, taking into account the procedures in ISO 52000-1:2017, Clause 9.

Certain thermally unconditioned spaces may, for reasons of simplicity, be assumed to have the same conditions of use as the adjacent thermally conditioned spaces and then joined.

EXAMPLE Attic, staircase, atrium, and garage. See extensive discussion in ISO/TR 52000-2[7].

The choice whether these thermally unconditioned spaces are assumed to have the same conditions of use as the adjacent thermally conditioned spaces may have a very strong impact on the calculated energy performance.

Also, the choice whether the size of these spaces, such as the useful floor area, reference floor area or reference volume, is included in the size of the building may have a very strong impact on the numerical indicator for the energy performance.

NOTE 1 Consistency is needed between these successive choices. The rationale behind and some of the consequences of these choices are presented in ISO/TR 52000-2 [7].

Such a choice may also depend on the national legal infrastructure and building tradition,

It is not feasible to choose on the basis of the construction that forms the main thermal barrier: the internal or external construction of the thermally unconditioned space or spaces.

NOTE 2 A decision based purely on these physical data is not evident, especially when air infiltration, glazing, thermal bridges and / or ground floor areas are involved: a detailed assessment of the thermal transmission and ventilation heat transfer properties could be difficult and not efficient.

For some types of spaces it can be legally mandatory to consider these as within the thermal envelope (e.g. a bedroom) or (for other types of spaces) outside the thermal envelope (e.g. a garage or gasoline storage).

Spaces that are always to be regarded as thermally unconditioned:

— spaces that are ventilated highly (such as: car garage, indoor car park). A highly ventilated space is defined as a space with a permanent ventilation capacity of at least 3 dm^3/s per m^2 of useful floor area of that space; and

— spaces with opening to outside air that are large. A large opening in a space to the outdoor air is defined as one or more permanent openings with a total area of at least 0,003 m^2 per m^2 of useful floor area of that space.

6.4.2.3 Zoning step 2: Grouping according to space category

A space category is characterized by a specific set of conditions of use. Therefore, initially, all adjacent spaces belonging to the same space category are grouped into one thermal zone.

Thermally unconditioned spaces, adjacent to thermally conditioned spaces, are as a rule modelled in a simplified way, see 6.4.5. However, if a thermally unconditioned zone has a strong effect on the overall calculation, it can be considered as a thermally conditioned zone (with zero heating and cooling power).

Thermally unconditioned spaces that are completely surrounded by other spaces inside the thermal envelope are assumed to be of the same category as the adjacent space. In case of more than one adjacent category, the category with the largest floor area is selected.

6.4.2.4 Zoning step 3: Grouping in case of large openings in between

In case of permanent large openings between two spaces, the spaces are combined into one thermal zone. Doors that are likely to remain open frequently are considered as permanent large openings. A large opening in a space to a space or spaces inside the thermal envelope is defined as one or more permanent openings with a total area of at least 0,003 m^2 per m^2 of useful floor area of that space.

If the thermal conditions of use differ between the spaces, the most stringent conditions apply, unless the simplifications of Step 9 or Step 10 apply in this case.

The thermal conditions of use are in this respect the minimum and maximum temperature and/or moisture settings and the period(s) of the settings, such as the number of hours per day and days per week.

NOTE See ISO/TR 52016-2 [1] for more explanations and justifications.

6.4.2.5 Zoning step 4: Split to have same combination of services

A thermal zone is split in such a way that a thermal zone contains only spaces that share the same combination of the relevant services: heating only, cooling only, cooling and dehumidification, or heating plus cooling, etc. It may be checked if the simplifications given in Step 9 or Step 10 apply.

NOTE If the principle of “assumed system” according to ISO 52000-1:2017, Table A.19, Table B.19 is followed for both heating and cooling, then this step is redundant, because in that case the services needed to fulfil the required conditions of use for the given space category are assumed to be present in any case. See ISO/TR 52016-2 [1] for an explanation.

6.4.2.6 Zoning step 5: Further grouping according to similar thermal conditions of use

If the conditions for the simplifications according to Step 9 or according to Step 10 are met, then these simplifications are applied first.

NOTE Because these are easier to check.

Otherwise the following applies:

The thermal conditions of use are defined as the minimum and maximum temperature and/or moisture settings and the period(s) of the settings, such as the number of hours per day and days per week.

Adjacent thermally conditioned zones may be combined if the thermal conditions of use are the same.

Adjacent thermally conditioned zones may also be combined if the thermal conditions of use are similar; which is considered to be the case if the following conditions apply:

— the difference in temperature settings for heating and (if applicable) is less than 4 K and the difference in minimum and maximum moisture content settings (if applicable) is less than 0,2 kg/kg(dry air); and

— the daily operation periods do not differ more than three hours.

NOTE The last condition implies, for instance, that grouping is not allowed if one thermal zone is operated during the weekend and the other is not.

In this case, the weighted mean values for the thermal conditions apply. The weighting is done according to the allocation rules given in ISO 52000-1 for the subdivision of thermal zones.

Adjacent thermally conditioned zones may also be combined if the rule applies for the spatial averaging of set-point for residential buildings as described in 6.4.6.

6.4.2.7 Zoning step 6: Split according to specific system or subsystem properties

In case of system specific calculations (taking into account specific heating, cooling, ventilation or (de-)humidification system properties), a thermal zone may need to be split up, due to rules (if any) in the relevant system standards, aiming at certain homogeneity in the system or subsystem within a thermal zone.

If the conditions for the simplifications according to Step 9 or according to Step 10 are met, then these simplifications are applied first.

NOTE Because these are easier to check.

Otherwise the following applies:

The procedures for this step have to be found in the relevant system standards under the EPB modules M3-1 to M7-1.

6.4.2.8 Zoning step 7: (Further) split to have sufficient homogeneity in thermal balance

A thermal zone is to be split in such a way that a thermal zone is to some degree homogeneous in the thermal balance. The criteria are more stringent if cooling is involved.

NOTE 1 See ISO/TR 52016-2[1] for explanations and justifications.

If the conditions for the simplifications according to Step 9 or according to Step 10 are met, then these simplifications are applied first.

NOTE 2 Because these are easier to check.

Otherwise the following applies:

For each of the following criteria two different sections of the thermal zone are considered, covering each at least 25 % of the useful floor area of the considered zone.

It would be counterproductive to perform detailed calculations to assess if these criteria are met. Therefore, it is sufficient to roughly estimate the properties mentioned as criteria below.

The thermal zone has to be split if:

— between the two sections the monthly mean internal gains (including recoverable system losses) plus solar gains in a representative cold month are estimated to differ more than a factor three. This does not apply if the average value is below 15 W per m^2 useful floor area.

NOTE 3 See ISO/TR 52016-2 [1] for explanations and justifications.

In addition, if the calculation involves the calculation of cooling needs or loads or indoor temperature calculation, the thermal zone has to be split if:

— between the two sections the internal effective heat capacity (monthly method) or area weighted average thermal capacity of the constructions (hourly method) are estimated to differ more than two classes according to Table 21 in 6.6.9; or

— between the two sections the monthly mean internal gains, including recoverable system losses, plus solar gains in a representative warm month are estimated to differ more than a factor three. This does not apply if the average value is below 30 W per m^2 useful floor area.

NOTE 4 See ISO/TR 52016-2 [1] for explanations and justifications.

6.4.2.9 Zoning step 8: (Further) grouping of thermally unconditioned zones

Adjacent thermally unconditioned zones may be combined into one thermally unconditioned zone.

6.4.2.10 Zoning step 9: Simplification in case of small thermal zones

A thermal zone may be (re-)combined with an adjacent thermal zone if it has the same combination of services (see Step 4), but different thermal conditions of use (compare Step 5) or different thermal balance properties (compare Step 7), provided that it has a useful floor area of less than 5 % of the total useful floor area of the assessed object.

In that case the thermal conditions of use of the adjacent thermal zone apply.

6.4.2.11 Zoning step 10: Simplification in case of very small thermal zones

A thermal zone may be (re-)combined with an adjacent thermal zone, even if it has a different combination of services (compare Step 4), provided that it has a useful floor area of less than 1 % of the total useful floor area of the assessed object.

In that case the combination of services and thermal conditions of use of the adjacent thermal zone apply. In case of more than one adjacent thermal zone, the combination of services and thermal conditions of use are adopted from the adjacent zone with the most similar services and / or most similar conditions of use.

6.4.2.12 Alternative method

At each step described above, a choice is allowed for an alternative method. Table A.3 provides the normative template for the choice of alternative methods and input data, with informative default choices and input data in Table B.3.

NOTE The alternative method can also consist of an amendment of the described method.

6.4.2.13 Adapted thermal zoning for design load calculations

The thermal zones used for a cooling or heating load calculation shall be specified on the basis of the intended system design. The load calculation shall support the dimensioning of the equipment. Multiple emission elements in a thermal zone or repetitive system design may not require a zoning to the level of the equipment.

NOTE See the explanation and justification in ISO/TR 52016-2:2017 [1] in 6.4.2.1.

6.4.3 Size of the thermal zones and thermal envelope

The useful floor area of each thermal zone, $A_{use;zt}$, is equal to the sum of the useful floor area of each of its spaces, as determined in ISO 52000-1.

The volume of the air of each thermal zone, $V_{int;a;zt}$ is equal to the sum of the volume of the air of each of its spaces, as determined in ISO 52000-1.

6.4.4 Heat exchange between thermal zones and service areas

If heat is exchanged between a thermal zone and a system related service area, the assignment rules given in ISO 52000-1:2017, 10.5 apply.

NOTE See the explanation in ISO/TR 52016-2 [1].

6.4.5 Adjacent thermally unconditioned zones

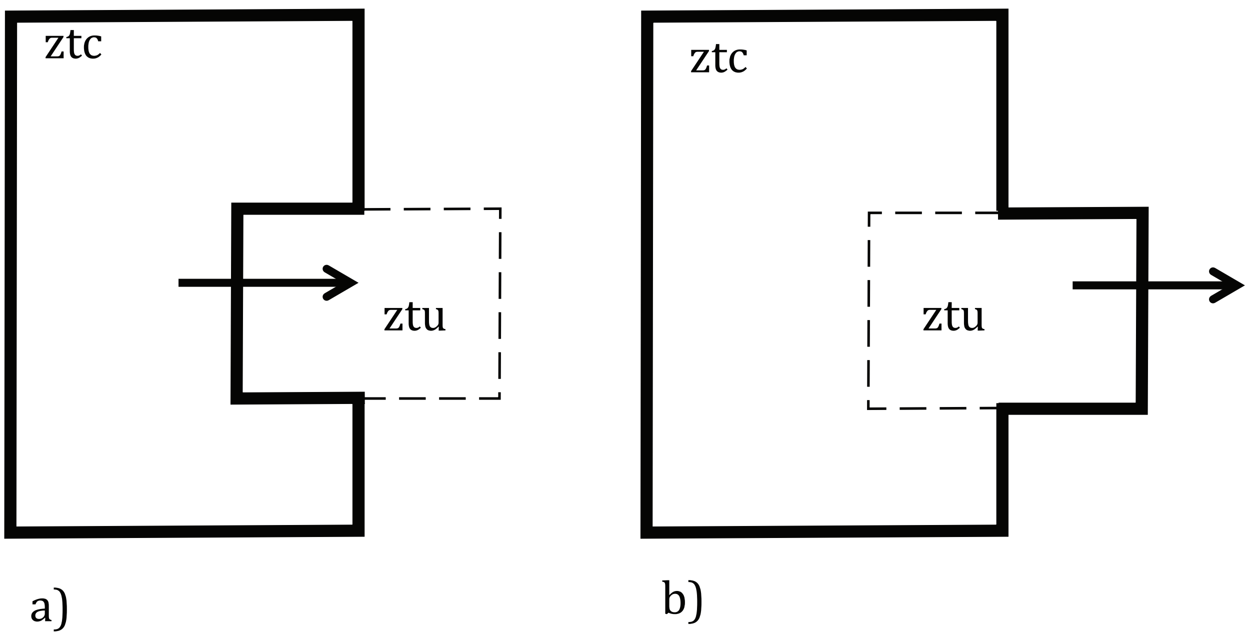
6.4.5.1 Two types

Two types of thermally unconditioned zones are distinguished, with respect to the assessment of the thermal transmission properties and the corresponding adjustment of the heat transfer through and the gains in the thermally unconditioned zone:

— **External unconditioned zone (ztue):** the internal partition is taken as the boundary for the thermal transmission.

— **Internal unconditioned zone (ztui):** the external partition is taken as the boundary for the thermal transmission.

NOTE 1 See illustration in Figure 1. A more detailed overview of the differences and similarities in treatment of heat transfer and heat gains in case of the two types (external and internal thermally unconditioned zones), both for the hourly and the monthly calculation method, is given in ISO/TR 52016-2 [1].



Key

a) External thermally unconditioned zone (ztue)

b) Internal thermally unconditioned zone (ztui)

Figure 1 — External versus internal thermally unconditioned zones

An external unconditioned zone, ztue, is the default type.

An internal unconditioned zone, ztui, is applicable in case of situations where:

— the thermal properties and geometry of the external construction elements can be determined more accurately than the properties of the internal construction elements; and

— the internal and solar gains in the adjacent space are not dominating.

NOTE 2 Consequently, the internal thermally unconditioned zone type is not suitable for sunspaces or atria. See the explanation in ISO/TR 52016-2 [1].

If the internal thermally unconditioned zone type is applied, care shall be taken not to include the size of the thermally unconditioned zone in the reference size and/or useful floor area of the thermally conditioned space, unless this is explicitly instructed.

Table A.4 provides the normative template for the options and values, with informative default choice and values in Table B.4.

The choice may have an impact on the assessment of the thermal envelope area according to the relevant standard under EPB module M2-5.1.

6.4.5.2 Calculation procedures

An adjustment factor is needed to take into account the effect of a thermally unconditioned zone, adjacent to a thermally conditioned zone. In case of more than one thermally conditioned zone there is also the need for a distribution factor.

Different methods are given to take into account the effect of a thermally unconditioned zone on the heat transfer by transmission and ventilation and the gains.

Alternatively, default values for the adjustment and distribution factor may be available, as described in 6.4.5.5.

The calculation procedures for the adjustment and distribution factor are given in 6.4.5.4.

Calculation procedures for the heat gains in thermally unconditioned zones with internal or solar gains are given in E.3 of Annex E.

6.4.5.3 Calculated temperature in an adjacent thermally unconditioned zone as output variable

The temperature in the thermally unconditioned zone is needed as output variable, e.g. to assess heat losses from heat or cold generators, storage and distribution systems (pipes and ducts) located in thermally unconditioned space or spaces.

NOTE 1 For simplicity, no distinction is made between air or operative temperature.

For the **hourly calculation method**:

The hourly temperature in an external type (as defined in 6.4.5.1) of thermally unconditioned zone *k*, $\theta_{\text{ztu},k;t}$, in °C, is given in 6.5.9. The temperature includes the effect of internal and solar heat gains (for instance in case of a sunspace or atrium).

The hourly temperature in an internal type (as defined in 6.4.5.1) of thermally unconditioned zone *k*, $\theta_{\text{ztu},k;\text{t}}$, in °C, is equal to the operative temperature of the adjacent thermally conditioned zone *j*, $\theta_{\text{int;op;ztc},j;m}$, as determined in 6.5.5. The temperature is excluding the effect of internal or solar gains. These (if any) are attributed to the adjacent thermally conditioned zone(s).

For the **monthly calculation method**:

The monthly mean temperature in an external or an internal thermally unconditioned zone k, $\theta_{\text{ztu},k;\text{m}}$, in °C, is given by:

$$\theta_{\text{ztu},k;\text{H/C};m} = \theta_{\text{e;a};m} + b_{\text{ztu},k;m} \cdot \left(\theta_{\text{calc;H/C;ztc},j;m} - \theta_{\text{e;a};m}\right) \quad (1)$$

where, for each month m

$b_{\text{ztu},k;m}$ is the adjustment factor for the thermally unconditioned adjacent zone k, in month m, as determined in 6.4.5.4;

$\theta_{\text{calc;H/C;ztc},j;m}$ is the calculation temperature of the adjacent thermally conditioned zone j for heating/cooling, as determined in 6.6.11, in °C;

in case of multiple adjacent thermally conditioned zones, the temperatures are weighted according to the distribution factor for the heat transfer between the thermally conditioned zone *ztcj* and the thermally unconditioned zone k, $F_{\text{ztc},j;\text{ztu},k;m}$, as determined in 6.4.5.4;

$\theta_{\text{e;a};m}$ is the monthly mean (air) temperature of the external environment, obtained from the relevant standard under EPB module M1-13, in °C.

The temperature of the thermally unconditioned zone is excluding the effect of internal or solar gains. These (if any) are attributed to the adjacent thermally conditioned zone(s).

If, in the relevant system standard using this temperature as an input, no distinction can be made between heating and cooling mode, the temperature for heating and cooling mode shall be weighted for on a monthly basis, according to the heating and cooling need.

6.4.5.4 Adjustment and distribution factor

For the hourly and for the monthly calculation method the adjustment factor for the thermally unconditioned zone in month m, $b_{\text{ztu},k;m}$, is given by:

$$b_{ztu;m} = \frac{H_{ztu;\text{e};m}}{H_{ztu;\text{tot};m}} \quad (2)$$

$$H_{ztu;\text{tot};m} = \sum_j \left(H_{\text{ztc},j;ztu;m}\right) + H_{ztu;\text{e};m} \quad (3)$$

The distribution factor in case of multiple adjacent thermally conditioned zones is given by:

If more than one adjacent thermally conditioned zones, ztc,j:

$$F_{\text{ztc},i;ztu;m} = \frac{H_{\text{ztc},i;ztu;m}}{\sum_j \left(H_{\text{ztc},j;ztu;m}\right)} \quad (4)$$

If only one adjacent thermally conditioned zone *ztc*:

$$F_{ztc;ztu;m} = 1 \quad (5)$$

where

$F_{\mathrm{ztc},i;ztu;m}$ is the distribution factor for the heat transfer between the thermally conditioned zone *i* and the adjacent thermally unconditioned zone *ztu,* for month *m*;

$b_{ztu;m}$ is the adjustment factor for the thermally unconditioned adjacent zone *ztu*, in month *m*;

$H_{ztu;\mathrm{e};m}$ is the heat transfer coefficient between the thermally unconditioned zone *ztu* and the external environment for month *m*, determined in accordance with ISO 13789:2017, 7.5, (determination of H_{ue}) in W/K;

$H_{ztu;\mathrm{tot};m}$ is the sum of the heat transfer coefficients between the thermally unconditioned zone *ztu*, the adjacent thermally conditioned zone(-s) and the external environment for month *m*, in W/K;

$H_{\mathrm{ztc},j;ztu;m}$ is the heat transfer coefficient between the thermally conditioned zone ztc,*j* and the thermally unconditioned zone *ztu* for month *m*, determined in accordance with ISO 13789:2017, 7.5, (determination of H_{iu}) in W/K;

ztc,*j* is the index for any thermally conditioned zone adjacent to the thermally unconditioned zone *ztu*.

NOTE 1 The procedure to calculate the adjustment factor is equal to the procedure in ISO 13789:2017, 7.5, but expanded with the possibility of multiple adjacent thermally conditioned zones. The values will normally be constant over the year, but in some cases the values may be variable, in which case monthly (mean) values can be introduced. A too refined calculation is usually not justified, because it concerns only an adjustment.

In Table A.5 (normative template), with informative default choice in Table B.5 a choice is given to link the value of the heat transfer coefficient by ventilation through the external partition ($H_{\mathrm{ue;ve}\ k;m}$) to the value of the heat transfer by transmission ($H_{\mathrm{ue;tr}k;m}$), for the thermally unconditioned zone *k*, in month *m*, which results in the following formula, replacing the Formula in ISO 13789:2017, 7.5:

$$H_{\mathrm{ztu;e};k;m} = \left(1 + c_{\mathrm{ztu;ve}}\right) \cdot H_{\mathrm{tr;ue};k;m} \tag{6}$$

where, for a thermally unconditioned zone *k*, in month *m*

$H_{\mathrm{ztu;e};k;m}$ is the heat transfer coefficient between the thermally unconditioned zone and the external environment, in W/K.

$H_{\mathrm{tr;ue}\ k;m}$ is the heat transfer coefficient between the thermally unconditioned zone and the external environment by transmission, determined in accordance with ISO 13789:2017, 7.5, (determination of H_{ue}) in W/K;

$c_{\mathrm{ztu;ve}}$ is the coefficient to express the default contribution of ventilation in the heat transfer coefficient through the external partition, as determined in Table A.5 (normative template), with informative default value in Table B.5.

NOTE 2 The ventilation rate through the external partition is often much larger than the ventilation rate through the internal partition. See explanation in ISO/TR 52016-2[1].

Alternatively, the default values of 6.4.5.5 may apply.

6.4.5.5 Default adjustment and distribution factor values

Default values for the adjustment factor, $b_{\mathrm{ztu},k;m}$ and the distribution factor, $F_{\mathrm{tcz,zt;ztu},k;m}$, may be used, if available, for instance as function of the type and/or size of the adjacent thermally unconditioned space, as determined in Table A.4 (normative template), with informative default values in Table B.4 presented in 6.4.5.1.

6.4.6 Residential buildings or building units, adjustment for spatial average temperature

For residential buildings or building units where parts of the building are predominantly thermally unconditioned (e.g. master and/or spare bedrooms, study, attic: the “moderately conditioned” spaces), the temperature set-point for heating shall be adjusted. There are three options to adjust the temperature set-point.

Which of the options is applicable is provided in Table A.6 (normative template), with informative default choice provided in Table B.6.

Option A (single zone, no adjustment):

For hourly and monthly calculation method.

When the residential building or building unit is calculated as a single zone, *ztc*:

the temperature set-point for the whole building or building unit calculated as single zone *ztc*, is equal to the temperature set-point for the thermally full conditioned spaces.

Option B (single zone, adjustment):

For hourly and monthly calculation method.

When the residential building or building unit is calculated as a single zone, *ztc*:

the adjusted temperature set-point for the whole building or building unit calculated as single zone *ztc*, is equal to the temperature set-point for the thermally full conditioned spaces, decreased with $\Delta\theta_{\text{int;set;H,}m}$:

$$\Delta\theta_{\text{int;set;H;ztc;m}} = \frac{\left(f_{\text{mod;t}}\ f_{\text{mod;sp}}\right) \times \left(f_{\text{mod;sp}}\ H_{\text{H;e;spec;ztc;m}}\right) \times \left(\theta_{\text{int;set;H;stc}} - \theta_{\text{e;a;m}}\right)}{\left(f_{\text{mod;sp}} \times H_{\text{H;e;spec;ztc;m}}\right) + H_{\text{H;int;spec}}} \quad (7)$$

where, for the building or building unit as single zone, *ztc*, in month *m*

$H_{\text{H;e;spec;}ztc;m}$ is the specific heat transfer coefficient by transmission and ventilation in month *m*, in W/(m²·K) determined according to:

$$H_{\text{H;e;spec;}ztc;m} = \frac{H_{\text{H;tr;}ztc;m} + H_{\text{H;ve;}ztc;m}}{A_{\text{use;}ztc}} \quad (8)$$

and

$H_{\text{H;tr;}ztc;m}$ is the overall heat transfer coefficient by transmission, in W/K;

$H_{\text{H;ve;}ztc;m}$ is the overall heat transfer coefficient by ventilation, in W/K;

$A_{\text{use;}ztc}$ is the useful floor area, as determined in 6.4.3 in m²;

$f_{\text{mod;t}}$ is the assumed (fixed) dimensionless fraction in time that the moderately conditioned part (on average) is operated at moderate comfort level instead of at full comfort level, as determined in Table A.6 (normative template), with informative default value provided in Table B.6;

$f_{\text{mod;sp}}$ is the assumed (fixed) dimensionless space fraction of the moderately conditioned part in the building, with the value provided in Table A.6 (normative template), with informative default value provided in Table B.6

$H_{H;int;spec}$ is the assumed (fixed) overall internal heat transfer coefficient per m^2 of useful floor area in W/(m^2·K), with the value provided in Table A.6 (normative template), with informative default value provided in Table B.6;

$\theta_{int;set;H;stc}$ is the temperature set-point for the thermally full conditioned space or spaces, determined in accordance with 6.5.5 (hourly method) or 6.6.11 (monthly method), in °C;

$\theta_{e;a;m}$ is the monthly mean external air temperature, obtained from the relevant standard under EPB module M1-13, in °C.

NOTE 1 The fixed values will lead to a rough approximation. See explanation and examples in ISO/TR 52016-2[1].

For cooling, the temperature set-point of the whole building or building unit calculated as single zone *ztc*, is assumed to be equal to the temperature set-point for the thermally conditioned spaces.

NOTE 2 For cooling this is a conservative approach. See explanation and justification in ISO/TR 52016-2[1].

Option C (thermally uncoupled zones):

For hourly and monthly calculation method.

Calculation in different thermally uncoupled zones. In this option the internal heat exchange by thermal transmission and ventilation and air circulation between the zones is ignored.

NOTE 3 The internal thermal coupling by transmission and ventilation/air circulation is usually (much) larger than the external thermal coupling.

Option D (thermally coupled zones):

Only for hourly calculation method:

When the residential building is calculated as two or more thermally coupled zones (see 6.4.7 and Annex D): thermally full conditioned zone(s) and thermally partly conditioned zone(s). The temperature set-points in the thermally full and partly conditioned zones shall be obtained from the relevant standard under EPB module M1-6.

6.4.7 Thermally coupled or uncoupled zones

A calculation in case of multiple thermally conditioned zones, can be done with or without thermal coupling between the zones.

The choice is given in Table A.7 (normative template) and Table B.7 (informative default choice).

Default thermal coupling characteristics (transmission and ventilation/air circulation) are given in Table A.8 (normative template) and Table B.8 (informative default quantities and values).

A multi-zone calculation with interactions between the zones requires significantly more and often arbitrary input data (on transmission properties and air flow direction and size) and may lead to other technical and procedural complications that add uncertainties to the quality of the results. Therefore, the benefits may be smaller than the drawbacks.

NOTE Examples of complications are given in ISO/TR 52016-2[1].

The calculation rules for thermally coupled zones are given in Annex D.

6.5 Hourly calculation procedures

6.5.1 Principle

The basic principles are described in 5.2.1.

The internal temperature of a building thermal zone is solved, on an hourly basis, by a system of equations of the transient heat transfers between the external and internal environment through the opaque and transparent elements bounding the zone's envelope. The equations are solved as a matrix. The calculation result is the temperature of each component, including the internal air and (if any) the heating or cooling needs.

Each construction element (e.g. floor, window, wall) is modelled as a series of a few nodes: Opaque elements are divided in 4 layers with 5 nodes. Windows and doors are not divided into separate layers and have 2 nodes. The number of equations describing the building elements is therefore: 5 x the number of opaque elements + 2 × the number of windows and doors.

The hourly method covers three application areas:

a) energy need calculation;

b) internal temperature calculation; and

c) design heating and cooling load calculation.

For some applications the equations have to be solved several times per time interval. Therefore for each application a procedure is given that results in the required output.

6.5.2 Applicable time interval and calculation period

The calculation procedures described in 6.5 are suitable for an hourly time interval.

The calculation period is a full year, except for the application for peak indoor temperatures and design loads, which are calculated over a short representative period.

System specific energy need calculations:

The lengths of the heating, cooling and (de-)humidification seasons are defined by the operation time of the respective technical systems. This has to be taken into account in the system specific calculations. It may differ from the time resulting from the basic energy needs calculation.

NOTE 1 The length of the season could be shorter than in the needs calculation, suppressing off-season needs, or could be longer, causing system losses during times without needs.

In case of restrictions on the length of the period to be taken into account in the calculations, these restrictions shall be conveyed through all relevant EPB standards.

Such restrictions shall be taken into account in the relevant system standards, EPB modules M3-1 to M7-1, calculation of the system energy use. The choice for such restrictions is provided in Annex A (normative template) and Annex B (informative default choice) in these standards.

NOTE 2 These restrictions could e.g. be due to national or regional regulations.

6.5.3 Assumptions and specific conditions

For all application areas the following basic assumptions are made:

Same assumptions as in ISO 52017-1:

— the air temperature is uniform throughout the room or zone;

— the various surfaces of the room or zone elements are isothermal;

— the heat conduction through the room or zone elements (excluding to the ground) is assumed to be one-dimensional;

— the heat conduction to the ground through room elements is treated by an equivalent one-dimensional heat flow rate in accordance with ISO 13370;

- the heat storage contribution of (linear or point) thermal bridges is neglected;
- (linear or point) thermal bridges are directly thermally coupled to the internal and outdoor air temperatures;
- air spaces within envelope components are treated as air layers bounded by two isothermal and parallel surfaces;
- the heat storage effects in the various planes of a glazed element are neglected;
- the density of heat flow rate due to the short-wave radiation absorbed by each plane of a glazed element is treated as a source term;

In addition:

- the thermal zone is considered to be a closed space delimited by enclosure elements;
- the thermophysical properties of the materials composing the thermal zone elements are time-independent, but switching component properties is not excluded: e.g. movable solar shading, shutters;
- the external radiant environment (sky excluded) is at the external air temperature;
- the spatial distribution of solar radiation within the room is even and time-independent;
- the distribution of mass in each construction is simplified;
- solar properties of windows are not solar angle dependent; and the total solar energy transmittance is assumed to be direct transmittance into the zone; and
- the mean radiant temperature is calculated as the area-weighted average of the internal surface temperatures of each component.

Assumptions inherited from ISO 13789 (EPB module M2-5.1) and related EPB standards under EPB module M2-5:

- convective heat transfer coefficients at the external surface depend on the wind velocity and direction, but are considered time-invariant;
- convective heat transfer coefficients at the internal surface depend on the direction of the heat flow and are considered time-invariant;
- the long-wave heat transfer coefficients at the external surfaces of the room elements to the external air is considered time-invariant;
- the choice of the dimensions used for the determination of the heat flow by thermal transmission (internal dimensions, external dimensions or overall internal dimensions) is specified in the context of the standards in EPB module M2-5 and shall be maintained throughout the EPB assessment. The choice of dimensions for the determination of the heat flow by thermal transmission can differ from the choice of dimensions for the metric of a space or zone such as the useful floor area. In the latter case also other criteria may need to be considered.

NOTE For instance: in many countries parts of the floor are excluded from the useful floor area, e.g. if the ceiling is lower than a specific minimum height (e.g. 1,5 m).

The energy needs for active preheating or precooling hygienic ventilation air (e.g. in an air handling unit or in a trickle ventilator) is not included in this method (and thus not included in the energy needs for heating and cooling), but is treated by the relevant standards under EPB module M5-6.

6.5.4 Calculation procedure

6.5.4.1 Application: Calculation of the basic loads and needs and system specific loads and needs

There are two calculations: basic loads and needs and system specific loads and needs.

Basic loads and needs:

Calculation of the loads and needs without the influence of a specific choice of technical building systems.

Which provisions are excluded is to be obtained from the relevant clauses of the standard under EPB module M2-4.

EXAMPLE Often the heat recovery unit from the ventilation system is included in the basic needs calculations, to avoid a major deviation from the operating area for the calculation and to avoid contradictions with assumptions associated to the choice of a heat recovery unit.

The basic energy needs include the situation where standard indoor environment conditions are assumed for the given space category, which require a heating and/or cooling system, while the actual system is absent or undersized: in that case the basic energy needs are calculated anyway.

NOTE 1 Depending on the choices made in standards providing input to the calculation, iteration can be required. See also the calculation steps specified in ISO 52000-1.

System specific loads and needs:

Possible repetition of the calculation(s) due to the interaction of the basic calculations, with the specific characteristics and specific control of the technical building systems.

NOTE 2 Again, depending on the choices made in standards providing input to the calculation, further iteration can be required. See also the calculation steps specified in ISO 52000-1.

The following system influences are possible:

— limited heating or cooling power: hourly method only; input requested in 6.5.5.2;

— specific value for the convective fraction of the heating and cooling system; input requested in 6.5.6.2;

— recoverable heat losses; input requested in 6.5.12.2;

— adjustment of the temperature set-points (value and time-schedule); input requested in 6.5.5.1;

— limitation of the heating or cooling season for the calculation; input requested in 6.5.4.2 and 6.5.4.3;

— absence of heating or cooling system: no system specific calculation or calculation with fictitious heating or cooling system, according to the principle chosen in ISO 52000-1:2017, Table A.9 (normative template) and Table B.9 (informative default choice);

— in case of fictitious heating or cooling: input requested in the subclauses mentioned above;

— in case of no heating or cooling: input requested in 6.5.5.2.

For the system influences applicable to (de-)humidification systems, see 6.5.14.

In the system specific calculation, it will be recorded to what extent, during the comfort periods, the temperature did not reach the heating or cooling set point. The latter is needed for a level playing field. For this reason the underheating and overheating is recorded as output at monthly level, see 6.5.15.2.

NOTE 3 In case of an undersized or absent heating or cooling system, there is no level playing field in the comparison of the energy performance with other buildings; this could be overcome by a clear warning or a penalty. See explanation and examples in ISO/TR 52016-2[1].

6.5.4.2 Energy need for (sensible) heating and cooling

Warning — there is no differentiation yet in subscript between calculation of 'basic energy' and 'system specific' loads and needs.

The monthly energy needs for heating/cooling in a thermally conditioned zone, *ztc*, are calculated as the sum over the hourly heating/cooling loads:

$$Q_{\mathrm{H/C;nd};ztc;m} = 0,001 \times \sum_{t} \left(\Phi_{\mathrm{H/C;ld};ztc;t} \cdot \Delta t_{\mathrm{h}} \right) \tag{9}$$

where, for the thermally conditioned zone, *ztc*

$Q_{\mathrm{H/C;nd};ztc;m}$ are the heating/cooling needs in the zone, in month *m*, in kWh.

$\Phi_{\mathrm{H/C;ld};ztc;t}$ are the heating/cooling loads in the zone, at time interval *t*, as determined in 6.5.5, in W;

Δt_{h} is the length of the time interval *t*, in h; Δt_{h} = 1 for hourly time interval.

The annual energy needs for heating/cooling are calculated as the sum over the monthly needs:

$$Q_{\mathrm{H/C;nd};ztc;\mathrm{an}} = \sum_{m} Q_{\mathrm{H/C;nd};ztc;m} \tag{10}$$

where

$Q_{\mathrm{H/C;nd};ztc;\mathrm{an}}$ are the annual heating/cooling needs in the zone, in kWh.

$Q_{\mathrm{H/C;nd};ztc;m}$ are the heating/cooling needs in the zone, in month *m*, in kWh.

System specific energy need:

For the calculation of the system specific energy needs for heating and cooling, restrictions, as described in 6.5.2 may apply on the length of the heating or cooling season.

6.5.4.3 Latent energy need for (de-)humidification

Warning — there is no differentiation yet in subscript between calculation of 'basic energy' and 'system specific' loads and needs.

The monthly latent energy needs for (de-)humidification in a thermally conditioned zone, *ztc*, are calculated as the sum over the hourly heating/cooling loads:

$$Q_{\mathrm{HU/DHU;nd};ztc;m} = 0,001 \times \sum_{t} \left(\Phi_{\mathrm{HU/DHU;ld};ztc;t} \cdot \Delta t_{\mathrm{h}} \right) \tag{11}$$

where, for the thermally conditioned zone, *ztc*

$Q_{\mathrm{HU/DHU;nd};zt;m}$ are the (de-)humidification needs in the zone, in month *m*, in kWh.

$\Phi_{\mathrm{HU/DHU;ld};zt;t}$ are the (de-)humidification loads in the zone, at time interval *t*, as determined in 6.5.14, in W;

Δt_{h} is the length of the time interval *t*, in h; Δt_{h} = 1 for hourly time interval.

The annual latent energy needs for (de-)humidification are calculated as the sum over the monthly needs:

$$Q_{\mathrm{HU/DHU;nd};zt;\mathrm{an}} = \sum_{m} Q_{\mathrm{HU/DHU;nd};zt;m} \tag{12}$$

where

$Q_{HU/DHU;nd;zt;an}$	are the annual (de-)humidification needs in the zone, in kWh.
$Q_{HU/DHU;nd;zt;m}$	are the (de-)humidification needs in the zone, in month m, in kWh

System specific energy need:

For the calculation of the system specific energy needs for (de-)humidification, restrictions, as described in 6.5.2 may apply on the length of the season.

6.5.4.4 Application: internal temperature calculation

In case of internal temperature calculation to assess overheating under summer design conditions, the assumptions and specific conditions are the same as for the design cooling load calculation, given in 6.5.4.5, but the system related conditions are ignored.

In case of zero heating or cooling power, the internal temperatures shall be calculated according to 6.5.5.3 taking $\Phi_{HC;ld;ztc;t} = 0$, by setting the maximum heating and cooling power in the zone ztc to zero:

$\Phi H;max;ztc = \Phi C;max;ztc = 0$.

For the assessment of the internal temperature under standard climatic conditions (as for the calculation of the energy needs for heating and cooling), the calculation shall be done according to calculation of the energy needs for heating and cooling given in 6.5.4.2, with zero heating and cooling power.

6.5.4.5 Application: Design heating or cooling load calculation

6.5.4.5.1 General

The thermal zones used for a design heating or cooling load calculation shall be determined on the basis of the intended system design. The design load calculation shall support the dimensioning of the equipment. Multiple emission elements in a thermal zone or repetitive system design may not require a zoning to the level of the equipment.

NOTE The required zoning can differ from the zoning for the energy needs calculation. A system design calculation can for instance require to focus on a ‘worst case’ space.

6.5.4.5.2 Design sensible heating load calculation for a thermal zone

The calculation of the (annual) design heating load of a thermal zone is done by calculation of the energy need according to 6.5.4.2, but with the climatic and operational conditions given below.

The design sensible heating load of a thermal zone is:

$$\Phi_{H;ld;des;ztc;an} = \max_{t}\left(\Phi_{H;ld;ztc;t}\right) \tag{13}$$

where

$\Phi_{H;ld;des;ztc;an}$	is the design sensible heating load in the thermally conditioned zone ztc, in W.
$\Phi_{H;ld;ztc;t}$	is the (sensible) heating load in the zone, at time interval t, calculated according to 6.5.5, in W.

Climatic conditions:

The climatic data used for the design heating load calculation shall be a sequence of hourly values, as described in ISO 15927-4, for a period of the number of days *n* according to ISO 15927-5, with the following properties:

— The average external air temperature of the sequence shall be equal to the external design temperature according to EN 12831-1;

— The minimum hourly value for the external air temperature shall be the minimum hourly temperature having an average return period of 1 year (e.g. occurring on average 20 times in 20 years).

The initialization period shall consist of one or more repetitions of the cyclic period, so that the initialization period is at least 14 days long.

NOTE (from ISO 52017-1) The actual calculation period is preceded by an initialization period that is long enough to make the influence of the temperatures of each node at the start of the calculation negligible when the actual calculation period starts.

Conditions of use:

For the design heating load calculation the set-points and the internal gains shall be obtained from the relevant standard under EPB module M1-6 as for the energy needs calculation. The internal gains shall be reduced by a factor $f_{\mathrm{H;ig}}$ to be determined according to the normative template given in Table A.9. A default choice is given in Table B.9.

For the **basic design sensible heating load** calculation of a thermal zone, the following operational conditions apply:

— The system is operating continuously; input requested in 6.5.5.1;

— The available system power is unrestricted; input requested in 6.5.5.2;

— The heat supply is purely convective: $f_{\mathrm{H},ztc}$= 1 (input requested in 6.5.6.2);

For the **system specific design sensible heating load** calculation of a thermal zone, the following operational conditions apply:

— The system may be operating interruptedly; input requested in 6.5.5.1;

— The available system power may be restricted to an intended design value; input requested in 6.5.5.2;

— The convective fraction of the heat supply is chosen according to the intended system type: $f_{\mathrm{H},ztc} \leq 1$ (input requested in 6.5.6.2).

6.5.4.5.3 Design sensible heating load calculation for a sub-system

The (annual) design sensible heating load of **a sub system** *ss* is:

$$\Phi_{\mathrm{H;ld;des;}ss\mathrm{;an}} = \max_{t}\left(\sum_{ztc}\left(\Phi_{\mathrm{H;\,ld;}ztc;t}\right)\right) \tag{14}$$

where

$\Phi_{\mathrm{H;ld;des;}ss\mathrm{;an}}$	is the (annual) design sensible heating load in the subsystem *ss*, in W.
$\Phi_{\mathrm{H;ld;}ztc;t}$	is the sensible heating load in the thermally conditioned zone *ztc*, at time interval *t*, calculated according to 6.5.5, in W.

NOTE This is the maximum of the superposed profiles of all thermal zones rather than the sum of the maxima.

If a system covers only part of a thermal zone the attribution rules given in ISO 52000-1 apply.

6.5.4.5.4 Design sensible cooling load calculation for a thermal zone

The calculation of the (annual) design cooling load of a thermal zone is done by calculation of the energy need according to 6.5.4.2, but with the climatic and operational conditions given below.

The (annual) design sensible cooling load of a thermal zone is

$$\Phi_{\mathrm{C;ld;des;}ztc\mathrm{;an}} = \max_{t}\left(\Phi_{\mathrm{C;ld;}ztc;t}\right) \tag{15}$$

where

$\Phi_{\mathrm{C;ld;des;}ztc\mathrm{;an}}$	is the (annual) design sensible cooling load in the thermally conditioned zone *ztc*, in W.
$\Phi_{\mathrm{C;ld;}ztc;t}$	is the (sensible) cooling load in the zone, at time interval *t*, calculated according to 6.5.5, in W.

For the **basic design sensible cooling load** calculation of a thermal zone, the following operational conditions apply:

— The system is operating continuously; input requested in 6.5.5.1

— The available system power is unrestricted; input requested in 6.5.5.2;

— The heat extraction is purely convective: $f_{\mathrm{C},cztc} = 1$ (input requested in 6.5.6.2).

For the **system specific design sensible cooling load** calculation of a thermal zone, the following operational conditions apply:

— The system may be operating interruptedly; input requested in 6.5.5.1;

— The available system power may be restricted to an intended design value; input requested in 6.5.5.2;

— The convective fraction of the heat extraction is chosen according to the intended system type: $f_{\mathrm{C},cztc} \leq 1$ (input requested in 6.5.6.2).

Climatic conditions:

The climatic data used for the design cooling load calculation shall be calculated and presented according to ISO 15927-2.

The initialization period shall consist of one or more repetitions of the cyclic period, so that the initialization period is at least 14 days long.

(From ISO 52017-1) The actual calculation period shall be preceded by an initialization period that is long enough to make the influence of the temperatures of each node at the start of the calculation negligible when the actual calculation period starts.

Conditions of use:

The set-points and the internal gains shall be taken as for the energy needs calculation, except for the following difference:

If there are simultaneity factors applied to the use data for the energy calculation, this shall not be applied for the design load calculation.

NOTE 2 This means the daily profiles of the space use data are applied directly, without any reduction ratio. This requires the building use data in EPB module M1–6 being made available in the respective form.

6.5.4.5.5 Design sensible cooling load calculation for a sub-system

The (annual) design sensible cooling load of **a sub system** *ss* is:

$$\Phi_{\text{C; ld;des;}ss\text{;an}} = \max_{t}\left(\sum_{ztc}\left(\Phi_{\text{C; ld;}ztc;t}\right)\right) \tag{16}$$

where

$\Phi_{\text{C;ld;des;}ss\text{;an}}$	is the (annual) design sensible cooling load (value ≥ 0) in the subsystem *ss*, in W.
$\Phi_{\text{C;ld;}ztc;t}$	is the sensible cooling load in the thermally conditioned zone *ztc*, at time interval *t*, calculated according to 6.5.5, in W.

NOTE This is the maximum of the superposed profiles of all thermal zones rather than the sum of the maxima.

If a sub-system covers only part of a thermal zone, the attribution rules of ISO 52000-1 apply.

6.5.4.5.6 Design supply air conditions for humidification and dehumidification

The calculation of the (annual) design (de-)humidification moisture load and design latent heat load of a thermal zone is done by calculation of the moisture and latent heat load according to 6.5.14, but with the climatic conditions given below.

The (annual) design humidification moisture load is

$$G_{\text{HU;ld;des;}ztc\text{;an}} = \max_{t}\left(\sum_{t} G_{\text{HU;ld;}ztc;t}\right) \tag{17}$$

The (annual) design dehumidification moisture load is

$$G_{\text{DHU;ld;des;}ztc\text{;an}} = \max_{t}\left(\sum_{t} G_{\text{DHU;ld;}ztc;t}\right) \tag{18}$$

The (annual) design latent heat load for humidification is

$$\Phi_{\text{HU;ld;des;}ztc\text{;an}} = \max_{t}\left(\sum_{t} \Phi_{\text{HU;ld;}ztc;t}\right) \tag{19}$$

The (annual) design latent heat load for dehumidification is

$$\Phi_{\text{DHU;ld;des;}ztc\text{;an}} = \max_{t}\left(\sum_{t} \Phi_{\text{DHU;ld;}ztc;t}\right) \tag{20}$$

where, for the thermally conditioned zone *ztc*

$G_{\text{HU;ld;des;}ztc;an}$	is the (annual) design humidification moisture (supply) load needed to maintain a minimum moisture set-point, in kg/s;
$G_{\text{DHU;ld;des;}ztc;an}$	is the (annual) design dehumidification moisture (removal) load needed to maintain a maximum moisture set-point, in kg/s;
$G_{\text{HU;ld;}ztc;t}$	is the humidification moisture (supply) load needed to maintain a minimum moisture set-point at time interval *t*, as determined in 6.5.14.1.1, in kg/s;
$G_{\text{DHU;ld;}ztc;t}$	is the dehumidification moisture (removal) load needed to maintain a maximum moisture set-point at time interval *t*, as determined in 6.5.14.1.1, in kg/s;

$\Phi_{HU;ld;des;ztc;an}$ is the (annual) design latent heat load for humidification, in W;

$\Phi_{DHU;ld;des;ztc;an}$ is the (annual) design latent heat load for dehumidification, in W;

$\Phi_{HU;ld;ztc;t}$ is the latent heat load for humidification at time interval t, as determined in 6.5.14.1.1, in W;

$\Phi_{DHU;ld;ztc;t}$ is the latent heat load for dehumidification at time interval t, as determined in 6.5.14.1.1, in W.

The (annual) design (de-)humidification moisture load can be converted to an increase and decrease in mechanical ventilation supply air moisture content compared to the moisture content of external air, $\Delta x_{a;sup;HU/DHU;ld;des;ztc;an}$, in accordance with the relevant formulae in 6.5.14.2:

$$\Delta x_{a;sup;HU;ld;des;ztc;an} = \left(x_{a;sup;HU;req;ztc;t} - x_{a;e;t} \right) = \frac{G_{HU;ld;ztc;t}}{\rho_a \cdot q_{V;mech;k;t}} \quad (21)$$

$$\Delta x_{a;sup;DHU;ld;des;ztc;an} = \left(x_{a;e;t} - x_{a;sup;DHU;req;ztc;t} \right) = \frac{G_{DHU;ld;ztc;t}}{\rho_a \cdot q_{V;mech;k;t}} \quad (22)$$

with t the time interval that the design humidification or dehumidification load occurs.

Climatic conditions:

The design supply air conditions for humidification and dehumidification shall be calculated as the calculation of the latent heat load according to 6.5.14, under design climatic conditions.

These design climatic conditions shall contain a minimum/maximum hourly value for the humidity content of the external air, having an average return period of 1 year (e.g. occurring on average 20 times in 20 years).

6.5.5 Calculation of (sensible) heating and cooling loads and temperatures

6.5.5.1 Temperature set-points

The internal temperature set-point for heating, $\theta_{int;set;H;ztc;t}$, and cooling, $\theta_{int;set;C;ztc;t}$, in each thermally conditioned zone ztc, at time interval t, shall be obtained on an hourly basis from the relevant standard under EPB module M1-6, taking into account the space category (specified in ISO 52000-1) and taking also into account possible night time and/or daytime temperature set-back, weekend or other periodical interruptions or set-back periods.

In some buildings, such as schools, unoccupied periods during the heating or cooling season, such as holiday periods, lead to a reduction in space heating or cooling energy use.

If the rule applies for the spatial averaging of the temperature set-point for residential buildings as described in 6.4.6, the temperature set-point for heating shall be adjusted accordingly.

System specific energy need:

For the calculation of the system specific energy needs for heating and cooling, adjustment of the values and the period(s) (such as the number of hours per day and days per week) of the temperature set-points may apply, depending on specific characteristics of the relevant technical building system, to be obtained from the relevant standards under EPB modules M3-1 to M7-1.

6.5.5.2 Sensible heating and cooling load

For each hour and each zone the actual internal operative temperature $\theta_{int;ac;op;zt;t}$ and the actual heating or cooling load, $\Phi_{HC;ld;ztc;t}$, is calculated using the following step-wise procedure:

Step 1: Check if cooling or heating is needed.

Take $\Phi_{\text{HC;ld;}ztc;t}$ = 0 and calculate the internal operative temperature $\theta_{\text{int;op;}ztc;t}$ according to 6.5.5.3,

where, for thermally conditioned zone *ztc* at time interval *t*

$\Phi_{\text{HC;ld;}ztc;t}$ is the heating or cooling load, in W;

$\theta_{\text{int;op;}ztc;t}$ is the internal operational temperature, in °C.

Name the resulting $\theta_{\text{int;op;}ztc;t}$ as $\theta_{\text{int;op;0;}ztc;t}$ where

$\theta_{\text{int;op;}ztc;t}$ is the internal operational temperature, in °C;

$\theta_{\text{int;op;0;}ztc;t}$ is the operating temperature in free floating conditions, in °C;

and store all calculated node temperatures as starting point for the calculation of the next time interval:

$$\theta_{\text{int;a;}ztc;(t+1)\text{-1}} = \theta_{\text{int;a;}ztc;t} \quad (23)$$

$$\theta_{pli;eli;(t+1)\text{-1}} = \theta_{pli;eli;t}$$

where, for thermal zone *zt*, at time interval *t*

$\theta_{\text{int;a;}zt;t}$ is the internal air temperature, in °C;

$\theta_{\text{int;a;}zt;(t+1)\text{-1}}$ is the previous time interval value of the internal air temperature at time interval (t+Δt), in °C;

$\theta_{pli;eli;t}$ is the temperature at node *pli* of the building element *eli*, in °C;

$\theta_{pli;eli;(t+1)\text{-1}}$ is the previous time interval value of the temperature at node *pli* of the building element *eli* at time interval (t+ Δt), in °C.

If $\theta_{\text{int;set;H;}zt;t} \leq \theta_{\text{int;op;0;}zt;t} \leq \theta_{\text{int;set;C;}zt;t}$:

$$\Phi_{\text{HC;ld;}zt;t}, = 0 \quad (24)$$

$$\theta_{\text{int;op;ac;}zt;t} = \theta_{\text{int;op;0;}zt;t}$$

where, for thermally conditioned zone *ztc*, at time interval *t*

$\Phi_{\text{HC;ld;}zt;t}$ is the heating or cooling load in the calculation, in W;

$\theta_{\text{int;op;ac;}zt;t}$ is the actual internal operative temperature, in °C;

$\theta_{\text{int;op;0;}zt;t}$ is the operating temperature in free floating conditions, in °C;

$\theta_{\text{int;set;H;}zt;t}$ is the internal operative temperature set-point for heating, as determined in 6.5.5.1, in °C;

$\theta_{\text{int;set;C;}zt;t}$ is the internal operative temperature set-point for cooling, as determined in 6.5.5.1, in °C;

and go to step 5.

If not: apply step 2.

Step 2: Determine if the heating or the cooling temperature set-point applies and calculate the heating or cooling load:

if $\theta_{int;op;0;ztc;t} > \theta_{int;set;C;ztc;t}$, take $\theta_{int;op;set;ztc;t} = \theta_{int;set;C;ztc;t}$ (25)

if $\theta_{int;op;0;ztc;t} < \theta_{int;set;H;ztc;t}$, take $\theta_{int;op;set;ztc;t} = \theta_{int;set;H;ztc;t}$

where, for thermally conditioned zone *ztc*, at time interval *t*

$\theta_{int;op;0;ztc;t}$	is the operating temperature in free floating conditions, in °C;
$\theta_{int;op;set;ztc;t}$	is the required internal operative temperature set-point, in °C;
$\theta_{int;set;H;ztc;t}$	is the internal operative temperature set-point for heating, as determined in 6.5.5.1, in °C;
$\theta_{int;set;C;ztc;t}$	is the internal operative temperature set-point for cooling, as determined in 6.5.5.1, in °C.

Calculate the internal operative temperature $\theta_{int;op;zt;t}$ according to 6.5.5.3 taking $\Phi_{HC;zt;t} = \Phi_{HC;upper;zt;t}$

with

— if a maximum heating respectively cooling power is available:

$\Phi_{HC;upper;ztc;t} = \Phi_{HC;avail;ztc;t}$ (26)

— otherwise: $\Phi_{HC;upper;ztc;t} = 10 \times A_{use;ztc}$.

Name the resulting $\theta_{int;op;ztc;t}$ as $\theta_{int;op;upper;ztc;t}$.

where, for thermal zone *ztc* at time interval *t*

$\Phi_{HC;ld;ztc;t}$	is the heating or cooling load, in W;
$\Phi_{HC;upper;ztc;t}$	is the upper value of the heating load, in W;
$\theta_{int;op;ztc;t}$	is the internal operational temperature, in °C;
$\theta_{int;op;upper;ztc;t}$	is the internal operational temperature, obtained for the upper value of the heating load, in °C;
$A_{use;ztc}$	is the useful floor area of the zone, as determined in 6.4.3, in m^2.

Calculate $\Phi_{HC;ld;un;ztc;t}$ by:

$$\Phi_{HC;ld;un;ztc;t} = \Phi_{HC;upper;ztc;t} \cdot \frac{\left(\theta_{int;op;set;ztc;t} - \theta_{int;op;0;ztc;t}\right)}{\left(\theta_{int;op;upper;ztc;t} - \theta_{int;op;0;ztc;t}\right)} \quad (27)$$

where, for thermal zone *ztc* at time interval *t*

$\Phi_{HC;ld;un;ztc;t}$ is the unrestricted heating or cooling load to reach the required temperature set-point, in W;

$\Phi_{HC;upper;ztc;t}$ is the upper value of heating or cooling load, in W;

$\theta_{int;op;set;ztc;t}$ is the required internal operative temperature set-point in zone *ztc* at time interval *t*, in °C;

$\theta_{int;op;0;ztc;t}$ is the operating temperature in free floating conditions, in °C;

$\theta_{int;op;upper;ztc;t}$ is the internal operational temperature, obtained for the upper heating or cooling load, in °C.

Step 3: Check if the available cooling or heating power is sufficient:

If $\Phi_{HC;ld;un;ztc;t}$ is between $\Phi_{H;avail;ztc;t}$ and $\Phi_{C;avail;ztc;t}$:

$$\Phi_{HC;ld;ztc;t} = \Phi_{HC;ld;un;ztc;t} \quad (28)$$

$$\theta_{int;op;ac;ztc;t} = \theta_{int;op;set;\, ztc;t}$$

where, for thermal zone *ztc* at time interval *t*

$\Phi_{HC;ld;un;ztc;t}$ is the unrestricted heating or cooling load to reach the required temperature set-point, in W;

$\Phi_{H;avail;ztc;t}$ is the maximum available heating power at time interval *t*, as determined in the relevant standards under EPB module M3-1, in W;

for the calculation of the system specific energy needs, specific restrictions may apply on the maximum available heating power;

$\Phi_{C;avail;ztc;t}$ is the maximum available cooling power at time interval *t* (value ≤ 0), as determined in the relevant standards under EPB module M4-1, in W;

for the calculation of the system specific energy needs, specific restrictions may apply on the maximum available cooling power;

$\Phi_{HC;ld;un;ztc;t}$ is the unrestricted heating or cooling load to reach the required temperature set-point, in W;

$\theta_{int;op;ac;ztc;t}$ is the actual internal operative temperature, in °C;

$\theta_{int;op;set;ztc}$ is the required internal operative temperature set-point, in °C.

and store all calculated node temperatures as starting point for the calculation of the next time interval:

$$\theta_{int;a;ztc;(t+1)-1} = \theta_{int;a;ztc;t} \quad (29)$$

$$\theta_{pli;eli;(t+1)-1} = \theta_{pli;eli;t}$$

where

(same as in Step 1)

and go to step 5.

If not: apply step 4.

Step 4: Calculate the internal temperature, if the available heating or cooling power is insufficient.

If $\Phi_{HC;ld;un;ztc;t}$ is positive, take $\Phi_{H;ld;ztc;t} = \Phi_{H;avail;ztc;t}$. (30)

If $\Phi_{HC;ld;un;ztc;t}$ is negative, take $\Phi_{C;ld;ztc;t} = - \Phi_{C;avail;ztc;t}$

Calculate the internal operative temperature $\theta_{int;op;ztc;t}$ from the result of Step 2 where the maximum heating or cooling power is used as the upper value of the power:

$$\theta_{int;op;ztc;t} = \theta_{int;op;upper;ztc;t} \quad (31)$$

where, for thermal zone *ztc* at time interval *t*

(same as in Step 3)

and store all calculated node temperatures as starting point for the calculation of the next time interval:

$$\theta_{int;a;ztc;(t+1)-1} = \theta_{int;a;ztc;t} \quad (32)$$

$$\theta_{pli;eli;(t+1)-1} = \theta_{pli;eli;t}$$

where

(same as in Step 1)

NOTE In this case, the temperature set-point is not attained.

Step 5: Calculation of the actual energy load for heating and cooling as output of the calculation:

If $\Phi_{HC;ld;ztc;t}$ is positive, the actual (sensible) heating and cooling load for a given hour is given by:

$$\begin{aligned} \Phi_{H;ld;ztc;t} &= \Phi_{HC;ld;ztc;t} \\ \Phi_{C;ld;ztc;t} &= 0 \end{aligned} \quad (33)$$

If $\Phi_{HC;ld;ztc;t}$ is negative, the actual (sensible) heating and cooling load for a given hour is given by:

$$\begin{aligned} \Phi_{C;ld;ztc;t} &= -\Phi_{HC;ld;ztc;t} \\ \Phi_{H;ld;ztc;t} &= 0 \end{aligned} \quad (34)$$

where, for thermal zone *ztc* at time interval *t*

$\Phi_{HC;ld;ztc;t}$ is the actual (sensible) heating (if positive) or cooling (if negative) load, in W;

$\Phi_{H;ld;ztc;t}$ is the actual heating load, in W;

$\Phi_{C;ld;ztc;t}$ is the actual cooling load (value ≥ 0), in W.

Alternative options for this solution technique are allowed, provided that the verification cases in 7.2 are applied to validate the method, and the deviations with the reference results are reported.

Table A.10 provides the normative template for the choice between the prescribed technique or alternative techniques, with an informative default choice in Table B.10.

Initialization period:

The actual calculation period shall be preceded by an initialization period that is long enough to make the influence of the temperatures of each node at the start of the calculation negligible when the actual calculation period starts. For this application the initialization period shall consist of at least two weeks preceding the actual period. So for annual calculations, starting at January 1, the calculation shall be preceded by at least the period December 18 - 31 that precedes January 1.

Iteration:

Depending on the choices made in standards providing input to the calculation, iteration may be required. See also the calculation steps specified in ISO 52000-1:2017, 11.2 and 11.3.

6.5.5.3 Operative temperature

The operative temperature in zone *ztc* at time interval *t* is given by:

$$\theta_{\mathrm{int;op};ztc;t} = \frac{\theta_{\mathrm{int;a};ztc;t} + \theta_{\mathrm{int;r;mn};ztc;t}}{2} \qquad (35)$$

where, for thermal zone *ztc* at time interval *t*

$\theta_{\mathrm{int;op};ztc;t}$ is the internal operational temperature, in °C;

$\theta_{\mathrm{int;a};ztc;t}$ is the internal air temperature, as determined in 6.5.5.4, in °C;

$\theta_{\mathrm{int;r;mn};ztc;t}$ is the mean radiant temperature, as determined in the formula below, in °C.

The mean radiant temperature is the weighted average of the internal surface temperatures of all building elements *eli* = 1 to *eln* in zone *ztc* and is given by:

$$\theta_{\mathrm{int;r;mn};ztc;t} = \frac{\sum_{eli=1}^{eln} \left(A_{eli} \cdot \theta_{pli=\mathrm{pln};eli;t} \right)}{\sum_{eli=1}^{eln} A_{eli}} \qquad (36)$$

where

$\theta_{\mathrm{int;r;mn};ztc;t}$ is the mean radiant temperature, in °C;

A_{eli} is the area of building element *eli*, as determined in 6.5.7, in m^2;

$\theta_{pli=\mathrm{pln};eli;t}$ is the temperature at node *pli* = pln of the building element *eli*, as determined in 6.5.5.5, in °C.

6.5.5.4 Internal air temperature

The internal air temperature in the zone *ztc* at time interval *t*, $\theta_{\mathrm{int;a};ztc;t}$, is determined by solving the formulae in paragraph 6.5.6 for that time interval.

6.5.5.5 Surface temperature of a building element

The surface temperature of building element *eli* in zone *ztc* at time interval *t*, is the temperature at the internal node *pli* = pln and is determined by solving the formulae in 6.5.6 for that time interval.

NOTE In line with the international convention, the numbering of layers (nodes) in the construction elements is from outside (node number *pli* = 1) to inside (node number *pli* = pln).

6.5.6 Overall energy balance of a thermal zone

6.5.6.1 General

Solve for thermal zone *ztc* and time interval *t* the formulae of 6.5.6.2 and 6.5.6.3 which form a square matrix:

[Matrix A] × [Node temperature vector X] = [State vector B] (37)

where

[Matrix A]	the (known) coefficients in the left hand side of the formulae of 6.5.6.2 and 6.5.6.3
[Vector B]	the (known) terms in the right hand side of the formulae of 6.5.6.2 and 6.5.6.3
[Node temperature vector X]	State vector; the (unknown) temperatures to be solved (*pli*=1...*pln*, *eli*=1...*eln*): $(\theta_{1;1;ztc;t}, \ldots\theta_{1;eli;ztc;t}, \ldots\theta_{pli;1;ztc;t}, \ldots, \theta_{pli,eli;ztc,t}, \ldots, \theta_{pln,eli;ztc,t}, \ldots, \theta_{pli,eln;ztc,t}, \ldots, \theta_{pln,eln;ztc,t}, \theta_{int;a;ztc;t})$

where, for thermal zone *ztc* at time interval *t*

$\theta_{pli,eli;ztc,t}$	is the temperature at node *pli* of the building element *eli,* as described in the formulae of 6.5.6.2 and 6.5.6.3, in °C;
$\theta_{int;a;ztc;t}$	is the internal air temperature, as described in the formula of 6.5.6.2, in °C.

6.5.6.2 Energy balance on zone level

The energy balance for zone *ztc* and time interval *t*:

$$\left[\frac{C_{int;ztc}}{\Delta t} + \sum_{eli=1}^{eln}\left(A_{eli} \cdot h_{ci;eli}\right) + \sum_{vei=1}^{ven} H_{ve;vei;t} + H_{tr;tb;ztc}\right] \cdot \theta_{int;a;ztc;t} - \sum_{eli=1}^{eln}\left(A_{eli} \cdot h_{ci;eli} \cdot \theta_{pln;eli;t}\right)$$
$$= \frac{C_{int;ztc}}{\Delta t} \cdot \theta_{int;a;ztc;t-1} + \sum_{vei=1}^{ven}\left(H_{ve;vei;t} \cdot \theta_{sup;vei;t}\right) + H_{tr;tb;ztc} \cdot \theta_{e;a;t}$$
$$+ f_{int,c} \cdot \Phi_{int;ztc;t} + f_{sol,c} \cdot \Phi_{sol;ztc;t} + f_{H/C,c} \cdot \Phi_{HC;ztc;t} \quad (38)$$

where, for thermal zone *ztc* at time interval *t*

$C_{int;ztc}$	is the internal thermal capacity of the zone, as determined in 6.5.11, in J/K;
Δt	is the length of the time interval *t*, in s;
$\theta_{int;a;ztc;t}$	is the internal air temperature, in °C;
$\theta_{int;a;ztc;t-1}$	is the internal air temperature in the zone at previous time interval (*t*-Δ*t*), in °C;
A_{eli}	is the area of building element *eli*, as determined in 6.5.8, in m²;
$h_{ci;eli}$	is the internal convective surface heat transfer coefficient of the building element *eli*, as determined per type of construction element in 6.5.7, in W/(m²·K);

$\theta_{\text{pln};eli;t}$ is the internal surface temperature of the building element *eli*, in °C;

$H_{\text{ve};k;t}$ is the overall heat exchange coefficient by ventilation, for ventilation flow element *k*, as determined in 6.5.10, in W/K;

$\theta_{\text{sup};k;t}$ is the supply temperature of the ventilation flow *k* entering the zone, as determined in 6.5.10, in °C;

$\theta_{\text{e;a};t}$ is the external air temperature, obtained from the relevant standard under EPB module M1-13, in °C;

$H_{\text{tr;tb};ztc}$ is the overall heat transfer coefficient for thermal bridges, as determined in 6.5.8.5, in W/K;

$f_{\text{int,c};ztc}$ is the convective fraction of the internal gains, as determined in Table A.11 (normative template), with informative values in Table B.11;

$f_{\text{sol,c}\ ztc}$ is the convective fraction of the solar radiation, as determined in Table A.11 (normative template), with informative values in Table B.11;

$f_{\text{H/C,c}\ ztc}$ is the convective fraction of the heating/cooling system, as determined in Table A.11 (normative template), with informative values in Table B.11, in m^2; for the calculation of the system specific energy needs, specific values may apply as obtained from the relevant standards under EPB module M3-1 and M4-1;

$\Phi_{\text{int};ztc;t}$ is the total internal heat gain, as determined in 6.5.12, in W;

$\Phi_{\text{HC};ztc;t}$ is the heating load (if positive) or cooling load (if negative) in the calculation zone *ztc*, at time interval *t*, depending on the type of application of the calculation, as determined in 6.5.4, in W;

$\Phi_{\text{sol};ztc;t}$ is the directly transmitted solar heat gain into the zone, summed over all windows *wi*, as determined in 6.5.13, in W.

NOTE 1 The internal surface temperature of the building element $\theta_{\text{pln};eli;t}$ is not suitable to estimate condensation risk.

NOTE 2 See ISO/TR 52016-2[1] for an extensive explanation of the equations in 6.5.6.2 and 6.5.6.3.

6.5.6.3 Energy balance on building element level

6.5.6.3.1 General

Each building element is divided (discretized) into a number of parallel layers, separated by nodes.

For opaque building elements, the number of nodes is 5 (node *pli*=1...5), being respectively one external surface node, three nodes inside the building element and one internal (zone facing) surface node.

For elements in contact with the ground, the number of nodes is also 5, used for a combination of the layers as described in the standard under EPB module M2-5.2: the fixed ground layer and the floor; with the external surface heat transfer coefficients replaced by the thermal conductance of the virtual layer of the ground.

For windows and doors, the number of nodes is 2, being respectively the external surface node and the internal (zone facing) surface node. For simplicity, the effect of absorbed solar radiation is taken into account as directly transmitted solar radiation.

Internal partitions or building elements adjacent to other buildings or to other thermally conditioned zones are modelled as opaque building elements. As alternative, these building elements may be ignored or replaced by default data. Table A.12 provides the normative template with an informative default choice in Table B.12.

Alternative options for the subdivision of each construction elements into a number of nodes of thermal resistances and capacitances are allowed, provided that the verification cases in 7.2 are applied to validate the method, and the deviations with the reference results are reported.

The same applies to an alternative method for the calculation of the thermal (longwave) radiation exchange (based on approximation for the view factors) between the surfaces in the thermal zone (see the formula of 6.5.6.2). Table A.10, presented in 6.5.5.2, provides the normative template for these choices between the prescribed calculation method or alternative methods, with an informative default choice in Table B.10.

NOTE See also 7.3.

6.5.6.3.2 Calculation procedures

For opaque elements the energy balance for the nodes pli=1…5 is given in Formulae (39) to (41).

For elements in contact with the ground the same formulae apply, with specifically adapted values (see 6.5.7.3).

In case of internal partitions Formula (41) is replaced by Formula (42).

For windows and doors the energy balance for the node pli=1 to 2 is given in Formulae (39) and (41) only, while Formula (40) is invalid, since the inside nodes do not exist.

The energy balance per building element eli for zone ztc and time interval t:

6.5.6.3.3 Internal surface node

For pli = pln (surface node facing calculation zone ztc):

$$-\left(h_{pli-1;eli}\cdot\theta_{pli-1;eli;t}\right)+\left[\frac{\kappa_{pli;eli}}{\Delta t}+h_{\text{ci};eli}+h_{\text{ri};eli}\cdot\sum_{elk=1}^{eln}\left(\frac{A_{elk}}{A_{\text{tot}}}\right)+h_{pli-1;eli}\right]\cdot\theta_{pli;eli;t}$$
$$-h_{\text{ci};eli}\cdot\theta_{\text{int;a};zt;t}-\sum_{elk=1}^{eln}\left(\frac{A_{elk}}{A_{\text{tot}}}\cdot h_{\text{ri};eli}\cdot\theta_{pli;elk;t}\right)$$
$$=\frac{\kappa_{pli;eli}}{\Delta t}\cdot\theta_{pli;eli;t-1}+\frac{1}{A_{\text{tot}}}\cdot\left[\left(1-f_{\text{int,c}}\right)\cdot\Phi_{\text{int};ztc;t}+\left(1-f_{\text{sol,c}}\right)\cdot\Phi_{\text{sol};ztc;t}+\left(1-f_{\text{H/C,c}}\right)\cdot\Phi_{\text{HC};ztc;t}\right]$$
(39)

where, for each element eli and at time interval t

A_{elk}	is the area of (this or other) building element elk, in zone ztc, as determined in 6.5.8, in m^2;
A_{tot}	is the sum of areas A_{elk} of all building elements elk = 1, .., eln, in m^2;
$\theta_{pli;eli;t}$	is the temperature at node pli, in °C;
$\theta_{pli\text{-}1;eli;t}$	is the temperature at node pli-1. in °C;
$\theta_{\text{int;a};ztc;t}$	is the internal air temperature in the zone, in °C;
$h_{pli\text{-}1;eli}$	is the conductance between node pli and node pli-1, as determined per type of construction element in 6.5.7, in W/(m^2·K);
$\kappa_{pli;eli}$	is the areal heat capacity of node pli, as determined in 6.5.7, in J/(m^2·K);

$h_{\text{ci};eli}$ is the internal convective surface heat transfer coefficient, as determined per type of construction element in 6.5.7, in W/(m²·K);

$h_{\text{ri};eli}$ is the internal radiative surface heat transfer coefficient, as determined per type of construction element in 6.5.7, in W/(m²·K);

$\theta_{pli;eli;t\text{-}1}$ is the temperature at node *pli* at previous time interval (t-Δt), in °C;

and with the other variables declared in the previous formulae or in 6.5.6.2.

6.5.6.3.4 Inside node

For *pli* = 2, ..., *pln*-1 (each inside node):

$$-h_{pli-1;eli}\cdot\theta_{pli-1;eli;t}+\left[\frac{\kappa_{pli;eli}}{\text{”}\,t}+h_{pli;eli}+h_{pli-1;eli}\right]\cdot\theta_{pli;eli;t}-h_{pli;eli}\cdot\theta_{pli+1;eli;t}=\frac{\kappa_{pli;eli}}{\Delta t}\cdot\theta_{pli;eli;t-1}$$

(40)

where, for building element *eli* at time interval *t*

$\theta_{pli+1;eli;t}$ is the temperature at node *pli+1,* in °C;

$h_{pli;eli}$ is the conductance between node *pli+1* and node *pli*, as determined per type of construction element in 6.5.7, in W/(m²·K);

and with the other variables declared in the previous formulae or in 6.5.6.2.

NOTE 1 Formula (40) is not relevant for windows and doors, since these elements are divided in two end nodes only (*pln* = 2) and don't contain these middle nodes.

6.5.6.3.5 External surface node

For *pli* = *1* (surface node facing 'external' side):

$$\left(\frac{\kappa_{pli;eli}}{\Delta t}+h_{\text{ce};eli}+h_{\text{re};eli}+h_{pli;eli}\right)\cdot\theta_{pli;eli;t}-h_{pli;eli}\cdot\theta_{pli+1;eli;t}$$
$$=\frac{\kappa_{pli;eli}}{\Delta t}\cdot\theta_{pli;eli;t-1}+\left(h_{\text{ce};eli}+h_{\text{re};eli}\right)\cdot\theta_{\text{e};t} \qquad (41)$$
$$+a_{\text{sol};pli;eli}\cdot\left(I_{\text{sol;dif};eli;t}+I_{\text{sol;dir};eli;t}\;F_{\text{sh;obst};eli;t}\right)-\Phi_{\text{sky};eli;t}$$

where, for element *eli* at time interval *t*

$\theta_{\text{e};t}$ is the temperature of the external environment, as determined per type of construction element in 6.5.7, in °C;

$h_{\text{ce};eli}$ is the external convective surface heat transfer coefficient, as determined per type of construction element in 6.5.7, in W/(m²·K);

$h_{\text{re};eli}$ is the external radiative surface heat transfer coefficient, as determined per type of construction element in 6.5.7, in W/(m²·K);

$a_{\text{sol};eli}$ is the solar absorption coefficient at the external surface, as determined per type of construction element in 6.5.7;

$I_{sol;dir;tot;eli;t}$ is the direct part (excluding circumsolar) of the solar irradiance on the element, with tilt angle β_{eli} and orientation angle γ_{eli}, obtained from the relevant standard under EPB module M1-13, in W/m^2;

$I_{sol;dif;tot;eli;t}$ is the diffuse part (including circumsolar) of the solar irradiance on the element, with tilt angle β_{eli} and orientation angle γ_{eli}, obtained from the relevant standard under EPB module M1-13, in W/m^2;

$F_{sh;obst;eli;t}$ is the shading reduction factor for external obstacles for the element, as determined in Annex F. In the calculation procedures this is, where relevant, further specified as the shading reduction factor for external obstacles for window element k, $F_{sh;obst;w,k}$, or opaque element k, $F_{sh;obst;op,k}$;

$\Phi_{sky;eli;t}$ is the (extra) thermal radiation to the sky, as determined in 6.5.13.3, in W/m^2;

β_{eli} is the tilt angle of the element (from horizontal, measured upwards facing), obtained from the geometric data of the construction element, in degrees;

γ_{eli} is the orientation angle of the element, obtained from the geometric data of the construction element, in degrees (expressed as the geographical azimuth angle of the horizontal projection of the inclined surface normal; convention: angle from South, eastwards positive, westwards negative);

and with the other variables declared in the previous formulae or in 6.5.6.2.

NOTE 2 The shading reduction factor is given as a function of time t. However, it could be simplified to a monthly or seasonal value; see Annex F.

NOTE 3 None of the internal node temperatures $\theta_{plneli;t}$, calculated in this paragraph, are suitable to estimate condensation risk.

NOTE 4 See ISO/TR 52016-2[1] for an extensive explanation of the equations in 6.5.6.2 and 6.5.6.3.

6.5.6.3.6 External surface node in case of internal partition

If applicable (see Table A.12 and Table B.12 introduced in 6.5.6.3.1), internal partitions (e.g. floors or walls) within the thermal zone (two exposed surfaces) or between the thermal zone and other buildings are modelled similarly, by using the properties to the middle of the construction and assuming adiabatic boundary conditions at that position:

For pli = 1(surface node facing 'external' side):

$$h_{ce;eli} = h_{re;eli} = 0\text{ , } a_{sol;pli;eli} = 0 \text{ and } \Phi_{sky;eli;t} = 0 \quad (42)$$

where, at time interval t

all variables are declared in the previous formulae or in 6.5.6.2.

In case of asymmetric constructions the middle can be approximated by the estimated middle of the mass of the construction.

NOTE 5 Given the relatively small influence, this is a sufficiently accurate approximation.

6.5.6.3.7 Heat transfer to adjacent thermally conditioned zones

If the adjacent thermally conditioned space is a thermal zone of the assessed object and the option of calculation as thermally coupled thermal zones is chosen, the calculation rules of Annex D apply. In other cases: the construction element to the adjacent zone is treated as an internal partitions (e.g. floors or walls) between the thermal zone and other buildings, as described above.

6.5.7 Type of construction dependent properties of the nodes

6.5.7.1 General

The conversion from the physical properties to the properties per layer (node) is given in the following subclauses, respectively for opaque, ground coupled and transparent building elements.

Alternative conversion techniques may be chosen and specified. Table A.10, presented in 6.5.5.2, provides the normative template for the choice between the prescribed conversion technique or alternative conversion techniques, with an informative default choice in Table B.10.

6.5.7.2 Opaque elements (walls, roofs, etc.)

All variables at the left side of the formulae are declared in 6.5.6.

Number of nodes:

The number of nodes, *pln* = 5.

Node conductances:

The conductance between nodes *pli* and node *pli*-1, is given by:

$$h_{\text{pl4}eli} = h_{\text{pl1};eli} = \frac{6}{R_{\text{c};eli}}$$
$$h_{\text{pl2};eli} = h_{\text{pl3};eli} = \frac{3}{R_{\text{c};eli}} \qquad (43)$$

where

$R_{\text{c};eli}$ is the thermal resistance of opaque building element *eli*, as determined in 6.5.8, in m²·K/W.

Surface heat transfer coefficients:

The internal and external, convective and radiative surface heat transfer coefficients of element *eli*, $h_{\text{ci};eli}$ as function of heat flow direction and $h_{\text{ri};eli}$, $h_{\text{ce};eli}$, and $h_{\text{re};eli}$, are obtained from ISO 13789:2017, 9.5, in W/(m²·K).

Node heat capacities:

Each opaque element is assumed to be in a given class for the distribution of the mass in the construction. The specification for each class shall be obtained from Table A.13. The informative default specifications are given in Table B.13.

Depending on the class of construction with respect to the distribution of the mass in the construction, the areal heat capacity of node *pli* of opaque element *eli* per unit of area is divided over the nodes as follows:

Class I (mass concentrated at internal side):

$$\kappa_{\text{pl5};eli} = \kappa_{\text{m};eli}$$
$$\kappa_{\text{pl1};eli} = \kappa_{\text{pl2};eli} = \kappa_{\text{pl3};eli} = \kappa_{\text{pl4};eli} = 0 \qquad (44)$$

Class E (mass concentrated at external side):

$$\kappa_{\text{pl1};eli} = \kappa_{\text{m};eli}$$
$$\kappa_{\text{pl2};eli} = \kappa_{\text{pl3};eli} = \kappa_{\text{pl4};eli} = \kappa_{\text{pl5};eli} = 0 \tag{45}$$

Class IE (mass divided over internal and external side):

$$\kappa_{\text{pl1};eli} = \kappa_{\text{pl5};eli} = \frac{\kappa_{\text{m};eli}}{2}$$
$$\kappa_{\text{pl2};eli} = \kappa_{\text{pl3};eli} = \kappa_{\text{pl4};eli} = 0 \tag{46}$$

Class D (equally distributed):

$$\kappa_{\text{pl2};eli} = \kappa_{\text{pl3};eli} = \kappa_{\text{pl4};eli} = \frac{\kappa_{\text{m};eli}}{4}$$
$$\kappa_{\text{pl1};eli} = \kappa_{\text{pl5};eli} = \frac{\kappa_{\text{m};eli}}{8} \tag{47a}$$

Class M (mass concentrated inside):

$$\kappa_{\text{pl1};eli} = \kappa_{\text{pl2};eli} = \kappa_{\text{pl4};eli} = \kappa_{\text{pl5};eli} = 0$$
$$\kappa_{\text{pl3};eli} = \kappa_{\text{m};eli} \tag{47b}$$

where

$\kappa_{\text{m};eli}$ is the areal heat capacity of opaque element *eli,* as determined below, in J/(m²·K).

Each opaque element is assumed to be in one of a limited number of classes with a given value of the areal heat capacity for each class, $\kappa_{\text{m;op}}$, in J/(m²·K). The classes with values for the areal heat capacity of construction elements are obtained from Table A.14. The informative default specifications are given in Table B.14.

Alternative methods for the calculation of the thermal transmittance through opaque building elements may be allowed. Table A.10, presented in 6.5.5.2, provides the normative template for the choice between the prescribed calculation method or alternative method, with an informative default choice in Table B.10.

NOTE See also 6.5.6.

Temperature of external environment:

For construction elements to the outdoor environment, the temperature of the external environment at time interval *t*, $\theta_{\text{e};t}$ in Formula (41) is equal to the outdoor air temperature, $\theta_{\text{e;a};t}$, obtained from the relevant standard under EPB module M1-13.

For construction elements to a thermally unconditioned adjacent zone *k*, the temperature of the external environment at time interval *t*, $\theta_{\text{e};t}$ in Formula (41) is equal to the temperature of the unconditioned zone, $\theta_{\text{ztu},k;t}$ as determined in 6.4.5.3, in °C.

If the adjacent thermally conditioned space is a thermal zone of the assessed object and the option of calculation as thermally coupled thermal zones is chosen, the calculation rules of Annex D apply. In other cases: the construction element to the adjacent zone is treated as an internal partition (e.g. floor or wall) between the thermal zone and other buildings, as described in 6.5.6.3.

Solar absorption coefficient:

The solar absorption coefficient, $a_{sol;eli}$, at the external surface of opaque element *eli,* is obtained from Table A.15 (normative template), with informative default values given in Table B.15.

6.5.7.3 Elements in contact with the ground

All variables at the left side of the formulae are declared in 6.5.6.

Number of nodes:

The number of nodes, *pln* = 5.

Node conductances:

The conductance between nodes *pli* and node *pli*+1, is given by:

$$h_{pl4eli} = \frac{4}{R_{c;eli}}$$
$$h_{pl3;eli} = \frac{2}{R_{c;eli}}$$
$$h_{pl2;eli} = \frac{1}{\left(\frac{R_{c;eli}}{4} + \frac{R_{gr;eli}}{2}\right)} \qquad (48)$$
$$h_{pl1;eli} = \frac{2}{R_{gr;eli}}$$

where

$R_{c;eli}$ is the thermal resistance $=R_{c;fl;eff}$ of the ground floor element (including the effect of the ground), *eli*, as determined in 6.5.8.2, in m²·K/W;

$R_{gr;eli}$ is the thermal resistance of the fixed ground layer in the model for the ground floor element *eli*, as determined in 6.5.8.2, in m²·K/W.

Surface heat transfer coefficients:

The internal convective and radiative surface heat transfer coefficients of ground floor element *eli*, $h_{ci;eli}$ and $h_{ri;eli}$, are obtained from ISO 13789:2017, 9.5, in W/(m²·K).

The external convective and radiative surface heat transfer coefficients of ground floor element *eli*, $h_{ce;eli}$ and $h_{re;eli}$, are zero, but in the model the combined conductance is used for the thermal resistance of the virtual ground layer:

$$\left(h_{ce;eli} + h_{re;eli}\right) = 1 / R_{gr;vi;el;m} \qquad (49)$$

where

$R_{gr;vi;el;m}$ is the thermal resistance of a virtual ground layer, as determined in 6.5.8.2, in (m²·K)/W, and areal heat capacity, κ_{vi}, in J/m²·K);

Node heat capacities:

Depending on the class of construction with respect to the distribution of the mass in the construction, the areal heat capacity of node *pli* of the ground floor element *eli* per unit of area is divided over the node as follows:

Class I (mass concentrated at internal side):

$$\kappa_{\text{pl5};eli} = \kappa_{\text{m};eli}$$
$$\kappa_{\text{pl3};eli} = \kappa_{\text{pl4};eli} = 0 \quad (50a)$$

Class E (mass concentrated at external side):

$$\kappa_{\text{pl3};eli} = \kappa_{\text{m};eli}$$
$$\kappa_{\text{pl4};eli} = \kappa_{\text{pl5};eli} = 0 \quad (50b)$$

Class IE (mass divided over internal and external side):

$$\kappa_{\text{pl3};eli} = \kappa_{\text{pl5};eli} = \frac{\kappa_{\text{m};eli}}{2}$$
$$\kappa_{\text{pl4};eli} = 0 \quad (50c)$$

Class D (equally distributed):

$$\kappa_{\text{pl3};eli} = \kappa_{\text{pl5};eli} = \frac{\kappa_{\text{m};eli}}{4}$$
$$\kappa_{\text{pl4};eli} = \frac{\kappa_{\text{m};eli}}{2} \quad (50d)$$

Class M (mass concentrated inside):

$$\kappa_{\text{pl4};eli} = \kappa_{\text{m};eli}$$
$$\kappa_{\text{pl3};eli} = \kappa_{\text{pl5};eli} = 0 \quad (50e)$$

For all classes:

$$\kappa_{\text{pl2};eli} = \kappa_{\text{gr}}$$
$$\kappa_{\text{pl1};eli} = \kappa_{\text{gr;vi}} = 0 \quad (50f)$$

where

$\kappa_{\text{m};eli}$ is the areal heat capacity of the ground floor element *eli*, as determined below, in J/(m²·K);

κ_{gr} is the areal heat capacity of the fixed ground element, as determined in 6.5.8.2, in J/(m²·K).

NOTE 1 The areal heat capacity of the virtual ground element, $\kappa_{\text{gr;vi}}$, is zero.

Each ground floor element is assumed to be in one of a limited number of classes with a given value of the areal heat capacity for each class, $\kappa_{\text{m};eli}$, in J/(m²·K). The classes with values for the areal heat capacity of ground floor elements are the same as for opaque external elements, obtained from Table A.14. The informative default specifications are given in Table B.14.

Temperature of external environment:

For construction elements to the ground, the temperature of the external environment at time interval t, $\theta_{e;t}$ in Formula (41) is equal to the virtual ground temperature, $\theta_{gr;vi;m}$, as determined in 6.5.8.

NOTE 2 For construction elements externally bounded by water, the temperature of the external environment at time interval t, $\theta_{e;t}$ in Formula (41) is equal to the water temperature.

Solar absorption coefficient and sky radiation:

The solar absorption coefficient at the external surface of the ground floor element *eli* is zero: $a_{sol;eli} = 0$.

The thermal radiation to the sky at the external surface of the ground floor element *eli* is also set to zero: $\Phi_{sky;eli;t}$,= 0 for each time interval t.

Alternative solution techniques for the hourly thermal transmittance through ground coupled building elements may be allowed. Table A.10, presented in 6.5.5.2, provides the normative template for the choice between the prescribed technique or alternative technique, with an informative default choice in Table B.10.

6.5.7.4 Window, door and curtain walling elements

All variables at the left side of the formulae are declared in 6.5.6.

Number of nodes:

The number of nodes, $pln = 2$.

Node conductances:

The conductance between nodes pl1 and node pl2, is given by:

$$h_{pl1;eli} = \frac{1}{R_{c;eli}} \tag{51}$$

where

$R_{c;eli}$ is the thermal resistance of window, door and curtain walling elements *eli*, as determined in 6.5.8, in m²·K/W.

Surface heat transfer coefficients:

The internal and external, convective and radiative surface heat transfer coefficients of element *eli*, $h_{ci;eli}$ as function of heat flow direction and $h_{ri;eli}$, $h_{ce;eli}$, and $h_{re;eli}$, are obtained from ISO 13789:2017, 9.5, in W/(m²·K).

Node heat capacities:

And the areal heat capacity, $\kappa_{pli;eli}$, of node *pli* of transparent element *eli*:

$$\kappa_{pl1;eli} = \kappa_{pl2;eli} = 0 \tag{52}$$

Temperature of external environment:

For construction elements to the outdoor environment, the temperature of the external environment at time interval t, $\theta_{e;t}$ in Formula (41) is equal to the outdoor air temperature, $\theta_{e;a;t}$, obtained from the relevant standard under EPB module M1-13.

For construction elements to a thermally unconditioned adjacent zone k, the temperature of the external environment at time interval t, $\theta_{e;t}$ in Formula (41) is equal to the temperature of the unconditioned zone, $\theta_{ztu,k;t}$ as determined in 6.4.5.3, in °C.

Solar absorption coefficient:

The solar absorption coefficient at the external surface of the transparent element *eli* is zero: $a_{sol;eli} = 0$.

NOTE 3 The effect of absorbed solar radiation in transparent construction elements is included in the total solar energy transmittance, *g*.

6.5.8 Thermal transmission properties

6.5.8.1 Opaque building elements

For external opaque building elements(walls and roofs) the following properties shall be obtained from ISO 13789:

— the area of the construction, A_c, in m^2;

— the thermal resistance, R_c, in $(m^2 \cdot K)/W$.

If the construction element is connected to an adjacent thermally unconditioned zone *ztu*, in case Method 2 (Internal unconditioned zone, ztui) of 6.4.5 is applied, the thermal resistance shall be corrected as shown below.

6.5.8.2 Elements in thermal contact with the ground

For building elements in thermal contact with the ground, including slab-on-ground floors, suspended floors and basements, the following properties shall be shall be obtained from ISO 13789:

— the area of the construction, A_c, in m^2;

— the effective thermal resistance of the floor including the effect of the ground, $R_{c;fl;eff}$, in $(m^2 \cdot K)/W$;

— the thermal resistance, R_{gr}, in $(m^2 \cdot K)/W$, and the areal heat capacity, κ_{gr}, in J, of a 0,5 m thick ground layer;

— the thermal resistance, $R_{gr;vi}$, in $(m^2 \cdot K)/W$, and areal heat capacity, $\kappa_{gr;vi}$, in $J/(m^2 \cdot K)$, of a virtual ground layer;

— the virtual ground temperature, $\theta_{gr;vi;m}$, in °C, for each month *m*.

NOTE 1 The properties are calculated in ISO 13370, but all thermal transmission properties are gathered via ISO 13789, in order ensure consistency. See ISO/TR 52016-2[1].

NOTE 2 More information on the calculation procedures for ground floor heat transfer can be found in ISO/TR 52016-2[1] and ISO/TR 52019-2[10].

6.5.8.3 Window, door and curtain walling elements

For transparent building elements (window, door or curtain wall), the following properties shall be shall be obtained from ISO 13789:

— the area of the construction, A_c, in m^2;

— the thermal transmittance of windows and doors, U_w and U_d, in $W/(m^2 \cdot K)$;

NOTE 3 The thermal transmittance or *U*-value on the CE-marking, based on the product standard EN 14351-1[9] is only valid if the size of the window or door in question differs less than 10% from the size used in EN 14351-1. Quote from EN 14351-1:2005: “Where detailed calculation of the heat loss from a specific building is required, the manufacturer shall provide accurate and relevant, calculated or tested thermal transmittance values (design values) for the size(s) in question.”

— in case of windows, when shutters are present, the thermal transmittance of a window with closed shutters, U_{wsht} in $W/(m^2 \cdot K)$, shall be obtained from ISO 13789; whether a shutter is present at the given time interval or not, is obtained on an hourly basis in accordance with G.2.2.1 in Annex G.

— the thermal transmittance of curtain walling, U_{cw}, in W/(m²·K).

— for a dynamic window or façade the thermal transmittance is obtained on an hourly basis in accordance with G.2.2.1 in Annex G.

The thermal resistance of a window, door or curtain walling element is given by:

$$R_c = \frac{1}{U_c} - R_{si;v} - R_{se;v} \tag{53}$$

where

R_c is the thermal resistance of window or door element, in m²·K/W;

$R_{si;v}$ is the internal surface thermal resistance of window, door and curtain walling elements for vertical position, $R_{si;v}$ = 0,13 W/(m²·K);

$R_{se;v}$ is the external surface thermal resistance of window and door elements for vertical position, $R_{se;v}$ = 0,04 W/(m²·K);

U_c is the heat transfer coefficient of window, door or curtain walling element as external construction element, in W/(m²·K).

NOTE 4 The rationale for using internal and external surface thermal resistance of window, door and curtain walling elements for vertical position is described in ISO/TR 52016-2[1].

If the construction element is connected to an adjacent thermally unconditioned zone *ztu*, in case Method 2 (Internal unconditioned zone, ztui) of 6.4.5 is applied, the thermal resistance shall be corrected as shown below.

6.5.8.4 Correction of thermal resistance in case of internal adjacent thermally unconditioned zone (“Method 2”, ztui)

In case of a construction element, *eli*, connected to an adjacent thermally unconditioned zone *ztu*, in case Method 2 (Internal unconditioned zone, ztui) of 6.4.5 is applied, the thermal resistance, $R_{c;k}$, shall be corrected as given by the following formula:

$$R_{c,eli(\mathrm{corrected});m} = \frac{R_{c,eli} + b_{ztu;m} \cdot \left(1 / h_{si,eli} + 1 / h_{se,eli}\right)}{\left(1 - b_{ztu;m}\right)} \tag{54}$$

with

$$h_{si,eli} = h_{ci,eli} + h_{ri,eli} \tag{55}$$

$$h_{se,eli} = h_{ce,eli} + h_{re,eli} \tag{56}$$

where

$b_{ztu,m}$ is the adjustment factor for the thermally unconditioned zone *ztu*, for month *m*, determined in accordance with 6.4.5.4;

$h_{ci;eli}$ is the convective heat transfer coefficient at the internal surface of the construction element *eli*, obtained from ISO 13789:2017, 9.5 , in W/(m²·K);

$h_{ri;eli}$ is the long-wave radiative heat transfer coefficient of the construction element *eli* at the internal surface, obtained from in ISO 13789:2017, 9.5, in W/(m²·K);

$h_{ce;eli}$ is the convective heat transfer coefficient of the construction element *eli* at the external surface, obtained from ISO 13789:2017, 9.5, in W/(m²·K);

$h_{re;eli}$ is the long-wave radiative heat transfer coefficient of the construction element *eli* at the external surface, obtained from ISO 13789:2017, 9.5, in W/(m²·K).

6.5.8.5 Thermal bridges

The overall heat transfer coefficient for thermal bridges, $H_{tr;tb;zt}$, in W/K, is calculated with the following formula:

$$H_{tr;tb;zt} = \sum_k \left(l_{tb;k} \cdot \Psi_{tb;k} \right) \quad (57)$$

where, for thermal zone *zt*

$l_{tb;k}$ is the length of a linear thermal bridge *k*, obtained from ISO 13789, in m.;

$\Psi_{tb;k}$ is the linear thermal transmittance of a linear thermal bridge *k*, obtained from ISO 13789, in W/(m·K).

NOTE 5 This includes the thermal bridge of ground floor edge.

NOTE 6 See Note 1 in 6.6.5.2.

Alternatively, the overall heat transfer coefficient for thermal bridges, $H_{tr;tb;zt}$, in W/K, is directly obtained as overall (default) value from ISO 13789.

6.5.9 Temperature of adjacent thermally unconditioned zone

In case of an external thermally unconditioned zone (see 6.4.5), the effect of the external partition on the heat transfer by transmission and ventilation and on the internal and solar gains in the adjacent thermally unconditioned zone is taken into account by replacing the temperature of the external (outdoor) environment by the temperature of the thermally unconditioned zone.

The temperature in that zone k, $\theta_{\text{ztu},k;t}$, in °C, is based on the adjustment factor, $b_{\text{ztu},k}$, for the thermally unconditioned zone plus the gains in the thermally unconditioned zone:

$$\theta_{ztu;t} = \theta_{\text{int;op};ztc;(t-1)} - b_{ztu;m} \cdot \left(\theta_{\text{int;op};ztc;(t-1)} - \theta_{\text{e};t}\right) + \frac{\Phi_{\text{gn;dir};ztu,k;t}}{H_{ztu;\text{tot};m}} \tag{58}$$

with a maximum value:

$$\theta_{ztu;t} = \min\left(\theta_{\text{e};t} + c_{\text{ztu;h;max}}\left(\theta_{\text{int;op};ztc;(t-1)} - \theta_{\text{e};t}\right);\theta_{ztu;t}\right) \tag{59}$$

and with:

$$\Phi_{\text{gn;dir};ztu;t} = \Phi_{\text{int;dir};ztu;t} + \Phi_{\text{sol;dir};ztu;t} \tag{60}$$

where, at time interval t

$\theta_{\text{int;op};ztc;t\text{-}1}$ is the internal operative temperature in the thermally conditioned zone ztc at the previous time interval (t-Δt),determined in accordance with 6.5.5.3, in °C;

in case of multiple adjacent thermally conditioned zones, the temperatures are weighted according to the distribution factor for the heat transfer between the thermally conditioned zone $ztcj$ and the thermally unconditioned zone ztu, $F_{ztcj;ztu;m}$, as determined in 6.4.5.4;

$b_{ztu;m}$ is the adjustment factor for the thermally unconditioned adjacent zone ztu, in month m, as determined in 6.4.5.4;

$\theta_{\text{e};t}$ is the temperature of the external environment, obtained from the relevant standard under EPB module M1-13, in °C;

$c_{\text{ztu,h;max}}$ is a coefficient to limit the assumed temperature in the thermally unconditioned zone, obtained according to Table A.16 (normative template) with informative default value in Table B.16;

$\Phi_{\text{gn;dir};ztu;t}$ is the sum of the internal and solar gains in the thermally unconditioned zone ztu, in W;

$\Phi_{\text{int;dir};ztu;t}$ are the internal gains in the thermally unconditioned zone ztu, as determined in E.3 in Annex E, in W;

$\Phi_{\text{sol;dir};ztu;t}$ are the solar gains in the thermally unconditioned zone ztu, as determined in E.3 in Annex E, in W;

$H_{ztu;\text{tot};m}$ is the sum of the heat transfer coefficients between the thermally unconditioned zone ztu, the adjacent thermally conditioned zone(-s) and the external environment for month m, determined in accordance with Formula (3), in W/K.

NOTE 1 For simplicity, no distinction is made between air or operative temperature in a thermally unconditioned zone.

NOTE 2 The rationale for the maximum value is described in ISO/TR 52016-2[1].

6.5.10 Ventilation heat transfer coefficient, supply temperature and moisture content

6.5.10.1 Heat transfer coefficient by ventilation

The heat transfer coefficient by ventilation for air flow element k, $H_{\text{ve},k;t}$, shall be obtained on an hourly basis as given by the following formula:

$$H_{\text{ve},k;t} = \rho_{\text{a}} \cdot c_{\text{a}} \cdot q_{\text{V},k;t} \tag{61}$$

where, for time interval t

$H_{\text{ve},k;t}$ is heat transfer coefficient by ventilation air flow element k, in W/K;

$\rho_{\text{a}}\cdot c_{\text{a}}$ is the heat capacity of air per volume, as specified in 6.3.6, in J/(m^3·K);

$q_{\text{V},k;t}$ is the airflow rate of air flow element, k, as provided by the relevant standard(s) under EPB module M5-5, in m^3/s.

NOTE 1 All relevant types of air flow in a zone, such as due to mechanical ventilation, passive duct ventilation, air infiltration, combustion air flow and window opening are represented by an air flow element k.

In case of an air flow element, k, for ventilation, including air infiltration, from an adjacent thermally unconditioned zone *ztu*, in case Method 2 (Internal unconditioned zone, ztui) of 6.4.5 is applied, the heat transfer coefficient by ventilation, $H_{\text{ve},k;t}$, shall be obtained on an hourly basis as given by the following formula:

$$H_{\text{ve},k;t} = b_{ztu;m} \cdot \rho_{\text{a}} \cdot c_{\text{a}} \cdot q_{\text{ve},k;t} \tag{62}$$

where

$b_{ztu;m}$ is the adjustment factor for the thermally unconditioned zone *ztu*, for month m, determined in accordance with 6.4.5.4;

and with the other variables declared in the previous formula.

NOTE 2 In case of an external type (as defined in 6.4.5.1) of thermally unconditioned zone the effect of the adjacent thermally unconditioned zone is taken into account by the supply temperature.

6.5.10.2 Supply temperature

The supply temperature of air flow element k at time interval t, $\theta_{\text{sup},k;t}$, is equal to:

— for ventilation, including air infiltration, from the exterior: the value of the temperature of the external environment, $\theta_{\text{e};t}$, obtained from the relevant standard under EPB module M1-13;

— in case of an air flow element, k, for ventilation, including air infiltration, from an adjacent external type (as defined in 6.4.5.1) of thermally unconditioned zone: the temperature of the thermally unconditioned zone, $\theta_{\text{ztu},k;t}$, which is obtained in accordance with 6.5.9;

— in case of a ventilation system element with a supply temperature different from the external air temperature: $\theta_{\text{sup};k;t}$ shall be obtained from the relevant standards under EPB module M5-6.

NOTE 3 This concerns for instance pre-heating or pre-cooling, heat recovery (with optional effects of by pass and/or frost protection), but also for instance external air heated by dissipated heat from fans and/or by heat leakage into or from the air ducts before reaching the considered thermal zone.

This is not applicable for air heating or cooling, where the supply temperature is fully controlled by the internal temperature (no pre-heating but air heating).

NOTE 4 The rationale for this is given in ISO/TR 52016-2[1].

6.5.10.3 Heat transfer to adjacent thermally conditioned spaces:

If the adjacent thermally conditioned space is a thermal zone of the assessed object and the option of calculation as thermally coupled thermal zones is chosen, the calculation rules of Annex D apply. In other cases: the air flow rate from the adjacent space is ignored.

6.5.11 Thermal capacity of the internal environment of the thermal zone

NOTE 1 From the perspective of the overall accuracy the value of the internal heat capacity can be approximate: a relative uncertainty ten times higher than that of the heat transfer is acceptable.

The thermal capacity of the internal environment of the thermally conditioned zone *ztc* is given by:

$$C_{\mathrm{m;int;a;}ztc} = \kappa_{\mathrm{m;int;a;}ztc} \cdot A_{\mathrm{use;}ztc} \tag{63}$$

where, for the thermally conditioned zone *ztc*

$C_{\mathrm{m;int;a;}ztc}$ is the thermal capacity of the internal environment of the zone, in J/K;

$\kappa_{\mathrm{m;int;a;}zt}$ is the areal thermal capacity of air and furniture, as determined in Table A.17 (normative template), with informative value in Table B.17, in J/(m²·K);

$A_{\mathrm{use;}ztc}$ is the useful floor area of the zone, as determined in 6.4.3, in m².

NOTE 2 The areal thermal capacity of internal partitions within the zone is taken into account separately (see also 6.5.6 - 6.5.8), although the parts that may be considered as directly accessible, without thermal resistance, could be included in the specific thermal capacity of air and furniture, by increasing this factor.

6.5.12 Internal heat gains

6.5.12.1 Overall internal heat gains into thermally conditioned zone

For a thermally conditioned zone *ztc* the heat gains from internal heat sources, $\Phi_{\mathrm{int;}ztc;t}$, in W, are calculated with the following formula:

$$\Phi_{\mathrm{int;}ztc;t} = \Phi_{\mathrm{int;dir;}ztc;t} \tag{64}$$

But in case of adjacent internal thermally unconditioned zones (see 6.4.5):

$$\Phi_{\mathrm{int;}ztc;t} = \Phi_{\mathrm{int;dir;}ztc;t} + \sum_{ztu=1}^{ztun} \left[\left(1 - b_{ztu;m}\right) \cdot F_{ztc;ztu;m} \cdot \Phi_{\mathrm{int;dir;}ztu;t} \right] \tag{65}$$

where, at time interval *t*

$\Phi_{\mathrm{int;dir;}ztc/ztu;t}$ are the internal heat gains in the thermally conditioned zone *ztc* / thermally unconditioned zone *ztu* itself, as determined in 6.5.12.2, in W;

$b_{ztu,\mathrm{m}}$ is the adjustment factor for adjacent thermally unconditioned zone *ztu*, for month *m*, as determined in 6.4.5.4;

$F_{ztc;ztu;m}$ is the distribution factor for gains in the thermally unconditioned zone *ztu* to the adjacent thermally conditioned zone *ztc*, for month *m*, as determined in 6.4.5.4.

NOTE See ISO/TR 52016-2[1] for an overview of the differences in calculation procedures for transmission and ventilation heat transfer and for internal and solar gains for both types (internal and external) of thermally unconditioned zones.

6.5.12.2 Internal heat gain sources into a thermal zone

For each thermally conditioned or unconditioned zone *zt* and for each time interval *t*, the heat gains from internal heat sources in a zone whether thermally conditioned or not, $\Phi_{int;,dir zt}$, in W, are calculated with the following formula:

$$\Phi_{int;dir;zt;t} = \left(q_{int;oc;zt;t} + q_{int;A;zt;t} + q_{int;L;zt;t} + q_{int;WA;zt;t} + q_{int;HVAC;zt;t} + q_{int;proc;zt;t}\right) \cdot A_{use;zt} \quad (66)$$

where, for thermal zone *zt* at time interval *t*

$q_{int;oc;zt;t}$ is the specific internal heat flow rate due to metabolic heat from occupants, as determined in the relevant standard under EPB module M1-6, in W/m^2;

$q_{int;A;zt;t}$ is the specific internal heat flow rate due to dissipated heat from appliances, as determined in the relevant standard under EPB module M1-6, in W/ m^2;

$q_{int;L;zt;t}$ is the specific internal heat flow rate due to recoverable losses from lighting, as determined in the relevant standard under EPB module M9-1, in W/ m^2;

$q_{int;WA;zt;t}$ is the specific internal heat flow rate due to recoverable losses from hot and mains water and sewage systems, as determined in the relevant standards under EPB modules M3-1 and M8-1, in W/ m^2;

$q_{int;HVAC;zt;t}$ is the specific internal heat flow rate due to recoverable losses from or to heating, cooling and ventilation systems, as determined in the relevant standards under EPB modules M3-1, M4-1 and M5-1, in W/ m^2; for the calculation of the system specific energy needs, system specific values may apply;

$q_{int;proc;zt;t}$ is the specific internal heat flow rate due to recoverable losses from or to processes and goods, as determined in the relevant standard under EPB module M1-6, in W/ m^2;

$A_{use;zt}$ is the useful floor area of the zone, as determined in 6.4.3, in m^2.

The principles for the calculation with regard to the recoverable heat losses are described in ISO 52000-1:2017, 8.1.3. This document considers only the heat recoverable in the building and not already (assumed to be) recovered in the system or subsystem.

NOTE 1 More details are given in ISO/TR 52016-2[1].

NOTE 2 A cold source, removing heat from the building (zone), shall be treated as a source, with a negative value.

6.5.13 Solar gains

6.5.13.1 Overall solar heat gains into thermally conditioned zone

For each thermally conditioned zone *ztc* the direct solar heat gains, $\Phi_{sol;ztc;t}$, in W, are calculated with the following formula:

$$\Phi_{sol;ztc;t} = \Phi_{sol;dir;ztc;t} \tag{67}$$

But in case of Method 2 (Internal unconditioned zone) of 6.4.5 is applied for one or more adjacent thermally unconditioned zones:

$$\Phi_{sol;ztc;t} = \Phi_{sol;dir;ztc;t} + \sum_{ztu=1}^{ztun} \left[\left(1 - b_{ztu;m}\right) \cdot F_{ztc;ztu;m} \cdot \Phi_{sol;dir;ztu;t} \right] \tag{68}$$

where, for thermal zone *ztc*, at time interval *t*

$\Phi_{sol;dir;ztc/ztu;t}$ are the direct solar gains in the thermally conditioned zone *ztc* / thermally unconditioned zone *ztu* itself, as determined in 6.5.13.2, in W;

$b_{ztu,m}$ is the adjustment factor for adjacent thermally unconditioned zone *ztu*, for month *m*, as determined in 6.4.5.4;

$F_{ztc;ztu;m}$ is the distribution factor for gains in the thermally unconditioned zone *ztu* attributed to the adjacent thermally conditioned zone *ztc*, for month *m*, as determined in 6.4.5.4.

NOTE See note in 6.5.12.1.

6.5.13.2 Solar heat gain sources into a thermal zone

The direct solar gains into the zone, summed over all transparent building elements (hereafter called windows), *wi* = 1,... *win* in the zone, is given by:

$$\Phi_{sol;dir;zt;t} = \sum_{wi=1}^{win} \left[g_{gl;wi;t} \cdot \left(I_{sol;dif;wi;t} + I_{sol;dir;wi;t} \cdot F_{sh;obst;wi;t} \right) \cdot A_{wi} \cdot \left(1 - F_{fr;wi}\right) \right] \tag{69}$$

where, for thermal zone *zt*, at time interval *t*

$\Phi_{sol;dir;zt;t}$ are the direct solar gains into the zone *zt*, summed over all windows *wi*, at time interval *t*, in W;

$g_{gl;wi;t}$ is the total solar energy transmittance of the transparent part of window *wi*, as determined in E.2.2;

A_{wi} is the area of window *wi*, as determined for thermal transmission properties in 6.5.8, in m^2; in case of protruded components the projected area shall be used;

$I_{sol;dir;tot;wi;t}$ is the direct part (excluding circumsolar) of the solar irradiance on window *wi*, with tilt angle β_{wi} and orientation angle γ_{wi}, obtained from the relevant standard under EPB module M1-13, in W/m^2;

$I_{sol;dif;tot;wi;t}$ is the diffuse part (including circumsolar) of the solar irradiance on window *wi*, with tilt angle β_{wi} and orientation angle γ_{wi}, obtained from the relevant standard under EPB module M1-13, in W/ m^2;

$F_{sh;obst;wi;t}$ is the shading reduction factor for external obstacles for window *wi*, at time interval *t*, as calculated for all types of building envelope elements in normative Annex F;

$F_{fr,wi}$ is the frame area fraction of window wi, ratio of the projected frame area to the overall projected area of the glazed element of window wi, as determined in E.2.1;

β_{wi} is the tilt angle of the window wi (from horizontal, measured upwards facing), obtained from the geometric data of the construction element, in degrees;

γ_{wi} is the orientation angle of the window wi, obtained from the geometric data of the construction element, in degrees (expressed as the geographical azimuth angle of the horizontal projection of the inclined surface normal; convention: angle from South, eastwards positive, westwards negative).

NOTE 1 For transparent building elements, the calculation of the solar transmittance is simplified. The total solar energy transmittance, $g_{gl;wi;t}$, (direct solar transmittance, plus effect from the absorption in and (multiple) reflection at the transparent element itself and other layers of the element) are approximated as being all direct transmittance through the window into the thermal zone. No additional absorption or reflectance components can therefore be taken into account.

NOTE 2 The shading reduction factor is given as a function of time t. However, it can be simplified as a constant factor over time, e.g. monthly or seasonal values.

NOTE 3 'External obstacles for the transparent element' are nearby obstacles such as overhangs or adjacent building parts. Distant obstacles can also be taken into account, depending on the choice made in this respect as provided in Annex F.

The direct solar gains of a thermally unconditioned zone k, $\Phi_{sol;ztu,k;t}$, in W, is determined in E.3.

6.5.13.3 Thermal radiation to the sky

The (extra) thermal radiation to the sky is given by:

$$\Phi_{sky;eli;t} = F_{sky;eli} \cdot h_{re;eli} \cdot \Delta\theta_{sky;t} \tag{70}$$

where, for each element eli and each time interval t

$\Phi_{sky;eli}$ is the extra thermal radiation to the sky from the element, in W/m^2;

$F_{sky;eli}$ is the view factor to the sky, as obtained from Table A.18. The informative default values are given in Table B.18;

$h_{re;eli}$ is the external radiative surface heat transfer coefficient, as determined as $h_{lr;e}$ in 6.5.8 for the thermal transmission, in W/(m^2·K);

$\Delta\theta_{sky;t}$ is the average difference between the apparent sky temperature and the air temperature, obtained from Table A.19. The informative default values are given in Table B.19, in K.

6.5.14 Moisture content and latent heat load

6.5.14.1 Humidification and dehumidification load

6.5.14.1.1 Calculation procedure

The humidification moisture load, $G_{HU;ld;ztc;t}$, in kg/s, needed to maintain a minimum moisture set-point in a thermally conditioned zone ztc, is given by:

$$\begin{aligned} G_{HU;ld;ztc;t} = {} & \sum_k \left[\rho_a \cdot q_{V;k;t} \cdot \left(x_{set;min;ztc;t} - x_{a;sup,k;t} \right) \right] - G_{int;ztc;t} \\ & + G_{abs;ztc;t} + \frac{\rho_a \cdot V_{int;a;ztc}}{\Delta t} \cdot \left(x_{set;min;ztc;t} - x_{int;a;ztc;t-1} \right) \end{aligned} \tag{71}$$

with: $G_{HU;\text{ld};ztc;t} = \max\left(G_{HU;\text{ld};ztc;t};0\right)$

The dehumidification moisture load, $G_{\text{DHU;ld};ztc;t}$, in kg/s, needed to maintain a maximum moisture set-point, is given by:

$$G_{\text{DHU;ld};ztc;t} = -\sum_{k}\left[\rho_{\text{a}} \cdot q_{\text{V};k;t} \cdot \left(x_{\text{set;max};ztc;t} - x_{\text{a;sup},k;t}\right)\right] + G_{\text{int};ztc;t} - G_{\text{abs};ztc;t} - \frac{\rho_{\text{a}} \cdot V_{\text{int;a};ztc}}{\Delta t} \cdot \left(x_{\text{set;max};ztc;t} - x_{\text{int;a};ztc;t-1}\right) \quad (72)$$

with: $G_{\text{DHU;ld};ztc;t} = \max(G_{\text{DHU;ld};ztc;t};0)$

where, for the thermally conditioned zone *ztc* and time interval *t*

$G_{\text{HU;ld};ztc;t}$ is the humidification moisture (supply) load needed to maintain a minimum moisture set-point, in kg/s;

$G_{\text{DHU;ld};ztc;t}$ is the dehumidification moisture (removal) load (value ≥ 0) needed to maintain a maximum moisture set-point, in kg/s;

ρ_{a} is the air density, as specified in 6.3.6, in kg/ m^3;

$q_{\text{V};k;t}$ is the volume flow rates of all air flow elements *k* entering the zone, as determined in the relevant standard(s) under EPB module M5-5, in m^3/s;

$x_{\text{set;min};ztc;t}$ is the minimum moisture content set-point, as determined in 6.5.14.1.2, in kg/kg dry air;

$x_{\text{set;max};ztc;t}$ is the maximum moisture content set-point, as determined in 6.5.14.1.2, in kg/kg dry air;

$x_{\text{a;sup},k;t}$ is the moisture content of all air flow elements *k* entering the zone, as determined in 6.5.14.1.3, in kg/kg dry air; in this formula, for the determination of the (de-)humidification load, the supply air flow of the mechanical ventilation is assumed to be untreated: $x_{\text{a;sup;mech};t} = x_{\text{e;a};t}$, the moisture content of outdoor air;

$G_{\text{int};ztc;t}$ is the moisture production in the zone, as determined on an hourly basis in the relevant standard under EPB module M1-6, in kg/s;

$G_{\text{abs};ztc;t}$ is the moisture absorption (positive value) or desorption (negative value) in materials in the zone, obtained according to Table A.20 (normative template, with informative choice in Table B.20), in kg/s;

$V_{\text{int;a};ztc}$ is the volume of the indoor air of the zone, in m^3;

$x_{\text{int;a};ztc;t\text{-}1}$ is the internal moisture content in the zone at previous time interval (t-Δt), in kg/kg dry air;

Δt is the length of the time interval *t*, in s.

The humidification or dehumidification moisture load can be converted to the latent heat (humidification or dehumidification) load:

$$\Phi_{\text{HU;ld};ztc;t} = h_{\text{we}} \cdot G_{\text{HU;ld};ztc;t} \quad (73)$$

$$\Phi_{\text{DHU;ld};ztc;t} = h_{\text{we}} \cdot G_{\text{DHU;ld};ztc;t} \quad (74)$$

where, for the thermally conditioned zone *ztc* and time interval *t*

$\Phi_{HU;ld;ztc;t}$	is the latent heat load for humidification at time interval t, in kg/s;
$\Phi_{DHU;ld;ztc;t}$	is the latent heat load for dehumidification (value ≥ 0) at time interval t, in kg/s;
h_{we}	the latent heat of vaporization of water, as specified in 6.3.6, in J/kg.

6.5.14.1.2 The minimum and maximum moisture content set-points

The minimum moisture content set-point for zone ztc, at time interval t is

$$x_{set;min;ztc;t} = 0{,}622 \times \frac{\frac{\varphi_{int;set;HU;ztc;t}}{100} \cdot p_{sat;int;ztc;t}}{p_{atm} - \frac{\varphi_{int;set;HU;ztc;t}}{100} \cdot p_{sat;int;ztc;t}} \quad (75)$$

The maximum moisture content set-point for zone ztc, at time interval t is

$$x_{set;max;ztc;t} = 0{,}622 \times \frac{\frac{\varphi_{int;set;DHU;t}}{100} \cdot p_{sat;int;ztc;t}}{p_{atm} - \frac{\varphi_{int;set;DHU;t}}{100} \cdot p_{sat;int;ztc;t}} \quad (76)$$

where, for the thermally conditioned zone ztc and time interval t

$x_{set;min;ztc;t}$	is the minimum moisture content set-point, in kg/kg dry air;
$x_{set;max;ztc;t}$	is the maximum moisture content set-point, in kg/kg dry air;
$\varphi_{int;set;HU;ztc;t}$	is the set-point relative humidity for humidification, for the zone, as determined in the relevant standard under EPB module M1-6, in %;
$\varphi_{int;set;DHU;ztc;t}$	is the set-point relative humidity for dehumidification, as determined in the relevant standard under EPB module M1-6, in %;
p_{atm}	is the atmospheric pressure as determined in 6.3.6, in Pa.

The saturation pressure of the zone air is

$$p_{sat;int;ztc;t} = 611{,}2 \times e^{\frac{17{,}62 \times \theta_{int;a;ztc;t}}{243{,}12 + \theta_{int;ztc;t}}} \quad (77)$$

where

$\theta_{int;a;ztc;t}$	is the air temperature of the zone, at time interval t.

6.5.14.1.3 Moisture content of supply air flows

For ventilation, including air infiltration, from the exterior, the moisture content of air flow element k, $x_{a;sup,k;t}$, is the value of the moisture content of the external environment, $x_{a;e;t}$, obtained in accordance with the relevant standard under EPB module M1-13.

For ventilation, including air infiltration, from an adjacent indoor space, the moisture content of air flow element k, $x_{a;sup,k;t}$, is assumed to be equal to the moisture content of the zone air at the previous time interval (t-Δt).

In case of a ventilation system element with air other than untreated external air, the moisture content of air flow element k, $x_{a;sup,k;t}$, shall be obtained from the relevant standard(s) under EPB module M5-6.

NOTE This includes situations where the air from the ventilation system is humidified or dehumidified at central level, in order to control the humidity level in the considered thermal zone, for instance as described in 6.5.14.2.

6.5.14.2 Central (de-)humidification

If the humidification or dehumidification moisture load needs to be covered by the air flow of the supply air of the mechanical ventilation, the minimum or maximum required moisture content of the supply air are given by:

$$x_{a;sup;HU;req;ztc;t} = x_{a;e;t} + \frac{G_{HU;ld;ztc;t}}{\rho_a \cdot q_{V;mech;k;t}} \tag{78}$$

$$x_{a;sup;DHU;req;ztc;t} = x_{a;e;t} - \frac{G_{DHU;ld;ztc;t}}{\rho_a \cdot q_{V;mech;k;t}} \tag{79}$$

where, for the thermally conditioned zone ztc and time interval t

$x_{a;sup;HU/DHU;req;ztc;t}$	is the required moisture content for central (de-)humidification of the mechanical supply air k entering the zone, in kg/kg dry air;
$q_{V;mech;k;t}$	is the volume flow rate of the mechanical supply air flow k entering the zone, as determined in the relevant standard(s) under EPB module M5-5, in m^3/s;

and with the other variables declared in the previous formulae.

These data are input for the relevant system standards under EPB modules M6-5 and M7-5. Whether or not the air conditioning system can meet the required moisture content is to be determined in these system standards.

NOTE Unlike the procedures for the sensible heating and cooling, where a maximum available heating and cooling power is given as input, this cannot be calculated directly in this document, because of the diversity of possible systems.

The relevant system standards under EPB modules M6-5 and M7-5, in case of central (de-)humidification, shall produce as their output, as input to this document, the actual system specific moisture content of the mechanical supply air, $x_{a;sup;ss;zt;t}$, , in kg/kg dry air.

The resulting system specific moisture content of the zone zt at the current time interval t is equal to:

$$x_{int;a;ztc;t} = \frac{\sum_k \left(\rho_a \cdot q_{V;k;t} \cdot x_{a;sup,k;t}\right) + \left(G_{int;ztc;t} - G_{abs;ztc;t}\right) + \frac{\rho_a \cdot V_{int;a;ztc}}{\Delta t} \cdot x_{int;a;ztc;t-1}}{\sum_k \left(\rho_a \cdot q_{V;k;t}\right) + \frac{\rho_a \cdot V_{int;a;ztc}}{\Delta t}} \tag{80}$$

where, for the thermally conditioned zone ztc and time interval t

$x_{int;a;ztc;t}$	is the resulting actual system specific moisture content of the zone (for central dehumidification), in kg/kg dry air;
$x_{a;sup,k;t}$	is the moisture content of all air flow elements k entering the zone; as determined in 6.5.14.1.3, in kg/kg dry air; with, in this formula, for mechanical ventilation: $x_{a;sup;mech;t} = x_{a;sup;ss;zt;t}$, the actual, system specific moisture content of the mechanical supply air, to be obtained from the relevant system standards under EPB modules M6-5 and M7-5;

and with the other variables declared in the previous formulae.

The resulting system specific humidification or dehumidification moisture load is equal to:

$$G_{\text{HU/DHU;ld;ss;}ztc;t} = \rho_{\text{a}} \cdot q_{\text{V;}k;t} \cdot \left(x_{\text{a;sup;ss;}ztc;t} - x_{\text{a;e;}t}\right) \tag{81}$$

and:

$$G_{\text{HU;ld;ss;}ztc;t} = \max(+G_{\text{HU/DHU;ld;ss;}ztc;t};0)$$

$$G_{\text{DHU;ld;ss;}ztc;t} = \max(-G_{\text{HU/DHU;ld;ss;}ztc;t};0)$$

where, for the thermally conditioned zone *ztc* and time interval *t*

$G_{\text{HU;ld;ss;}ztc;t}$	is the system specific humidification moisture (supply) load for humidification, in kg/s;
$G_{\text{DHU;ld;ss;}ztc;t}$	is the system specific dehumidification moisture (removal) load for dehumidification (value ≥ 0), in kg/s;

and with the other variables declared in the previous formulae.

Conversion to the system specific latent heat (humidification or dehumidification) load:

$$\Phi_{\text{HU;ld;ss;}ztc;t} = h_{\text{we}} \cdot G_{\text{HU;ld;ss;}ztc;t} \tag{82}$$

$$\Phi_{\text{DHU;ld;ss;}ztc;t} = h_{\text{we}} \cdot G_{\text{DHU;ld;ss;}ztc;t} \tag{83}$$

where, for the thermally conditioned zone *ztc* and time interval *t*

$\Phi_{\text{HU;ld;ss;}ztc;t}$	is the system specific latent heat load for humidification, in kg/s;
$\Phi_{\text{DHU;ld;ss;}ztc;t}$	is the system specific latent heat load for dehumidification (value ≥ 0), in kg/s;
h_{we}	the latent heat of vaporization of water, as specified in 6.3.6, in J/kg.

6.5.14.3 Moisture content in thermal zone, local or no humidification or dehumidification

The moisture content of the zone *zt* in case of local or no (de-)humidification system, at the time interval *t* is equal to:

$$x_{\text{int;a;}ztc;t} = \frac{\sum_k \left(\rho_{\text{a}} \cdot q_{\text{V;}k;t} \cdot x_{\text{a;sup,}k;t}\right) + \left(G_{\text{HU/DHU;ss;}ztc;t} + G_{\text{int;}zt;t} - G_{\text{abs;}ztc;t}\right) + \frac{\rho_{\text{a}} \cdot V_{\text{int;a;}zt}}{\Delta t} \cdot x_{\text{int;a;}ztc;t-1}}{\sum_k \left(\rho_{\text{a}} \cdot q_{\text{V;}k;t}\right) + \frac{\rho_{\text{a}} \cdot V_{\text{int;a;}ztc}}{\Delta t}}$$

(84)

where, for the thermally conditioned zone *ztc* and time interval *t*

$x_{int;a;ztc;t}$ is the resulting moisture content of the zone for no or local (de-)humidification at time interval t, in kg/kg dry air;

$x_{a;sup,k;t}$ is the moisture content of all air flow elements k entering the zone, as determined in 6.5.14.1.3, in kg/kg dry air; with, in this formula, for mechanical ventilation:

$x_{a;sup;mech;k;t} = x_{a;e;t}$, the moisture content of the outside air;

$G_{HU/DHU;ss;ztc;t}$ is the actual system specific moisture supply/removal by the local (de-)humidification system at time interval t, obtained from the relevant system standards under EPB modules M6-5 / M7-5 (if provided), in kg/s;

and with the other variables declared in the previous formulae.

In absence of a (de-)humidification system, the moisture content of the zone *ztc* is the actual moisture content calculated without system.

6.5.15 Calculation of key monthly data from hourly output

6.5.15.1 Monthly utilization factors

The following key monthly data are obtained from the hourly output of the calculation of the energy needs for heating and cooling, to characterise the calculation case. These characteristics are used in the reporting (see 7.1.2.2.1). These data are essential for a quick understanding of the main processes involved and as a means to derive correction and adjustment factors for the monthly method.

The monthly gain utilization factor for the thermal zone *ztc* and month *m*, $\eta_{H;gn;ztc;m}$, is given by:

$$\eta_{H;gn;ztc;m} = \frac{Q_{H;ht;ztc;m} - Q_{H;nd;ztc;m}}{Q_{H;gn;ztc;m}} \quad (85)$$

The monthly utilization factor for heat losses, $\eta_{C;ls;ztc;m}$, is given by:

$$\eta_{C;ls;ztc;m} = \frac{Q_{C;ht;ztc;m} - Q_{C;nd;ztc;m}}{Q_{C;ht;ztc;m}} \quad (86)$$

NOTE 1 The derivation is explained in ISO/TR 52016-2:2017, Annex K[1].

The values for $Q_{H/C;ht;ztc;m}$ and $Q_{H/C;gn;ztc;m}$ are obtained in accordance with the procedures for the monthly method. Sign convention for the cooling needs in the formula above: positive sign.

The heat balance ratio for heating respective cooling, $\gamma_{H/C;ztc;m}$ is derived from the values for $Q_{H/C;ht;ztc;m}$ and $Q_{H/C;gn;ztc;m}$.(see 6.6.10).

NOTE 2 This enables to plot the gain and loss utilization curves for the specific calculation case. Examples are given in the technical report ISO/TR 52016-2[1].

6.5.15.2 Monthly system undersizing, overheating and underheating

6.5.15.2.1 Undersizing of the heating system

If applicable, the annual amount of undersizing of the heating system for thermal zone *ztc*, for threshold *i*, $Q_{UH;thres,i,ztc;m}$ is calculated as the accumulated difference of the calculated heating load with unlimited heating power and the calculation of the heating load with unlimited heating power at time interval t:

$$Q_{\text{UH;thres},i;ztc;\text{an}} = 0,001 \times \sum_{t^*} \left(\Phi_{\text{HC;ld;nlim};ztc;t} - \Phi_{\text{HC;ld;lim};ztc;t} \right) \tag{87}$$

with sum over each time interval t^* over the year for which the following applies:

$$\left(\Phi_{\text{HC;ld;nlim};ztc;t} - \Phi_{\text{HC;ld;lim};ztc;t} \right) > \Phi_{\text{UH;ld;thres},i} \tag{88}$$

where, for thermally conditioned zone ztc

$Q_{\text{UH;thres},i,ztc;\text{an}}$ is the annual amount of undersizing of the heating system for threshold i, where the subscript thres,i is the placeholder for the threshold load $\Phi_{\text{UH;ld;thres},i}$, in KWh;

$\Phi_{\text{HC;ld;nlim}ztc;t}$ is the heating or cooling load with unlimited heating and cooling power at time interval t:, in W;

$\Phi_{\text{HC;ld;lim};ztc;t}$ is the heating or cooling load with limited heating and cooling power at time interval t, in W;

$\Phi_{\text{UH;ld;thres},i}$ is the threshold i (i = 1, 2, ...) for counting the difference, in W;

with a range of values $\Phi_{\text{UH;ld;thres},i}$ that provides a proper discrimination;

for example: $\Phi_{\text{UH;ld;thres},i} = X_i \cdot \max(\Phi_{\text{HC;ld;nlim}ztc;t})$, in W,

with $\max(\Phi_{\text{HC;ld;nlim}ztc;t})$ is the maximum cooling load over the year,

and where X_i stands for a range of fractions:

X_i = 0, 0,05, 0,10, 0,15, 0,20, for i = 1, 2, 3, 4.

6.5.15.2.2 Undersizing of the cooling system

If applicable, the annual amount of undersizing of the cooling system for thermal zone ztc, for threshold i, $Q_{\text{UC;thres},i,ztc;m}$ is calculated as the accumulated difference of the calculated cooling load with unlimited cooling power and the calculation of the cooling load with unlimited cooling power at time interval t:

$$Q_{\text{UC;thres},i;ztc;\text{an}} = 0,001 \times \sum_{t^*} \left(\Phi_{\text{HC;ld;lim};ztc;t} - \Phi_{\text{HC;ld;nlim};ztc;t} \right) \tag{89}$$

with sum over each time interval t^* over the year for which the following applies:

$$\left(\Phi_{\text{HC;ld;lim};ztc;t} - \Phi_{\text{HC;ld;nlim};ztc;t} \right) > \Phi_{\text{UC;ld;thres},i} \tag{90}$$

where, for thermally conditioned zone ztc

$Q_{UC;thres,i,ztc;an}$ is the annual amount of undersizing of the cooling system for threshold *i*, where the subscript thres,*i* is the placeholder for the threshold load $\Phi_{UC;ld;thres,I}$, in KWh;

$\Phi_{HC;ld;nlim ztc;t}$ is the heating or cooling load with unlimited heating and cooling power at time interval *t,* in W;

$\Phi_{HC;ld;lim;ztc;t}$ is the heating or cooling load with limited heating and cooling power at time interval *t,* in W;

$\Phi_{UC;ld;thres,i}$ is the threshold *i* (*i* = 1, 2, ...) for counting the difference, in W;

with a range of values $\Phi_{UC;ld;thres,i}$ that provides a proper discrimination;

for example: $\Phi_{UC;ld;thres,i} = - X_i \cdot \min(\Phi_{HC;ld;nlim ztc;t})$, in W, with $\min(\Phi_{HC;ld;nlim ztc;t})$ is the maximum cooling load over the year, and where X_i stands for a range of fractions:

X_i = 0, 0,05, 0,10, 0,15, 0,20, for *i* = 1, 2, 3, 4.

NOTE 1 The heating or cooling load, $\Phi_{HC;ld;ztc;t}$ has as sign convention: heating positive, cooling negative.

NOTE 2 The amount of undersizing of the heating/cooling for thermal zone *ztc*, is also indicated by the accumulated undertemperature (“underheating”) / overtemperature (“overheating”) as described below.

NOTE 3 Of course, any (other) frequency distribution can be derived from the hourly values over a month or year.

6.5.15.2.3 Underheating

The accumulated undertemperature (“underheating”) for thermal zone *ztc*, for threshold *i*, $T_{UH;thres,i,ztc;an}$, is given by:

$$T_{UH;thres,i;ztc;an} = \sum_{t^*} \left(\theta_{int;set;H;ztc;t} - \theta_{int;op;ztc;t} \right) \quad (91)$$

with sum over each time interval *t** over the year for which the following applies:

$$\left(\theta_{int;set;H;ztc;t} - \theta_{int;op;ztc;t} \right) > T_{UH;thres,i} \quad (92)$$

where, for thermally conditioned zone *ztc* at time interval *t*

$T_{UH;thres,i,ztc;an}$ is the annual accumulated undertemperature for threshold *i*, where the subscript thres,*i* is the placeholder for the threshold temperature difference $\Delta\theta_{UH;thres,i}$, in K·h;

$\theta_{int;op;ztc;t}$ is the internal operational temperature, as determined in 6.5.6, in °C;

$\theta_{int;set;H;zt;t}$ is the internal operative temperature set-point for heating, as determined in 6.5.5.1, in °C;

$\Delta\theta_{UH;thres,i}$ is the threshold *i* (*i* = 1, 2, ...) for counting the temperature difference, in K;

with range of values: $\Delta\theta_{UH;thres,i}$ = 0, 1, 2, 4, for *i* = 1, 2, 3, 4;

or another range of values $\Delta\theta_{UH;thres,i}$ if that provides a better discrimination.

For hours without heating set-point (unoccupied hours without temperature set-back) the set-point shall be set to -999 °C.

If there is no heating (no heating set-point at all, the calculation shall be done with constant heating set-point $\theta_{int;set;H;ztc}$ = 20 °C.

Optionally, more refined under- and overtemperature values can be recorded, by replacing the threshold value of zero by a series of threshold values: 0, +1, +2, ... K.

6.5.15.2.4 Overheating

The annual accumulated overtemperature (“overheating”) for thermal zone *ztc*, $T_{\text{OH};\,ztc;\text{an}}$, is given by:

$$T_{\text{OH};ztc;\text{an}} = \sum_{t^*} \left(\theta_{\text{int;op};ztc;t} - \theta_{\text{int;set;C};ztc;t} \right) \tag{93}$$

with sum over each time interval t^* over the year for which the following applies:

$$\left(\theta_{\text{int;op};ztc;t} - \theta_{\text{int;set;C};ztc;t} \right) > T_{\text{OH;thres},i} \tag{94}$$

where, for thermally conditioned zone *ztc* at time interval *t*

$T_{\text{OH;thres},i,ztc;\text{an}}$	is the annual accumulated overtemperature for threshold *i*, where the subscript thres,*i* is the placeholder for the threshold temperature $\Delta\theta_{\text{OH;thres},i}$, in K·h;
$\theta_{\text{int;op};ztc;t}$	is the internal operational temperature, as determined in 6.5.6, in °C;
$\theta_{\text{int;set;C};zt;t}$	is the internal operative temperature set-point for cooling, as determined in 6.5.5.1, in °C;
$\Delta\theta_{\text{OH;thres},i}$	is the threshold *i* (*i* = 1, 2, ...) for counting the difference, in K; with range of values: $\Delta\theta_{\text{OH;thres},i}$ = 0, 1, 2, 4, for *i* = 1, 2, 3, 4; or another range of values $\Delta\theta_{\text{OH;thres},i}$ if that provides a better discrimination.

For hours without cooling set-point (unoccupied hours without set-point) the set-point shall be set to +999 °C.

If there is no cooling (no cooling set-point at all), the calculation shall be done with constant cooling set-point $\theta_{\text{int;set;C};ztc}$ = 26 °C.

NOTE 4 The set-point for heating or cooling can vary over the day or week. Therefore, the undertemperature and overtemperature are relative values, compared to the set-point at given time interval. Of course, any (other) frequency distribution can be derived from the hourly values over a month or year.

The risk of overheating is assessed only at the level of a thermal zone. Depending on the specific rules for zoning, a thermal zone may contain spaces with different thermal properties and with different thermal loads. In that case the overheating indicator may underestimate the risk of overheating.

6.6 Monthly calculation procedures

6.6.1 Principle

The basic principles are described in 5.2.2.

The monthly method covers the application area: (sensible and latent) energy need calculation.

Because of the monthly time interval, it covers neither internal temperature calculation, nor design heating and cooling load calculation. However, a simplified indicator is added for the estimation of the risk of overheating in a thermal zone.

For some applications the equations have to be solved several times per time interval. Therefore for each application a procedure is given that results in the required output.

6.6.2 Applicable time interval and calculation period

The calculation procedures described in 6.6 are suitable for a monthly time interval.

The calculation period is a full year.

System specific energy need calculations:

The lengths of the heating, cooling and (de-)humidification seasons are defined by the operation time of the respective technical systems. This has to be taken into account in the system specific calculations. It may differ from the time resulting from the basic energy needs calculation.

NOTE 1 The length of the season could be shorter than in the needs calculation, suppressing off-season needs, or longer, causing system losses during times without needs.

In case of restrictions on the length of the period to be taken into account in the calculations, these restrictions shall be conveyed through all relevant EPB standards.

Such restrictions shall be taken into account in the relevant system standards, EPB modules M3-1 to M7-1 calculation of the system energy use. The choice for such restrictions is provided in Annex A (normative template) and Annex B (informative default choice) in these standards.

NOTE 2 These restrictions could e.g. be due to national or regional regulations.

6.6.3 Assumptions

The energy needs for heating, cooling and (de-)humidification are calculated with the assumption of infinite power of the systems.

Because of the monthly calculation time interval all time-variant interactions with the technical building systems can only be modelled in a simplified way, mainly by introducing correlation coefficients. The values of these coefficients are in most cases an inevitable function of climate, user behaviour and, for instance, type of systems and system control.

NOTE As a consequence, these are open for national or regional options.

Heating and cooling in the same month are determined by doing two separate calculations, each with its own values for the different variables and parameters, reflecting representative conditions for either heating or cooling (e.g. for ventilation, heat recovery, solar protection, etc.). The heating and cooling needs are each calculated for all twelve months of the year (whereby for some months the heating and/or cooling need may turn out to be zero).

The energy needs for active preheating or precooling hygienic ventilation air (e.g. in an air handling unit or in a trickle ventilator) is not included in this method (and thus not included in the energy needs for heating and cooling), but is treated by the relevant standards under EPB module M5-6.

6.6.4 Energy need for space heating and cooling

6.6.4.1 Calculation of the basic needs and system specific needs

There are two calculations: basic energy needs and system specific energy needs.

Warning — there is no differentiation yet in subscript between calculation of ‘basic energy’ and ‘system specific’ loads and needs.

Basic energy needs

Calculation of the monthly energy need for heating (in accordance with 6.6.4.2), for cooling (in accordance with 6.6.4.3) and for (de-)humidification (6.6.14) without the influence of a specific choice of technical building systems.

Which provisions are excluded is determined in the relevant clauses of the relevant standard under EPB module M2-4.

EXAMPLE Often the heat recovery unit from the ventilation system is included in the basic needs calculations, to avoid a major deviation from the operating area for the calculation and to avoid contradictions with assumptions associated to the choice of a heat recovery unit.

The basic energy needs include the situation where standard indoor environment conditions are assumed for the given space category, which require a heating and/or cooling system, while the actual system is absent or undersized: in that case the basic energy needs are calculated anyway.

NOTE 2 Depending on the choices made in standards providing input to the calculation, iteration can be required. See also the calculation steps specified in ISO 52000-1.

System specific energy needs

Possible repetition of the monthly calculation(s) due to the interaction of the need calculations with the specific characteristics and specific control of the technical building systems.

NOTE 3 Again, depending on the choices made in standards providing input to the calculation, further iteration can be required. See also the calculation steps specified in ISO 52000-1.

The following system influences are possible:

— limited heating or cooling power: not applicable (hourly method only);

— recoverable heat losses; input requested in 6.6.7.2;

— adjustment of the temperature set-points (value and time-schedule); input requested in 6.6.11;

— limitation of the heating or cooling season for the calculation; input requested in 6.6.4.2 and 6.6.4.3;

— absence of heating or cooling system: no system specific calculation or calculation with fictitious heating or cooling system, according to the principle chosen in ISO 52000-1:2017, Table A.9 (normative template) and Table B.9 (informative default choice); in case of fictitious heating or cooling: input requested in the subclauses mentioned above; in case of no heating or cooling: input requested in 6.6.4.2 and 6.6.4.3.

For the system influences applicable to (de-)humidification systems, see 6.6.14.

In the system specific calculation, it will be recorded to what extent, during the comfort periods, the temperature did not reach the heating or cooling set point. The latter is needed for a level playing field. However, this is not possible for the monthly calculation method.

NOTE 4 In case of an undersized or absent heating or cooling system, there is no level playing field in the comparison of the energy performance with other buildings; this could be overcome by a clear warning or a penalty. See explanation and examples in ISO/TR 52016-2[1].

6.6.4.2 Energy need for heating

The annual energy need for heating, $Q_{\mathrm{H;nd};ztc;\mathrm{an}}$, in kWh, for thermally conditioned zone *ztc*, is calculated with the following formula:

$$Q_{\mathrm{H;nd};ztc;\mathrm{an}} = \sum_{m=1}^{12} Q_{\mathrm{H;nd};ztc;m} \tag{95}$$

where

$Q_{\mathrm{H;nd};ztc;m}$ is the monthly energy need for heating for the thermally conditioned zone *ztc* and month *m*, as determined below, in kWh.

For the calculation of the monthly energy need for heating, a distinction is made between months with and without a long unoccupied period. For each thermally conditioned zone *ztc* and for each month *m*, the monthly energy need for heating, $Q_{\mathrm{H;nd};ztc;m}$, in kWh, is calculated according to 1 of the following 2 instances:

a) For months without a long unoccupied period, $Q_{H;nd;ztc;m}$ is calculated with the following two formulae:

if $\gamma_{H;ztc;m} \leq 0$ and $Q_{H;gn;ztc;m} > 0$: $Q_{H;nd;ztc;m} = 0$ (96)

if $\gamma_{H;ztc;m} > 2{,}0$: $Q_{H;nd;ztc;m} = 0$ (97)

else: $QH;nd;ztc;m = (QH;ht;ztc;m - \eta H;gn;ztc;m\ QH;gn;ztc;m)$ (98)

where, for each thermally conditioned zone *ztc* and month *m*

$\gamma_{H;ztc;m}$ is the dimensionless heat-balance ratio for the heating mode, as determined in 6.6.10.2;

$Q_{H;ht;ztc;m}$ is the total heat transfer for the heating mode, as determined in 6.6.4.4, in kWh;

$\eta_{H;gn;ztc;m}$ is the dimensionless gain utilization factor, as determined in 6.6.10.2;

$Q_{H;gn;ztc;m}$ are the total heat gains for the heating mode, as determined in 6.6.4.4, in kWh;

b) For months with a long unoccupied period, $Q_{H;nd;ztc;m}$ is determined in 6.6.11.5.

NOTE 1 The terms “total heat transfer” and “total heat gains” are an approximate naming. See ISO/TR 52016-2 [1] for explanation and background information.

NOTE 2 The rationale for the two ‘if statements’ is given in ISO/TR 52016-2[1].

System specific energy need:

For the calculation of the system specific energy need for heating, restrictions, as described in 6.6.2, may apply on the length of the cooling season.

6.6.4.3 Energy need for cooling

For each zone, the annual energy need for cooling, $Q_{C;nd;\ ;ztc;an}$, in kWh, is calculated with the following formula:

$$Q_{C;nd;ztc;an} = \sum_{m=1}^{12} Q_{C;nd;ztc;m} \quad (99)$$

where

$Q_{C;nd;ztc;m}$ is the monthly energy need for cooling, for the thermally conditioned zone *ztc* and month *m*, determined as specified below, in kWh.

The monthly energy need for cooling, $Q_{C,nd;ztc;m}$, in kWh, is calculated according to 1 of the following 3 instances, whichever is applicable.

c) For months without a long unoccupied period, $Q_{C;nd;ztc;m}$ is calculated with the following two formulae:

if $(1/\gamma_{C;ztc;m}) > 2{,}0$: $Q_{C;nd;ztc;m} = 0$ (100)

else: $QC;nd;ztc;m = aC;red\ (QC;gn;ztc;m - \eta C;ht;ztc;m\ QC;ht;ztc;m)$ (101)

where, for each thermally conditioned zone *ztc* and month *m*

$Q_{C;ht;ztc;m}$ is the total heat transfer for the cooling mode, as determined in 6.6.4.4, in kWh;

$\eta_{C;ht;ztc;m}$ is the dimensionless heat transfer utilization factor, as determined in 6.6.10.3

$Q_{C;gn;ztc;m}$ is the total heat gains for the cooling mode, as determined in 6.6.4.4, in kWh;

$a_{C;red\ ztc;m}$ is the dimensionless reduction factor for intermittent cooling, as determined in 6.6.11.4;

NOTE 1 The reduction factor for intermittent cooling is different compared to ISO 13790:2008. The rationale is explained in ISO/TR 52016-2 [1].

NOTE 2 The rationale for the two ‘if statements’ is given in ISO/TR 52016-2 [1].

d) For situations with a long unoccupied period, $Q_{C;nd;ztc;m}$ is determined in 6.6.11.5.

System specific energy need:

For the calculation of the system specific energy need for cooling, restrictions, as described in 6.6.2, may apply on the length of the cooling season.

6.6.4.4 Total heat transfer and heat gains

For each zone and for each month, the total heat transfer for heating and for cooling, $Q_{H;ht;ztc;m}$ and $Q_{C;ht;ztc;m}$, both in kWh, are calculated with the following two Formulae:

For heating: $Q_{H;ht;ztc;m} = Q_{H;tr;ztc;m} + Q_{H;ve;ztc;m}$ (102)

For cooling: $Q_{C;ht;ztc;m} = Q_{C;tr;ztc;m} + Q_{C;ve;ztc;m}$ (103)

where, for each thermally conditioned zone *ztc* and month *m*

$Q_{H;tr;ztc;m}$ is the total heat transfer by transmission for heating, as determined in 6.6.5, in kWh;

$Q_{H;ve;ztc;m}$ is the total heat transfer by ventilation for heating, as determined in 6.6.6, in kWh;

$Q_{C;tr;ztc;m}$ is the total heat transfer by transmission for cooling, as determined in 6.6.5, in kWh;

$Q_{C;ve;ztc;m}$ is the total heat transfer by ventilation for cooling, as determined in 6.6.6, in kWh.

The total heat gains for heating and for cooling, $Q_{H;gn;ztc;m}$ and $Q_{C;gn;ztc;m}$, both in kWh, are calculated with Formulae 104 and 105:

For heating: $Q_{H;gn;ztc;m} = Q_{H;int;ztc;m} + Q_{H;sol;ztc;m}$ (104)

For cooling: $Q_{C;gn;ztc;m} = Q_{C;int;ztc;m} + Q_{C;sol;ztc;m}$ (105)

where, for each thermally conditioned zone *ztc* and month *m*

$Q_{H;int;ztc;m}$ is the sum of internal heat gains for heating, as determined in 6.6.7, in kWh;

$Q_{H;sol;ztc;m}$ is the sum of solar heat gains for heating, as determined in 6.6.8, in kWh;

$Q_{C;int;ztc;m}$ is the sum of internal heat gains for cooling, as determined in 6.6.7, in kWh;

$Q_{C;sol;ztc;m}$ is the sum of solar heat gains for cooling, as determined in 6.6.8, in kWh.

6.6.5 Heat transfer by transmission

6.6.5.1 Calculation procedures

The total heat transfer by transmission for heating and for cooling, $Q_{H;tr;ztc;m}$ and $Q_{C;tr;ztc;m}$, both in kWh, are calculated with the following two formulae:

For heating:

$$Q_{H;tr;ztc;m} = (H_{H;tr(excl.gf;m);ztc;m} (\theta_{int;calc;H;ztc;m} - \theta_{e;a;m}) + H_{gr;an;ztc;m} (\theta_{int;calc;H;ztc;m} - \theta_{e;a;an}))\ 0{,}001\ \Delta t_m \quad (106)$$

For cooling:

$$Q_{C;tr;ztc;m} = (H_{C;tr(excl.gf;m);ztc;m} (\theta_{int;calc;C;ztc;m} - \theta_{e;a;m}) + H_{gr;an;ztc;m} (\theta_{int;calc;C;ztc;m} - \theta_{e;a;an}))\ 0{,}001\ \Delta t_m \quad (107)$$

where, for each thermally conditioned zone *ztc* and month *m*

$H_{H/C;tr(excl.gf)\ ;ztc;m}$ is the overall heat transfer coefficient by transmission for heating resp. cooling, for all building elements except elements connected to the ground, as determined in 6.6.5.2, in W/K;

$\theta_{int;calc;H/C;ztc;m}$ is the calculation temperature of the zone for heating resp. cooling, as determined in 6.6.11, in °C;

$\theta_{e;a;m}$ is the monthly mean air temperature of the external environment, obtained from the relevant standard under EPB module M1-13, in °C;

$H_{gr;an;ztc;m}$ is the ground heat transfer coefficient for building elements in thermal contact with the ground, including slab-on-ground floors, suspended floors and basements, for thermal zone *ztc* and month *m*, based on the annual temperature difference, obtained from ISO 13789, in W/K;

$\theta_{e;a;an}$ is the mean temperature of the external environment for the whole year, obtained from the relevant standard under EPB module M1-13, in °C;

Δt_m is the duration of the month *m*, obtained from the relevant standard under EPB module M1-13, in h.

NOTE 1 By convention, the heat transfer by transmission and ventilation is from inside to outside. The heat transfer or part of the heat transfer can have a negative sign during a certain period, in which case heat is added to the zone. The impact on heating and cooling is explained in ISO/TR 52016-2[1].

NOTE 2 The heat transfer coefficient by transmission of building elements in thermal contact with the ground, $H_{gr;ztc;m}$ is based on to the mean annual temperature difference. The heat transfer coefficient cannot be based on the monthly mean temperature difference. This is explained in ISO/TR 52016-2[1] and ISO/TR 52019-2[10].

Heat transfer to adjacent thermally conditioned spaces:

If the adjacent thermally conditioned space is a thermal zone of the assessed object and the option of calculation as thermally coupled thermal zones is chosen, the calculation rules of Annex D apply. In other cases: the heat transmission through the construction element to the adjacent space is ignored.

6.6.5.2 Overall heat transfer coefficient by transmission

NOTE 1 The area of building elements and their thermal transmittance, as well as the lengths and linear thermal transmittance of thermal bridges are obtained from or via the same source. The rationale is given in ISO/TR 52016-2[1].

NOTE 2 Instead of obtaining the *overall* heat transfer coefficient from ISO 13789, the values of the *individual elements* are used as input, for instance because of the thermal transmission through the ground and thermal transmission through thermally unconditioned spaces and because the solar absorption coefficient and long wave sky radiation which is different per element.

NOTE 3 The numeric value can differ between heating and cooling calculations (e.g. due to different hypotheses on the shutter use). The values can be different per month, e.g. due to different duration of use of shutters.

The overall heat transfer coefficient by transmission for heating resp. cooling, for all building elements except elements connected to the ground for thermally conditioned zone *ztc* and month *m*, $H_{\text{H/C;tr(excl. grnd flr)};m}$, in W/K, is calculated with the following formula:

$$H_{\text{H/C;tr(excl.gf)};ztc;m} = \sum_k \left(H_{\text{H/C;el},k;m} \right) + H_{\text{tr;tb};ztc} \tag{108}$$

where, for each month *m*

$H_{\text{H/C;el},k;m}$ is the overall heat transfer coefficient by transmission for heating resp. cooling, for building element *k*, in month *m*, determined as presented below, in W/K;

$H_{\text{tr;tb};ztc}$ is the overall heat transfer coefficient for thermal bridges in the thermally conditioned zone *ztc*, obtained as determined in 6.6.5.3, in W/K.

The overall heat transfer coefficient by transmission for heating resp. cooling, for building element *k*, in month *m*, $H_{\text{H/C;el},k;m}$, in W/K, is calculated with the following formulae:

For elements connected to the outdoor environment:

$$H_{\text{H/C;el};k;m} = U_{\text{H/C};k;m} \cdot A_{\text{el};k} \tag{109}$$

For elements connected to an adjacent external type (as defined in 6.4.5.1) of thermally unconditioned zone:

$$H_{\text{H;el};k;m} = b_{\text{ztu};k;m} \cdot U_{\text{H};k;m} \cdot A_{\text{el};k} \tag{110}$$

For elements connected to an adjacent internal type (as defined in 6.4.5.1) of thermally unconditioned zone:

$$H_{\text{H;el};k;m} = \left(1 - b_{\text{ztu};k;m}\right) \cdot U_{\text{H;tr};k;m} \cdot A_{\text{el};k} \tag{111}$$

where, for each month *m*

$U_{\text{H/C};k;m}$ is the thermal transmittance, obtained as described below, in W/(m²·K);

$b_{\text{ztu},k}$ is the adjustment factor for adjacent thermally unconditioned zone *k*, as determined in 6.4.5.4;

$A_{\text{el},k}$ is the area of a building envelope element, obtained for all types of building elements from ISO 13789.

The thermal transmittance of each building element not connected to the ground, $U_{\text{H/C};m}$, is obtained as follows:

The thermal transmittance of opaque building elements, $U_{\text{c;op}}$, shall be obtained from ISO 13789

The thermal transmittance of windows and doors, U_w and U_d, shall be obtained from ISO 13789.

NOTE 4 The thermal transmittance or U-value on the CE-marking, based on the product standard EN 14351-1[9] is only valid if the size of the window or door in question differs less than 10% from the size used in EN 14351-1. Quote from EN 14351-1:2005: "Where detailed calculation of the heat loss from a specific building is required, the manufacturer shall provide accurate and relevant, calculated or tested thermal transmittance values (design values) for the size(s) in question."

In case of windows, when shutters are present, the thermal transmittance of a window with closed shutters, U_{wsht}, in W/(m²·K), shall be obtained from ISO 13789. The monthly weighted mean value for the thermal transmittance with shutters open and closed is determined in accordance with G.2.2.2 in Annex G.

The thermal transmittance of curtain walling, U_{cw}, shall be calculated in accordance with ISO 13789.

In other cases, the U_W-value for the window is obtained from ISO 10077-1 or ISO 15099 for windows and doors or ISO 10292 for glazing (or see Subjects 1 and 2 in Table C.1).

In general, for a dynamic window or façade, the monthly weighted mean U_W-value is obtained in accordance with G.2.2.2 in Annex G.

6.6.5.3 Thermal bridges

The overall heat transfer coefficient for thermal bridges, $H_{tr;tb;zt}$, in W/K, is calculated with the following formula:

$$H_{tr;tb;zt} = \sum_k \left(l_{tb;k} \cdot \Psi_{tb;k} \right) \tag{112}$$

where, for thermal zone zt

$l_{tb;k}$ is the length of a linear thermal bridge k, obtained in accordance with ISO 13789, in m.;

$\Psi_{tb;k}$ is the linear thermal transmittance of a linear thermal bridge k, determined in accordance with ISO 13789, in W/(m·K).

NOTE 5 This includes the thermal bridge of ground floor edge.

NOTE 6 See Note 1.

Alternatively, the overall heat transfer coefficient for thermal bridges, $H_{tr;tb;zt}$, in W/K, is directly obtained as overall (default) value from ISO 13789.

6.6.6 Heat transfer by ventilation

6.6.6.1 Calculation procedures

For each thermally conditioned zone ztc and for each month m the total heat transfer by ventilation for heating and for cooling, $Q_{H/C;ve;ztc;m}$, in kWh, is calculated with the following two formulae:

$$Q_{H/C;ve;ztc;m} = H_{H/C;ve;ztc;m} \cdot \left(\vartheta_{int;calc;H/C;ztc} - \vartheta_{e;a;m} \right) \cdot \Delta t_m \tag{113}$$

where, for each thermally conditioned zone ztc and month m

$H_{H/C;ve;ztc;m}$ is the overall heat transfer coefficient by ventilation for heating/cooling, as determined in 6.6.6.2, in W/K;

$\theta_{int;calc;H/C;ztc}$ is the internal calculation temperature of the zone for heating/cooling, as determined in 6.6.11, in °C;

$\theta_{e;a;m}$ is the monthly mean (air) temperature of the external environment, obtained from the relevant standard under EPB module M1-13;

Δt_m is the duration of the month *m*, obtained from the relevant standard under EPB module M1-13, in h.

NOTE See the corresponding note about the possibly negative sign of the heat transfer in 6.6.5.1.

Heat transfer to adjacent thermally conditioned spaces:

If the adjacent thermally conditioned space is a thermal zone of the assessed object and the option of calculation as thermally coupled thermal zones is chosen, the calculation rules of Annex D apply.

In other cases: the air flow rate from the adjacent space is ignored.

6.6.6.2 Overall heat transfer coefficient by ventilation

The overall heat transfer coefficient by ventilation for zone *ztc* and month *m*, for heating and for cooling, $H_{H/C;ve;ztc;m}$, shall be obtained in accordance with one of the following two methods. The choice between Method A and Method B is indicated in Table A.27 (normative template), with the informative default choice provided in Table B.27. Method B is only applicable outside the CEN area.

NOTE 1 The numeric value of $H_{H/C;ve;ztc;m}$ can differ between heating and cooling calculations (e.g. due to different hypotheses concerning window opening).

Method A:

The value for the overall ventilation heat transfer coefficient, $H_{H/C;ve;ztc;m}$, in W/K, is calculated as given by the following formula:

$$H_{H/C;ve;ztc;m} = \rho_a \cdot c_a \cdot \sum_k \left(b_{ve,k;H/C;m} \cdot q_{V,k;H/C;m} \cdot f_{ve,dyn;k;m} \right) \tag{114}$$

where, for each month *m*

$H_{H/C;ve;ztc;m}$ is the overall heat transfer coefficient by ventilation for heating/cooling, for thermally conditioned zone *ztc*, in W/K;

$\rho_a \cdot c_a$ is the heat capacity of air per volume, as specified in 6.3.6, in J/(m³·K);

$q_{V;k;H/C;,m}$ is the monthly time-average airflow rate of air flow element, *k* entering the thermal zone, for heating/cooling, as provided by the relevant standard(s) under EPB module M5-5, in m³/s;

$b_{ve,,k;H/C;m}$ is the dimensionless temperature adjustment factor for air flow element *k*, for heating/cooling, determined as presented below;

$f_{ve;dyn;k;m}$ is the dynamics correction factor for air flow element *k*, determined as explained below;

k represents each of the relevant air flow elements, such as air infiltration, natural ventilation, mechanical ventilation and/or extra ventilation for night-time cooling.

NOTE 2 The temperature adjustment factor, $b_{H/C;ve,k;m}$, adjusts the coefficient instead of the temperature difference.

In a general manner, the temperature adjustment factor, $b_{ve,k;H/C;m}$, for air flow k is determined as:

$$b_{ve,k;H/C;m} = \frac{\left(\theta_{calc;H/C;m} - \theta_{sup,k;H/C;m}\right)}{\left(\theta_{calc;H/C;m} - \theta_{e;a;m}\right)} \quad (115)$$

where, for each month m

$b_{ve,k;H/C;m}$ is the temperature adjustment factor for air flow k, for heating/cooling;

$\theta_{calc;H/C;ztc;m}$ is the calculation temperature of the zone for heating/cooling, as determined in 6.6.11, in °C;

$\theta_{sup,k;H/C;m}$ is the supply temperature of air flow k, for heating/cooling, in °C;

$\theta_{e;a;m}$ is the monthly mean air temperature of the external environment, in °C.

The value $b_{ve,k;H/C;m} \neq 1$ if the supply temperature, $\theta_{sup,k;H/C;m}$, is not equal to the temperature of the external environment.

For ventilation, including air infiltration, from an external or internal type (as defined in 6.4.5.1) of thermally unconditioned zone the temperature adjustment factor, $b_{ve,k;H/C;m}$, for air flow k is equal to the adjustment factor for thermally unconditioned zones:

$$b_{ve,k;H/C;m} = b_{ztu;m} \quad (116)$$

where, for each month m

$b_{ve,k;H/C;m}$ is the temperature adjustment factor for air flow k, for heating/cooling;

$b_{ztu;m}$ is the adjustment factor for the thermally unconditioned zone *ztu*, as determined in 6.4.5.4.

In case of a ventilation system element with a supply temperature different from the external air temperature, the supply temperature of air flow element k, $\theta_{sup;k;H/C;m}$, shall be determined in accordance with the relevant standard(s) under EPB module M5-6.

NOTE 3 This concerns for instance pre-heating or pre-cooling, heat recovery (with optional effects of by pass and/or frost protection), dissipated heat from fans, heat leakage into or from air ducts.

This is not applicable for air heating or cooling, where the supply temperature is fully controlled by the internal temperature (no pre-heating but air heating).

NOTE 4 The rationale for this is given in ISO/TR 52016-2[1].

The dynamics correction factor for air flow element k, if it has a value $f_{ve;dyn;k;m}$, ≠ 1, corrects for significant differences between the pattern of the ventilation rate and/or supply temperature over the day (hourly) and week (work days, weekend) and the pattern of indoor and/or outdoor temperature and/or energy needs. Its value shall be determined in accordance with Table A.28 (normative template); the informative default choice is provided in Table B.28.

NOTE 5 It can be argued that such kind of corrections are already included in the gain and loss utilization factor curves for the heating and cooling needs respectively. See explanation in ISO/TR 52016-2[1].

Method B:

The value for the overall ventilation heat transfer coefficient, $H_{H/C;ve;ztc;m}$, in W/K, is determined in accordance with ISO 13789 and ISO/TR 52019-2:2017, Annex J[10]. This method is not suited for the assessment of the overall energy performance including the effect of specific ventilation systems.

6.6.7 Internal heat gains

6.6.7.1 Overall internal heat gains

For a thermally conditioned zone *ztc* the heat gains from internal heat sources, for heating/cooling, $Q_{\mathrm{H/C;int;ztc;m}}$, in kWh, are calculated with the following formula:

$$Q_{\mathrm{H/C;int;}ztc;m} = Q_{\mathrm{H/C;int;dir;}ztc;m} \quad (117)$$

But in case of one or more adjacent thermally unconditioned zones (see 6.4.5):

$$Q_{\mathrm{H/C;int;}ztc;m} = Q_{\mathrm{H/C;int;dir;}ztc;m} + \sum_{k=1}^{n} \left[\left(1 - b_{\mathrm{ztu,}k;m}\right) \cdot F_{ztc;\mathrm{ztu,}k;m} \cdot f_{\mathrm{gn;max;H;ztu,}k;m} \cdot Q_{\mathrm{H/C;int;dir;ztu,}k} \right] \quad (118)$$

where, for each thermally conditioned zone *ztc* and month *m*

$Q_{\mathrm{H/C;int;dir;}ztc;m}$	are the monthly internal heat gains in the thermally conditioned zone *ztc* itself, for heating/cooling, as determined in 6.6.7.2, in kWh;
$b_{\mathrm{ztu,}k;m}$	is the adjustment factor for adjacent thermally unconditioned zone *k*, as determined in 6.4.5.4;
$F_{ztc;\mathrm{ztu,}k;m}$	is the distribution factor for gains in the thermally unconditioned zone *k* attributed to the adjacent thermally conditioned zone *ztc*, as determined in 6.4.5.4;
$f_{\mathrm{gn;max;H;ztu,}k;m}$	is the reduction factor to avoid overestimation of the gains in the thermally conditioned zone *k* for the heating mode, as determined in E.3, in W/K;
$Q_{\mathrm{H/C;int;dir;ztu,}k;m}$	are the monthly internal heat gains of internal or external type (as defined in 6.4.5.1) of adjacent thermally unconditioned zone *k* itself, for heating/cooling, as determined in 6.6.7.2, in kWh.

6.6.7.2 Internal heat gain sources

For each thermally conditioned or unconditioned zone *zt* and for each month *m*, the heat gains from internal heat sources in a zone, for heating/cooling, whether thermally conditioned or not, $Q_{\mathrm{int;dir;}zt}$, in kWh, are calculated with the following formula:

$$Q_{\mathrm{H/C;int;dir;}zt;m} = \begin{pmatrix} Q_{\mathrm{H/C;spec;int;oc;}zt;m} + Q_{\mathrm{H/C;spec;int;A;}zt;m} + Q_{\mathrm{H/C;spec;int;L;}zt;m} \\ + Q_{\mathrm{H/C;spec;int;WA;}zt;m} + Q_{\mathrm{H/C;spec;int;HVAC;}zt;m} + Q_{\mathrm{H/C;spec;int;proc;}zt;m} \end{pmatrix} \times A_{\mathrm{use;}zt} \quad (119)$$

where, for thermal zone *zt* and month *m*

$Q_{\text{H/C;spec;int;oc;}zt\text{;m}}$ is the specific internal heat gains due to metabolic heat from occupants, for heating/cooling, as determined in the relevant standard under EPB module M1-6, in kWh/m²;

$Q_{\text{H/C;spec;int;A;}zt;m}$ is the specific internal heat gains due to dissipated heat from appliances, for heating/cooling, as determined in the relevant standard under EPB module M1-6, in kWh/m²;

$Q_{\text{H/C;spec;int;L;}zt;m}$ is the specific internal heat gains due to recoverable losses from lighting, for heating/cooling, as determined in the relevant standard under EPB module M9-1, in kWh/m²;

$Q_{\text{H/C;spec;int;WA;}zt;m}$ is the specific internal heat gains due to recoverable losses from hot and mains water and sewage systems, for heating/cooling, as determined in the relevant standards under EPB modules M3-1 and M8-1, in kWh/m²;

$Q_{\text{H/C;spec;int;HVAC;}zt;m}$ is the specific internal heat gains due to recoverable losses from or to heating, cooling and ventilation systems, for heating/cooling, as determined in the relevant standards under EPB modules M3-1, M4-1 and M5-1, in kWh/m²; for the calculation of the system specific energy needs, system specific values may apply;

$Q_{\text{H/C;spec;int;proc;}zt;m}$ is the specific internal heat gains due to recoverable losses from or to processes and goods, for heating/cooling, as determined in the relevant standard under EPB module M1-6, in kWh/m²;

$A_{\text{use;}zt}$ is the useful floor area of the zone, as determined in 6.4.3, in m².

The principles for the calculation with regard to the recoverable heat losses are described in ISO 52000-1:2017, 8.1.3. This document considers only the heat recoverable in the building and not already (assumed to be) recovered in the system or subsystem.

NOTE 1 More details are given in the technical report ISO/TR 52016-2[1].

NOTE 2 A cold source, removing heat from the building (zone), shall be treated as a source, with a negative value.

System specific energy need:

Such restrictions shall be taken into account in the relevant system standards under EPB modules M3-1 to M7-1 calculation of the system energy use.

Aggregated monthly input data:

The monthly values of the different components $Q_{\text{H/C;ipec;int;x}\ \ zt;m}$ of the internal gains, for heating/cooling, are determined in accordance with the sources that are referenced above. The following two situations may occur:

1. If the source directly gives the cumulative monthly value of a gain, the value is directly used as input for the monthly calculation method.
2. If the source only provides hourly values, the following procedure shall be applied:
    a. consider a subperiod of the month that repeats itself
    b. calculate the cumulative value for the subperiod of all the hourly gains
    c. scale the value of the subperiod to the full duration of the month in question (taking account of the variable length of the months)

NOTE 3 Common cases of subperiods of a month that repeat themselves (2.a above) are:

— a single day if all days of the month have the same hourly profile;

— a week, if all weeks are identical;

— the full month if there is no cyclic pattern;

NOTE 4 Common cases of scaling are:

— multiply a daily value with the number of days of the month; and

— divide a weekly value by 7 and then multiply this value with the number of days of the month.

6.6.8 Solar heat gains

6.6.8.1 Overall solar heat gains

For a thermally conditioned zone *ztc* the solar heat gains, for heating/cooling, $Q_{\mathrm{H/C;sol;ztc;m}}$, in kWh, are calculated with the following formula:

$$Q_{\mathrm{H/C;sol;}ztc;m} = Q_{\mathrm{H/C;sol;dir;}ztc;m} \tag{120}$$

But in case of one or more adjacent thermally unconditioned zones (see 6.4.5):

$$Q_{\mathrm{H/C;sol;}ztc;m} = Q_{\mathrm{H/C;sol;dir;}ztc;m} + \sum_{k=1}^{n}\left[\left(1 - b_{\mathrm{ztu},k;m}\right)\cdot F_{ztc;\mathrm{ztu},k;m}\cdot f_{\mathrm{gn;max;H;ztu},k;m}\cdot Q_{\mathrm{H/C;sol;dir;ztu},k}\right] \tag{121}$$

where, for each thermally conditioned zone *ztc* and month *m*

$Q_{\mathrm{H/C;sol;dir;}ztc;m}$	are the monthly solar heat gains of the thermally conditioned zone *ztc* itself, as determined in 6.6.8.2, in kWh.
$b_{\mathrm{ztu},k;m}$	is the adjustment factor for adjacent thermally unconditioned zone *k*, as determined in 6.4.5.4;
$F_{ztc;\mathrm{ztu},k;m}$	is the distribution factor for gains in the thermally unconditioned zone *k* attributed to the adjacent thermally conditioned zone *ztc*, as determined in 6.4.5.4;
$f_{\mathrm{gn;max;H;ztu},k;m}$	is the reduction factor to avoid overestimation of the gains in the thermally conditioned zone *k* for the heating mode, as determined in E.3, in W/K;
$Q_{\mathrm{H/C;sol;dir;ztu},k;m}$	are the monthly solar heat gains of adjacent external or internal type (as defined in 6.4.5.1) of thermally unconditioned zone *k* itself, as determined in 6.6.8.2, in kWh.

6.6.8.2 Solar heat gain elements

For each thermally conditioned or unconditioned zone *zt* and for each month *m*, the solar heat gains in a zone whether thermally conditioned or not, for heating cooling, $Q_{\mathrm{sol;dir;}zt}$, in kWh, are calculated with the following formula:

$$Q_{\mathrm{H/C;sol;dir;}zt;m} = \sum_{k=1} Q_{\mathrm{H/C;sol;wi},k} + \sum_{k=1} Q_{\mathrm{H/C;sol;op},k} \tag{122}$$

where, for each element *k* and month *m*

$Q_{\text{H/C;sol;wi};k;m}$ are the monthly solar gains through transparent element wi,k, for heating/cooling, as determined below, in kWh;

$Q_{\text{H/C;sol;op};l;m}$ are the monthly solar gains through opaque element op,k, for heating/cooling, as determined below, in kWh.

The heat flow by solar gains through transparent envelope element (hereafter called windows) *wi*, $Q_{\text{H/C;sol,}\,wi;m}$, in kWh, is calculated with the following formula:

$$Q_{\text{H/C;sol};wi} = g_{\text{gl};wi;\text{H/C};m} \cdot A_{wi} \cdot \left(1 - F_{\text{fr};wi}\right) \cdot F_{\text{sh;obst};wi;m} \cdot H_{\text{sol};wi;m} - Q_{\text{sky};wi;m} \quad (123)$$

where, for each window *wi* and month *m*

$g_{\text{gl};wi;\text{H/C};m}$ is the dimensionless monthly mean effective total solar energy transmittance, for heating/cooling (see E.2.2).

NOTE 1 The transparent element can contain clear glazing, but also (permanent) scattering or (permanent or mobile) solar shading layers (see E.2.2).

A_{wi} is the area of window *wi*, as determined for thermal transmission properties in 6.6.5.2, in m^2; in case of protruded components the projected area shall be used.

$F_{\text{fr},wi}$ is the frame area fraction of window *wi*, the ratio of the projected frame area to the overall projected area of the glazed element of window w*i*, as determined in E.2.1.

$F_{\text{sh;obst};wi;m}$ is the dimensionless shading reduction factor for external obstacles, as determined in Annex F.

$H_{\text{sol};wi;m}$ is the monthly solar irradiation per area on the element, with tilt angle β_{wi} and orientation angle γ_{wi}, obtained from the relevant standard under EPB module M1-13, in kWh/m^2.

$Q_{\text{sky};wi;m}$ is the monthly extra heat flow due to thermal radiation to the sky, as determined in 6.6.8.3, in kWh.

β_{wi} is the tilt angle of the window *wi* (from horizontal, measured upwards facing), obtained from the geometric data of the construction element, in degrees.

γ_{wi} is the orientation angle of the window *wi*, obtained from the geometric data of the construction element, in degrees (expressed as the geographical azimuth angle of the horizontal projection of the inclined surface normal; convention: angle from South, eastwards positive, westwards negative).

NOTE 2 'External obstacles for the transparent element' are nearby obstacles such as rebates, side fins or overhangs or adjacent building parts. Distant obstacles can also be taken into account, depending on the choice made in this respect as provided in Annex F.

NOTE 3 It is recommended to round the orientation angles to 45 degrees, in line with the discretization of the skyline segments for the monthly solar shading calculations in Annex F.

The heat flow by solar gains through opaque envelope element *k*, for heating/cooling, $Q_{\text{H/C;sol},k;m}$, in kWh, in month *m*, is calculated with the following formula:

$$Q_{\text{H/C;sol;op};k;m} = \alpha_{\text{sr};k} \cdot R_{\text{se};k} \cdot U_{\text{c;op};k} \cdot A_{\text{c};k} \cdot F_{\text{sh;obst};k;m} \cdot H_{\text{sol};k;m} - Q_{\text{sky};k;m} \quad (124)$$

where, for each opaque element *k* and month *m.*

$\alpha_{sol;k}$ is the dimensionless absorption coefficient for solar radiation, obtained from Table A.29, with informative default values given in Table B.29.

$R_{se;k}$ is the external surface heat resistance, $R_{se} = 1/(h_{ce} + h_{re})$, with the external surface heat transfer coefficients h_{ce} and h_{re} obtained from ISO 13789, in m^2K/W.

$U_{c;op;k}$ is the thermal transmittance, as determined in 6.6.5.2, in $W/(m^2{\cdot}K)$.

$A_{c;k}$ is the projected area, as determined in 6.6.5.2, in m^2.

and with the other variables declared in the previous formulae (replacing subscript *wi* by subscript *k*).

NOTE 4 Only in special cases one or more of the variables in the right hand side of the equation is different during heating and cooling mode.

If the building element contains a layer that is (e.g. naturally) ventilated with external air and the *U*-value is calculated with the assumption that the thermal resistance between this vented layer and the external environment can be neglected, the transmitted solar heat gain using the formula above will be overestimated. To avoid overestimation, a corrected *U*-value should be used in the formula above in which the vented layer is not considered as a short-cut, but as a physical mechanism that removes part of the solar heat. The corrected *U*-value can be calculated on the basis of the methods mentioned in E.3.5 for ventilated envelope elements.

NOTE 5 For example, in the case of roofs with roof tiles in an open structure enabling more than weak air circulation; see ISO 6946[11].

6.6.8.3 Thermal radiation to the sky

The monthly extra heat flow due to thermal radiation to the sky, $Q_{sky;m}$, for a specific building envelope element *k*, in month *m*, in kWh, is given by the following formula:

$$Q_{sky;k;m} = 0{,}001 \times F_{sky;k} \cdot R_{se;k} \cdot U_{c;k} \cdot A_{c;k} \cdot h_{lr;e;k} \cdot \Delta\theta_{sky;m} \cdot \Delta t_m \quad (125)$$

where, for each element *k* and month *m.*

$F_{sky;k}$ is the view factor between the element and the sky as obtained from Table A.30. The informative default values are given in Table B.30.

$R_{se;k}$ is the external surface heat resistance of the element, $R_{se} = 1/(h_{ce} + h_{re})$, with the external surface heat transfer coefficients h_{ce} and h_{re} obtained from ISO 13789, in m^2K/W.

$U_{c;k}$ is the thermal transmittance of the element, as determined in 6.6.5.2, in $W/(m^2{\cdot}K)$;

$A_{c;k}$ is the projected area of the element, as determined in 6.6.5.2, in m^2;

$h_{lr;e;k}$ is the external long-wave radiative heat transfer coefficient, obtained from ISO 13789, in $W/(m^2{\cdot}K)$;

$\Delta\theta_{sky;m}$ is the average difference between the apparent sky temperature and the air temperature, obtained from Table A.31. The informative default values are given in Table B.31, in K;

Δt_m is the duration of the month *m*, obtained from the relevant standard under EPB module M1-13, in h.

NOTE See the explanation in the NOTE of 6.6.4.2 why this term is included in the gains and not the losses.

6.6.9 Internal effective heat capacity of a zone

In the monthly calculation method the internal effective heat capacity of the thermal zone (air, furniture and construction elements) is needed. This quantity represents the total heat capacity as seen from the inside.

NOTE 1 From the perspective of the overall accuracy the value of the internal effective heat capacity can be approximate: a relative uncertainty ten times higher than that of the heat transfer is acceptable.

Two methods are given: a detailed method that takes into account details of each construction element, and a simple method that gives default values as a function of the useful floor area. The normative template for the choice between the detailed or simple method is given in Table A.32, with an informative default choice in Table B.32.

Detailed method

With this detailed method the internal effective heat capacity of a thermal zone is determined on the basis of the internal heat capacities of the building elements.

The internal effective heat capacity of a thermally conditioned zone *ztc*, $C_{m;int;eff;ztc}$, in J/K, is calculated by summing the heat capacities of all (internal and external) building elements in direct thermal contact with the internal air of the zone under consideration, as given by the following formula:

$$C_{m;int;eff;ztc} = \sum_{j} \kappa_{int;j} \cdot A_j \qquad (126)$$

where, for each building element *j* in the zone.

$\kappa_{int;j}$ is the internal areal heat capacity per area of the building element *j*, determined in accordance with the determination of κ_m in ISO 13786:2016, Clause 7 or, as a more simple alternative, in accordance with the determination of κ_m in ISO 13786:2016, Annex C, with maximum effective thickness of 0,10 m, in J/(m²·K).

A_j is the area of the element *j*, as determined in 6.6.5.2, in m².

Simple method

Table 21 contains classes of construction types with default values for the internal heat capacity.

Table 21 — Default values for internal effective heat capacity

Class	Monthly method $C_{m;int;eff;ztc}$ J/K [J/(K·m²) · m²]
Very light	80 000 × $A_{use;ztc}$
Light	110 000 × $A_{use;ztc}$
Medium	165 000 × $A_{use;ztc}$
Heavy	260 000 × $A_{use;ztc}$
Very heavy	370 000 × $A_{use;ztc}$

Where

$A_{use;ztc}$ is the useful floor area of the thermal zone *ztc*, as determined in 6.4.3, in m².

The internal heat capacity is calculated including internal surface resistance.

A normative template for specification of the classes is given in Table A.33, with an informative default specification in Table B.33.

6.6.10 Utilization factors

6.6.10.1 Principle

In the monthly method, the dynamic effects are taken into account by introducing the gain utilization factor for heating and the heat transfer utilization factor for cooling. The effect of inertia in the case of intermittent heating or cooling or in the case of switch-off is taken into account separately; see 6.6.11.

6.6.10.2 Gain utilization factor for heating

The dimensionless gain utilization factor for heating, $\eta_{H,gn}$, is a function of the heat-balance ratio for heating, γ_H, and a numerical parameter, a_H, which depends on the building inertia. It is calculated for each zone and for each month with the following two formulae:

if $\gamma_{H;ztc;m} > 0$ and $\gamma_H \neq 1$: $$\eta_{H;gn;ztc;m} = \frac{1-(\gamma_{H;ztc;m})^{a_{H;ztc;m}}}{1-(\gamma_{H;ztc;m})^{(a_{H;ztc;m}+1)}} \quad (127)$$

if $\gamma_{H;ztc;m} = 1$: $$\eta_{H;gn;ztc;m} = \frac{a_{H;ztc;m}}{a_{H;ztc;m}+1} \quad (128)$$

if $\gamma_{H;ztc;m} \leq 0$ and $Q_{H;gn;ztc;m} > 0$: $$\eta_{H;gn;ztc;m} = 1/\gamma_{H;ztc;m} \quad (129)$$

if $\gamma_{H;ztc;m} \leq 0$ and $Q_{H;gn;ztc;m} \leq 0$: $$\eta_{H;gn;ztc;m} = 1 \quad (130)$$

NOTE The rationale for the two ‘if statements’ is given in ISO/TR 52016-2[1].

with

$$\gamma_{H;ztc;m} = \frac{Q_{H;gn;ztc;m}}{Q_{H;ht;ztc;m}} \quad (131)$$

where, for each thermally conditioned zone *ztc* and month *m*:

$\gamma_{H;ztc;m}$	is the dimensionless heat-balance ratio for the heating mode;
$a_{H;ztc;m}$	is a dimensionless numerical parameter, determined as specified below;
$Q_{H;ht;ztc;m}$	is the total heat transfer for the heating mode, as determined in 6.6.4.4, in kWh;
$Q_{H;gn;ztc;m}$	are the total heat gains for the heating mode, as determined in 6.6.4.4, in kWh.

The dimensionless numerical parameter $a_{H;ztc;m}$ is calculated with Formula 132:

$$a_{H;ztc;m} = a_{H;0} + \frac{\tau_{H;ztc;m}}{\tau_{H;0}} \quad (132)$$

where, for each thermally conditioned zone *ztc* and month *m*:

$a_{H;0}$	is a dimensionless reference numerical parameter, as specified below;
$\tau_{H;ztc;m}$	is the time constant of the zone for heating, determined in accordance with 6.6.10.4, in h;
$\tau_{H;0}$	is a reference time constant, as specified below, in h.

The values of the reference numerical parameter, $a_{H;0}$, and the reference time constant, $\tau_{H;0}$, for the gain utilization factor shall be obtained from Table A.34. The informative default values are given in Table B.34.

6.6.10.3 Heat transfer utilization factor for cooling

The dimensionless heat transfer utilization factor for cooling, $\eta_{C;ht;ztc;m}$, is a function of the heat-balance ratio for cooling, $\gamma_{C;ztc;m}$, and a numerical parameter, $a_{C;ztc;m}$, which depends on the building thermal inertia. It is calculated for each zone and for each month as given by the following formulae:

if $\gamma_{C;ztc;m} > 0$ and $\gamma_{C;ztc;m} \neq 1$: $$\eta_{C;ht;ztc;m} = \frac{1-(\gamma_{C;ztc;m})^{-a_{C;ztc;m}}}{1-(\gamma_{C;ztc;m})^{-(a_{C;ztc;m}+1)}} \quad (133)$$

if $\gamma_{C;ztc;m} = 1$: $$\eta_{C;ht;ztc;m} = \frac{a_{C;ztc;m}}{a_{C;ztc;m}+1} \quad (134)$$

if $\gamma_{C;ztc;m} \leq 0$: $$\eta_{C;ht;ztc;m} = 1 \quad (135)$$

with

$$\gamma_{C;ztc;m} = \frac{Q_{C;gn;ztc;m}}{Q_{C;ht;ztc;m}} \quad (136)$$

where, for each thermally conditioned zone *ztc* and month *m*:

$\gamma_{C;ztc;m}$ is the dimensionless heat-balance ratio for the cooling mode;

$a_{C;ztc;m}$ is a dimensionless numerical parameter, determined as specified below;

$Q_{C;ht;ztc;m}$ is the total heat transfer by transmission and ventilation for the cooling mode, as determined in 6.6.4.4, in kWh;

$Q_{C;gn;ztc;m}$ are the total heat gains for the cooling mode, as determined in 6.6.4.4, in kWh.

The dimensionless numerical parameter $a_{C;ztc;m}$ is calculated with Formula 137:

$$a_{C;ztc;m} = a_{C;0} + \frac{\tau_{C;ztc;m}}{\tau_{C;0}} \quad (137)$$

where, for each thermally conditioned zone *ztc* and month *m*:

$a_{C;0}$ is a dimensionless reference numerical parameter, as specified below;

$\tau_{C;ztc;m}$ is the time constant of the zone for cooling, as determined in 6.6.10.4, in h;

$\tau_{C;0}$ is a reference time constant, as specified below, in h.

The values of the reference numerical parameter, $a_{C;0}$, and the reference time constant, $\tau_{C;0}$, for the heat transfer utilization factor shall be obtained from Table A.35. The informative default values are given in Table B.35.

6.6.10.4 Zone time constant

The time constant of the thermally conditioned zone *ztc*, τ, in hours, characterizes the internal thermal inertia of the conditioned zone. It may differ between heating and cooling calculations, and vary from month to month for each of both, depending on the variation (or not) of its constituting variables, notably H_{tr} and H_{ve}. It is calculated with the following two formulae:

$$\tau_{H;ztc;m} = \frac{C_{m;eff;ztc} / 3\,600}{H_{H;tr(excl.\,grfl);ztc;m} + H_{H;gr;adj;ztc} + H_{H;ve;ztc;m}} \tag{138}$$

$$\tau_{C;ztc;m} = \frac{C_{m;eff;ztc} / 3\,600}{H_{C;tr(excl.\,grfl);ztc;m} + H_{C;gr;adj;ztc} + H_{C;ve;ztc;m}} \tag{139}$$

where, for each thermally conditioned zone *ztc* and month *m.*

$C_{m;eff;ztc}$	is the effective internal heat capacity of the zone, as determined in 6.6.9, in J/K;
$H_{H/C;tr(excl.grflr)\,;ztc;m}$	is the overall heat transfer coefficient by transmission for heating resp. cooling, excluding the ground floor, as determined in 6.6.5, in W/K;
$H_{H/C;ve\ ztc;m}$	is the overall heat transfer coefficient by ventilation for heating resp. cooling, as determined in 6.6.6, in W/K;
$H_{H/C;gr;adj\ ztc}$	is the seasonal average overall heat transfer coefficient for transmission through the ground floor, adjusted for the seasonal temperature difference, for the heating resp. cooling season, obtained from ISO 13789, in W/K.

NOTE More information on thermal transmission through the ground floor can be found in ISO/TR 52016-2[1] and ISO/TR 52019-2[10].

6.6.11 Calculation temperature and intermittency modes

6.6.11.1 Temperature set-points and modes

There are different modes for heating and cooling to consider, namely:

— heating and/or cooling at constant temperature set-point: see 6.6.11.2;

— intermittent heating or cooling: day-time, night-time and/or weekend reduced temperature set-point and/or switch-off: see 6.6.11.3 (heating) or 6.6.11.4 (cooling);

— unoccupied periods (e.g. holidays): see 6.6.11.5

In case of intermittency a simplification is possible, by assuming an equivalent constant temperature set-point.

NOTE 1 If this simplification is applicable, this will be shown in the input from the relevant standard under EPB module M1-6; for instance for a specific space category or building category (e.g. residential buildings).

NOTE 2 For complicated situations, such as periods with boost modes where there is insufficient heating or cooling power during the boost, the monthly method is less applicable. See ISO/TR 52016-2[1] for more information on the limitations for application. This document does not give normative criteria on the applicability. These can be specified e.g. at national level by allowing the monthly method for specific applications, according to the choice given in Table A.2 / Table B.2.

For each month, the profile of the internal operative temperature set-point for heating, $\theta_{int;set;H;ztc}$, and cooling, $\theta_{int;set;C;ztc}$, for each thermally conditioned zone, *ztc*, shall be obtained for week days, weekend days and unoccupied periods from the relevant standard under EPB module M1-6. First, identify whether there is an unoccupied period or not. Next, (separately for the occupied and unoccupied periods, if applicable) determine whether the temperature set-point is constant or not.

If the rule applies for the spatial averaging of the temperature set-point for residential buildings as described in 6.4.6, the temperature set-point for heating shall be adjusted accordingly.

System specific energy need:

For the calculation of the system specific energy needs for heating and cooling, adjustment of the values and the period(s) (such as the number of hours per day and days per week) of the temperature set-points may apply, depending on specific characteristics of the relevant technical building system, to be obtained from the relevant standards under EPB modules M3-1 to M7-1.

6.6.11.2 Heating or cooling at constant temperature set-point

For uninterrupted heating at constant temperature set-point during the whole month one shall use as calculation temperature of the zone, $\theta_{int;calc;H}$, in °C, the temperature set-point for heating, $\theta_{int;H;set;ztc}$, as determined in 6.6.11.1, in °C.

For uninterrupted cooling at constant temperature set-point during the whole month o one shall use as calculation temperature of the zone, $\theta_{int;calc;C}$, in °C, the temperature set-points for cooling, $\theta_{int;C;set;ztc}$, as determined in 6.6.11.1, in °C. The value for the reduction factor for intermittent cooling, $a_{C,red;ztc;m} = 1$.

NOTE For the monthly methods, the actual mean internal temperature can be higher in the heating mode due to instantaneous overheating; however, this effect is accounted for by means of the gain utilization factor. Similarly, for the cooling mode the actual mean internal temperature can be lower due to instantaneous larger losses than gains.

6.6.11.3 Corrections for intermittent heating

In the case of heating at variable temperature set-points and/or with periods of switch-off, the calculation temperature of the zone for heating, $\theta_{int;calc;H;m}$, in °C, is calculated with the following formula:

$$\theta_{int;calc;H;ztc;m} = a_{H;red;ztc;m} \times \left(\theta_{int;set;H;ztc} - \theta_{e;a;m}\right) + \theta_{e;a;m} \quad (140)$$

where, for each thermally conditioned zone *ztc* and month *m.*

$\theta_{int;set;H;ztc}$ is the normal ('thermal comfort level') heating temperature set-point of the zone, obtained from the relevant standard under EPB module M1-6, in °C.

$\theta_{e;a;m}$ is the monthly mean air temperature of the external environment, obtained from the relevant standard under EPB module M1-13, in °C.

$a_{H;red;ztc;m}$ is the reduction factor for intermittent heating, as determined below.

NOTE 1 For the monthly calculation method it is not evident whether the monthly values for occupant-related data in case of intermittent heating are the data during occupancy or the time-average values over occupancy and non-occupancy periods (hours and/or days). Both choices introduce errors that are inevitable for the monthly calculation method. The choice is to use time-averaged values. See more explanation in the technical report, ISO/TR 52016-2[1].

The dimensionless reduction factor for intermittent heating, $a_{H,red;ztc;m}$ is calculated as given by one of the following two methods. The choice between method A and method B is indicated in Table A.36 (normative template), with informative default choice provided in Table B.36.

Method A

Using the following formula:

$$a_{H;red;ztc;m} = 1 - \left(1 - a_{H;red;day;ztc;m}\right) - \left(1 - a_{H;red;night;ztc;m}\right) - \left(1 - a_{H;red;wknd;ztc;m}\right) \quad (141)$$

with:

$$a_{H;red;y;ztc;m} = 1 - f_{H;red;y;ztc} + f_{H;red;y;ztc} \cdot d_{,\ H;red;mn;y;ztc;m} \quad (142)$$

with

$$f_{H;red;y;ztc} = \frac{\Delta t_{H;red;y;ztc} \cdot n_{rep;H;red;y;ztc}}{24 \times 7} \quad (143)$$

where, for each thermally conditioned zone *ztc* and month *m.*

$a_{H;red;y;ztc;m}$ is the reduction factor for intermittent heating with reduced set-point, with y = day, night or weekend.

$f_{H;red;y;ztc}$ is the relative part of the time (y = day, night or weekend) with reduced heating set-point:

$n_{rep;H;red;y;ztc}$ is the number of repetitions in a week of reduction period y, obtained from the relevant standard under EPB module M1-6.

NOTE 2 For instance: $n_{rep;H;red;y;ztc}$= 7 for day or night time set back; or 5 in case it is combined with weekend set-back or weekend switch-off.

$d\theta_{H;red;mn;y;ztc;m}$ is the average (relative) reduction in the temperature difference during the period of reduced temperature set-point, determined as specified below.

$\Delta t_{H;red;y;ztc}$ is the duration of the period with reduced heating set-point (y = day, night or weekend) , obtained from the relevant standard under EPB module M1-6, in h.

The following formulae under Method A apply for each of the intermittency periods (y = day, night or weekend), if applicable.

To calculate the average (relative) reduction in the temperature difference during the period of reduced temperature set-point, $d\theta_{H;red;mn;ztc;m}$, the following three additional quantities are determined:

The dimensionless (relative) reduction in set-point related to the difference with the outdoor temperature, $d\theta_{set;H;low;y;ztc;m}$, which is given by:

If ($\theta_{int;set;H;ztc} - \theta_{e;a;m}$) ≤ 0: $d\theta_{set;H;low;y;ztc;m} = 1$

And if ($\theta_{int;set;H;low;y;ztc} - \theta_{e;a;m}$) ≤ 0: $d\theta_{set;H;low;y;ztc;m} = 0$

Otherwise:

$$d\theta_{set;H;low;y;ztc;m} = \frac{\theta_{int;set;H;low;y;ztc} - \theta_{e;a;m}}{\theta_{int;set;H;ztc} - \theta_{e;a;m}} \quad (144)$$

where

$\theta_{int;set;H;low;y;ztc}$ is the reduced (‘economy level’) heating temperature set-point of the zone during intermittency period y, obtained from the relevant standard under EPB module M1-6, in °C.

The dimensionless (relative) reduction in difference between indoor and outdoor temperature at free floating conditions (zero heating), $d\theta_{\text{float};ztc;m} = \dfrac{\theta_{\text{int;float};ztc;m} - \theta_{\text{e;a};m}}{\theta_{\text{int;set;H};ztc} - \theta_{\text{e;a};m}}$, which is given by:

If $(\theta_{\text{int;set;H};ztc} - \theta_{\text{e;a};m}) \leq 0$:

$$d\theta_{\text{float};ztc;m} = 1 \tag{145}$$

NOTE 3 In this case there is no heating need anyway.

Otherwise:

$$d\theta_{\text{float};ztc;m} = \frac{Q_{\text{H;gn};ztc;m}}{\left(H_{\text{H;tr};ztc;m} + H_{\text{H;ve};ztc;m}\right) \cdot \left(\theta_{\text{int;set;H};ztc} - \theta_{\text{e;a};m}\right) \cdot \Delta t_m} \tag{146}$$

with maximum value: $d\theta_{\text{float};m} = 1$ and minimum value: $d\theta_{\text{float};m} = 0$.

NOTE 4 The minimum value is needed for the rare case that the gains are negative, in case of dominating thermal radiation to the sky.

where, for each thermally conditioned zone *ztc* and month *m*:

$Q_{\text{H;gn};ztc;m}$ are the total heat gains for the heating mode, as determined in 6.6.4.4, in kWh.

$H_{\text{H;tr};ztc;m}$ is the overall heat transfer coefficient by transmission for heating, as determined in 6.6.5, in W/K.

$H_{\text{H;ve};ztc;m}$ is the overall heat transfer coefficient by ventilation for heating, as determined in 6.6.6, in W/K.

NOTE 5 The right hand side of the equation looks similar to the heat-balance ratio for the heating mode, $\gamma_{\text{H};ztc;m}$ (see 6.6.10.2), but using that quantity here would create a circular loop.

The dimensionless (relative) length of the period until reduced set-point is reached:

If $(d\theta_{\text{set;H;low};ztc;m} - d\theta_{\text{float};ztc;m}) \leq 0$ or in case of switch-off of the heating: $f_{\text{H;red;low;y};ztc;m} = 1$.

And if $d\theta_{\text{float};ztc;m} = 1$: $f_{\text{H;red;low;y};ztc;m} = 0$.

Otherwise:

$$f_{\text{H;red;low;y};ztc;m} = \frac{\Delta t_{\text{H;red;low;y};ztc;m} / \tau_{\text{H};ztc;m}}{\Delta t_{\text{H;red;y};ztc;m} / \tau_{\text{H};ztc;m}} \tag{147}$$

with:

$$\frac{\Delta t_{\text{H;red;low;y};ztc;m}}{\tau_{\text{H};ztc;m}} = -\ln\left(\frac{d\theta_{\text{set;H;low;y};ztc;m} - d\theta_{\text{float};ztc;m}}{1 - d\theta_{\text{float};ztc;m}}\right) \tag{148}$$

and where

$\tau_{\text{H};ztc;m}$ is the time constant for the heating mode, in h.

The average (relative) reduction in the temperature difference during the period of reduced temperature set-point, $d\theta_{\text{H;red;mn;y};ztc;m}$, is equal to:

If $f_{H;red;low;ztc;m} \geq 1$:

$$d\theta_{H;red;mn;ztc;m} = d\theta_{float;y;ztc;m} + \left(\frac{1 - d\theta_{float;ztc;m}}{\Delta t_{H;red;y;ztc;m} / \tau_{H;ztc;m}} \right) \cdot \left(1 - e^{-\left(\Delta t_{H;red;y;ztc} / \tau_{H;ztc;m} \right)} \right) \quad (149)$$

In other cases:

$$d\theta_{H;red;mn;y;ztc;m} = \left(\frac{1 - d\theta_{set;H;low;y;ztc;m}}{\Delta t_{H;red;y;ztc;m} / \tau_{H;ztc;m}} \right) + f_{H;red;low;y;ztc;m} \cdot d\theta_{float;ztc;m} + \left(1 - f_{H;red;low;y;ztc;m} \right) \cdot d\theta_{set;H;low;y;ztc;m} \quad (150)$$

Method B

Another method, as specified in Table A.36 (normative template) and Table B.36 (informative default, in this case empty).

6.6.11.4 Corrections for intermittent cooling

The corrections in the case of cooling at variable temperature set-points and/or with periods of switch-off are applied on the cooling need and not on the calculation temperature. The calculation temperature of the zone for cooling, $\theta_{int;calc;C;m}$, in °C, remains the same as for continuous cooling, as determined in 6.6.11.1.

NOTE 1 For the monthly calculation method it is not evident whether the monthly values for occupant-related data in case of intermittent cooling are the data during occupancy or the time-average values over occupancy and non-occupancy periods (hours and/or days). Both choices introduce errors that are inevitable for the monthly calculation method. The choice is to use time-averaged values. See more explanations in ISO/TR 52016-2 [1].

The dimensionless reduction factor for intermittent cooling, $a_{C;red}$, is calculated as given by one of the following two methods. The choice between Method A and Method B is indicated in Table A.37 (normative template), with the informative default choice provided in Table B.37.

Method A

This method only considers a reduction of the cooling need if the cooling is reduced or switched off during the entire weekend (i.e. at least 48 hours/week). If this condition is not fulfilled, then $a_{C;red;ztc;m} = 1$.

The dimensionless reduction factor for intermittent cooling, $a_{C,red;ztc;m}$, in case of weekend reduction or switch-off, is calculated as given by the following formula:

$$a_{C;red;ztc;m} = a_{C;red;wknd;ztc;m} = \left(1 - f_{C;red;wknd;ztc} \right) + b_{C;red;wknd} \cdot f_{C;red;wknd;ztc} \quad (151)$$

with

$$f_{C;red;wknd;ztc} = \frac{\Delta t_{C;red;wknd;ztc} \times n_{rep;C;red;wknd;ztc}}{24 \times 7} \quad (152)$$

where, for each thermally conditioned zone *ztc*.

$f_{C;red;wknd;ztc}$	is the relative part of the week with intermittency;
$n_{rep;C;red;wknd;ztc}$	is the number of repetitions in a week of this intermittency, obtained from the relevant standard under EPB module M1-6;

NOTE 2 For instance: $n_{rep;C;red;wknd;ztc}$= 1 for weekend set-back or weekend switch-off and $n_{rep;C;red;wknd;ztc}$ = 0 without weekend set-back or weekend switch-off.

$\Delta t_{C;red;wknd;ztc}$ is the duration of the weekend with reduced temperature set-point for cooling or interruption, obtained from the relevant standard under EPB module M1-6, in h;

$b_{C;red;wknd}$ is an empirical correlation factor with the value provided in Table A.37 (normative template), with informative default value provided in Table B.37.

NOTE 3 The value of $a_{C;red;wknd;ztc;m}$ is only influenced by the duration of the weekend reduction or switch-off, and, for instance, not by the "reduced" temperature set-point. In ISO/TR 52016-2 [1] it is explained that for the monthly method a more accurate result is not justified.

Method B:

Another method, as specified in Table B.37.

6.6.11.5 Corrections for unoccupied period

In some building or space categories, such as schools, unoccupied periods during the heating or cooling season, such as holiday periods, lead to a reduction in space heating or cooling energy use.

The heating and cooling needs, taking into account unoccupied period, $Q_{H;nd;ztc;m}$ and $Q_{C;nd;ztc;m}$, in kWh, are calculated as follows. If a month contains an unoccupied period, perform the calculation twice: a) for the occupied (normal) heating/cooling settings and b) for the unoccupied settings and then interpolate the results linearly according to the time fraction of unoccupied mode versus occupied mode, as given by the following two formulae:

$$Q_{H;nd;ztc;m} = \left(1 - f_{H,nocc;ztc;m}\right) \cdot Q_{H;nd;occ;ztc;m} + f_{H,nocc;ztc;m} \cdot Q_{H;nd;nocc;ztc;m} \quad (153)$$

$$Q_{C;nd;ztc;m} = \left(1 - f_{C,nocc;ztc;m}\right) \cdot Q_{C;nd;occ;ztc;m} + f_{C,nocc;ztc;m} \cdot Q_{C;nd;nocc;ztc;m} \quad (154)$$

where, for each thermally conditioned zone *ztc* and month *m.*

$Q_{H/C;nd;occ;ztc;m}$ is the energy need for heating/cooling, calculated in accordance with 6.6.4.2 (heating) or 6.6.4.3 (cooling), assuming for all days of the month the control and thermostat settings of the occupied period, in kWh.

$Q_{H/C;nd;nocc;ztc;m}$ is the energy need for heating/cooling, calculated in accordance with 6.6.4.2 (heating) or 6.6.4.3 (cooling), assuming for all days of the month the control and thermostat settings of the unoccupied period, in kWh.

$f_{H/C;nocc;ztc;m}$ is the fraction of the month which is the unoccupied (heating/cooling) period (e.g. 10/31).

6.6.11.6 Calculated temperature of a thermally conditioned zone as output variable

The temperature in the thermally conditioned zone is needed as output variable, e.g. to assess heat losses from heat or cold generators, storage and distribution systems (pipes and ducts) located in a thermally conditioned space or spaces.

For the heating mode, the monthly mean temperature of the zone $\theta_{int;op;H;ztc;m}$, in °C, is equal to the calculation temperature, $\theta_{int;calc;H;ztc;m}$, in °C, as determined in 6.6.11.2 and 6.6.11.3 and 6.6.11.5.

For the cooling mode, the monthly mean temperature of the zone, $\theta_{int;op;C;ztc;m}$, in °C, is given by the following formulae:

$$\theta_{int;op;C;ztc;m} = \theta_{e;a;m} + \frac{\left(Q_{C;nd;ztc;m} + Q_{C;gn;ztc;m}\right)}{\left(H_{C;ht;ztc;m} \times 0{,}001 \times \Delta t_m\right)} \quad (155)$$

$$\text{with: } H_{C;ht;ztc;m} = \frac{Q_{C;ht;ztc;m}}{\left(\theta_{int,calc,C;ztc;m} - \theta_{e;a;m}\right)} \quad (156)$$

where

$\theta_{e;a;m}$ is the monthly mean air temperature of the external environment, obtained from the relevant standard under EPB module M1-13, in °C;

$Q_{C;nd;ztc;m}$ is the monthly energy need for cooling, for the thermally conditioned zone *ztc* and month *m*, determined as specified below, in kWh;

$Q_{C;gn;ztc;m}$ are the total heat gains for the cooling mode, as determined in 6.6.4.4, in kWh;

$Q_{C;ht;ztc;m}$ is the total heat transfer by transmission and ventilation for the cooling mode, as determined in 6.6.4.4, in kWh;

$\theta_{int;calc;C;ztc;m}$ is the calculation temperature of the zone for cooling, as determined in 6.6.11.2 and 6.6.11.4, in °C;

Δt_m is the duration of the month *m*, obtained from the relevant standard under EPB module M1-13, in h.

NOTE 1 The formulae are simply an expression of the monthly thermal balance, in which the effect of intermittency and the unutilized heat losses are taken into account.

If, in the relevant system standard using this temperature as an input, no distinction can be made between heating and cooling mode, the temperature for heating and cooling mode shall be weighted, on a monthly basis, with the heating and cooling need respectively.

NOTE 2 For thermally unconditioned zones the temperature as output variable for other standards is given in 6.4.5.3.

6.6.12 Overheating indicator

In case of absence of mechanical cooling, there is a risk of overheating.

NOTE 1 The risk of undersizing of a cooling system cannot be calculated with the monthly calculation method, unless reliable (national or regional) hourly cooling load frequency distribution curves are available for each space category.

The risk of overheating is assessed only at the level of a thermal zone. Depending on the specific rules for zoning, a thermal zone may contain spaces with different thermal properties and with different thermal loads. In that case the overheating indicator may underestimate the risk of overheating.

The overheating indicator of thermal zone *ztc* is set equal to the annual accumulated overtemperature, as given by the following 2 formulae:

$$I_{OH;ztc;an} = \sum_{m=1}^{12} T_{OH;ztc;m} \quad (157)$$

$$T_{OH;ztc;m} = \frac{1\,000 \times \left(Q_{OH;gn;ztc;m} - Q_{OH;ht;ztc;m}\right)}{H_{OH;tr;ztc;m} + H_{OH;ve;ztc;m}} \qquad (158)$$

where, for each thermally conditioned zone *ztc.*

$I_{OH;ztc;an}$	is the annual overheating indicator, in K·h;
$T_{OH;ztc;m}$	is the monthly accumulated overtemperature, in K·h;
$Q_{OH;gn;ztc;m}$	are the total heat gains for the overheating calculation, for month *m*, determined as described below, in kWh;
$Q_{OH;ht;ztc;m}$	is the total heat transfer by transmission and ventilation for the overheating calculation, for month *m*, determined as described below, in kWh;
$H_{O;tr;ztc;m}$	is the overall heat transfer coefficient by transmission for the overheating calculation, for month *m*, determined as described below, in W/K;
$H_{O;ve;ztc;m}$	is the overall heat transfer coefficient by ventilation for the overheating calculation, for month *m*, determined as described below, in W/K.

The calculations follow the same methodology and formulae as for the cooling calculation (see 6.6.4 to 6.6.11), but with the following differences:

— If there is no cooling set-point given, the calculation shall be done with cooling set-point $\theta_{int;set;C;ztc}$ = 26 °C.

— The boundary conditions are different, resulting in different numeric values for all the downstream variables concerned, whence the use of the subscript OH instead of the subscript C. The differences are according to one of the following 2 sets:

Boundary conditions, option A:

— The value of the overall heat transfer coefficient by transmission, $H_{OH;tr;ztc;m}$, is set equal to its value for cooling, $H_{C;tr;ztc;m}$, as determined in accordance with 6.6.5.2.

— The overall heat transfer coefficient by ventilation, $H_{OH;veztc;m}$, is determined taking into account the provisions for (day and/or night-time) intensive ventilation (e.g. secure windows opening) in order to evacuate superfluous heat. Specifications shall be given in the methods referenced in 6.6.6.

— The values of the internal and solar heat gains are set equal to their values for cooling,

Boundary conditions, Option B:

Any other set of conditions as specified in Table A.38 (normative template) and Table B.38 (informative default, in this case empty).

NOTE 2 Option B also accommodates small variants of option A. In that case all conditions of option A are copied and subsequently modified as needed.

NOTE 3 Background information can be found in ISO/TR 52016-2 [1].

6.6.13 Length of the heating and cooling season for operation of season-length-dependent provisions

If the operation time of season-dependent provisions, such as pumps for the heating system, has to be assessed and in absence of more detailed data, the length of the heating season can be approximated by the sum of the months with higher than zero heating needs.

If the operation time of season-dependent provisions, such as fans for the cooling system, has to be assessed and in absence of more detailed data, the length of the cooling season can be approximated by the sum of the months with higher than zero cooling needs.

NOTE To avoid infinitesimal small values of heating and cooling needs, limits are introduced in 6.6.4. In this approximation, the heating and cooling season can overlap.

6.6.14 Humidification and dehumidification

6.6.14.1 Humidification

The monthly latent energy need for humidification is given by:

$$Q_{\mathrm{HU;nd};ztc;m} = f_{\mathrm{HU};m} \cdot h_{\mathrm{we}} \cdot \left(1\text{-}\eta_{\mathrm{HU;rvd};ztc}\right) \cdot \rho_{\mathrm{a}} \cdot q_{\mathrm{V;mech};ztc;m} \cdot \left(\Delta x \cdot t\right)_{\mathrm{a;sup};ztc;\mathrm{an}} \quad (159)$$

where, for each thermally conditioned zone *ztc* and month *m*:

$Q_{\mathrm{HU;nd};ztc;m}$ is the humidification need, in kWh;

$f_{\mathrm{HU};m}$ is the monthly fraction of energy need for humidification, obtained according to Table A.39 (normative template, with informative choice in Table B.39);

h_{we} is the latent heat of vaporization of water, as specified in 6.3.6, in J/kg;

$\eta_{\mathrm{HU;rvd};ztc}$ is the efficiency of latent heat recovery of the system servicing thermal zone *ztc*, obtained from Table A.40 (normative template, with informative choice in Table B.40);

ρ_{a} is the air density, as specified in 6.3.6, in kg/m^3;

$q_{\mathrm{V;mech};ztc;m}$ is the monthly time-average mechanical supply airflow rate entering the zone, as determined in the relevant standard(s) under EPB module M5-5, in m^3/s;

$(\Delta x \cdot t)_{\mathrm{a;sup};ztc;\mathrm{an}}$ is the annually accumulated amount of moisture to be supplied per kg dry air supply, obtained from Table A.41 (normative template, with informative choice in Table B.41), in kg h/kg.

NOTE The accumulation of moisture content x time is a simplification, to avoid the need for separate tabulated values of moisture content and tabulated values of operational times, both as function of space category.

6.6.14.2 Dehumidification

The monthly latent energy needs for dehumidification is given by:

$$Q_{\mathrm{DHU;nd};ztc;m} = f_{\mathrm{DHU;C}} \cdot Q_{\mathrm{C;nd};ztc;m} \quad (160)$$

where, for each thermally conditioned zone *ztc* and month *m*:

$Q_{\mathrm{DHU;nd};ztc;m}$ is the dehumidification need, in kWh;

$Q_{\mathrm{C;nd};ztc;m}$ is the energy need for (sensible) cooling, as determined in 6.6.4, in kWh;

$f_{\mathrm{DHU;C};ss}$ is the fraction of sensible energy need to be added for dehumidification, per type of cooling system *ss*, obtained from the relevant system standard under EPB module M7-1.

6.6.14.3 Annual latent energy needs

The annual latent energy needs for (de-)humidification are calculated as the sum over the monthly needs:

$$Q_{\text{HU/DHU;nd};ztc;\text{an}} = \sum_{m} Q_{\text{HU/DHU;nd};ztc;m} \tag{161}$$

where, for each thermally conditioned zone ztc:

$Q_{\text{HU/DHU;nd};ztc;\text{an}}$	are the annual (de-)humidification needs, in kWh;
$Q_{\text{HU/DHU;nd};ztc;m}$	are the (de-)humidification needs, in kWh.

7 Quality control

7.1 Calculation report

7.1.1 General

The main purpose of the calculation report is:

— to enable to trace or verify the input, assumptions and chosen methods;

— to obtain a quick impression of the relative influence of each of these main factors in the calculation as a qualitative check on the credibility of the results and the sensitivity for certain input data, assumptions and/or mistakes.

NOTE 1 It is outside the jurisdiction of this document to dictate where and how this report should be made available.

A report giving an assessment of the energy needs, the internal temperature or the design heating or cooling load obtained in accordance with this document shall include at least the information described in the applicable paragraph of this Clause.

NOTE 2 Worked examples are presented in the ISO/TR 52016-2[1]. Also results from validation of the hourly and the monthly calculation methods are available in this report.

7.1.2 Energy need calculation

7.1.2.1 Input data

For the energy need calculation the calculation report shall include the values of the following data:

a) all input data shall be listed and justified, e.g. by reference to international or national standards, or by reference to the appropriate annexes to this document or to other documents. When the input data are not the standard data, an estimate of the accuracy and source of input data shall also be given.

b) a reference to this document;

c) the purpose of the calculation (e.g. for judging compliance with regulations, optimizing energy performance, assessing the effects of possible energy conservation measures, or predicting energy resource needs on a given scale);

d) a description of the building, its construction and its location;

e) a specification of the zone partitioning, if any, i.e. the allocation of rooms to each zone;

f) a note indicating which method (hourly or monthly) was used;

g) for the monthly or hourly method, H_{tr}, H_{ve}, A_{s} and C_{m} for each zone, for each month.

7.1.2.2 Calculation results

7.1.2.2.1 Hourly method

For each thermal zone and month:

— mean indoor (operative and air) temperature;

— mean outdoor temperature;

— mean global solar radiation on a horizontal plane;

— total heat transfer by transmission;

— total heat transfer by ventilation;

— total internal heat gains, including recoverable system thermal losses;

— total solar heat gains;

— energy need for heating;

— energy need for cooling.

A bar diagram showing these main terms of the monthly energy balance is strongly recommended to obtain a quick impression of the relative influence of each of these main factors.

For the whole building:

— annual energy need for heating;

— annual energy need for cooling.

Hourly data:

— At least the hourly outdoor temperature and global solar radiation and the calculated internal operative temperature and energy load for heating and cooling per zone shall be available as output from the calculation.

NOTE 1 Graphical plots over periods that are representative for different seasons are strongly recommended. See examples in the technical report, ISO/TR 52016-2[1].

NOTE 2 A plot of e.g. weekly averaged energy needs against outdoor temperature is strongly recommended. See ISO/TR 52016-2[1] for explanation and also for more examples to obtain insight in the relative impact of the various elements influencing the energy needs.

7.1.2.2.2 Monthly method

For each thermal zone and month:

For heating mode:

— total heat transfer by transmission;

— total heat transfer by ventilation;

— total internal heat gains, including recoverable system thermal losses;

— total solar heat gains;

— energy need for heating.

For cooling mode:

— total heat transfer by transmission;

— total heat transfer by ventilation;

— total internal heat gains, including recoverable system thermal losses;

— total solar heat gains;

— energy need for cooling.

For the whole building:

— annual energy need for heating;

— annual energy need for cooling.

7.1.3 Internal temperature calculation

For the internal temperature calculation the calculation report shall include the values of the following data:

a) Input data:

— climatic data (hourly values of the external air temperature and solar radiation intensity);

— building characteristics: description of the building and of the thermal zone investigated;

— volume of zone;

— for each element bounding the zone:

opaque elements: area, exposure, thermophysical properties of each layer;

glazed elements: area, exposure, thermophysical and solar characteristics of each glazed element.

Local clock time shall be used for all time-dependent input data with the exception of climatic data. If the climatic data time convention is different from local clock time, the difference shall be reported.

b) Output data:

— hourly values of the air ventilation flow rate (number of changes per hour);

— hourly values of the heat flow rate for internal sources (W/m^2 of floor area);

— hourly values of air temperature and mean radiant temperature.

The predicted temperatures shall be reported for the calculation period and not for the pre-conditioning period.

7.1.4 Design heating and cooling load calculation

Requirements for the calculation report are similar to the requirements for the energy need calculation using the hourly calculation method, with specification of the climatic data and other deviations, and reporting of the design loads.

7.2 Hourly method: verification cases

7.2.1 Scope and limitations

These test cases verify the calculation of the thermal balance in a single thermal zone and the calculation of the heating and cooling needs.

This includes, for the hourly calculation method, the solving of the equations of 6.5 and the step-wise procedure to calculate the heating and cooling needs according to 6.5.4.

These test cases do not include for instance:

— Ground floor heat transfer coupled to ground.

NOTE 1 This is covered in the example cases described in ISO/TR 52016-2[1].

— Thermal coupling between two or more zones.

— The effect of thermal bridges.

— Sunspace or other thermally unconditioned spaces.

— Solar shading by external obstacles (distant, remote or from own building elements).

— Complex control patterns (e.g. weekend interruption of mechanical ventilation and/or heating and cooling and/or solar shading, etc.; night time ventilation as free cooling, heat recovery by pass, etc.).

For the hourly calculation method these situations do not add complexity to the calculation, so these require no special testing, except if this requires iteration or approximations to avoid iteration, or if it requires measures to avoid oscillations.

For the monthly calculation method these aspects are covered by correction factors; the validity of such factors requires dedicated validation cases.

— Latent energy needs. Validation cases for the latent energy balance are not needed, because with the given assumptions, the equation is straightforward and can be easily checked analytically.

NOTE 2 For the **monthly calculation method** a verification would include solving of the equations in 6.6. However, the monthly method contains many optional coefficients that depend on specific regional conditions, which makes a verification using the given specific test cases not realistic. The monthly method can be compared against the hourly method, especially with the help of the key monthly data derived from the hourly calculation as described in 6.5.15. Moreover, the basic formulae for the monthly method can be easily checked manually. The calculation elements in the monthly method that suffer the highest risk of errors are the special calculation elements that are not covered by the standard verification cases.

7.2.2 Verification procedure for the whole calculation method

7.2.2.1 General

Whole model verification considers the calculation of the operative temperatures and the sensible energy needs for heating and cooling for a full year for several cases indicated below.

NOTE The verification cases are based on the BESTEST 600 and 900 cases as described in ANSI/ASHRAE 140[8].

7.2.2.2 Geometry of the test room

The various test cases refer to a geometry consisting of a single zone with two different types of envelope: lightweight and heavyweight. The geometry of the test room is shown in Figure 2. The geometrical characteristics of the rooms are given in Table 22.

Unless otherwise stated, all constructions are external (outdoor).

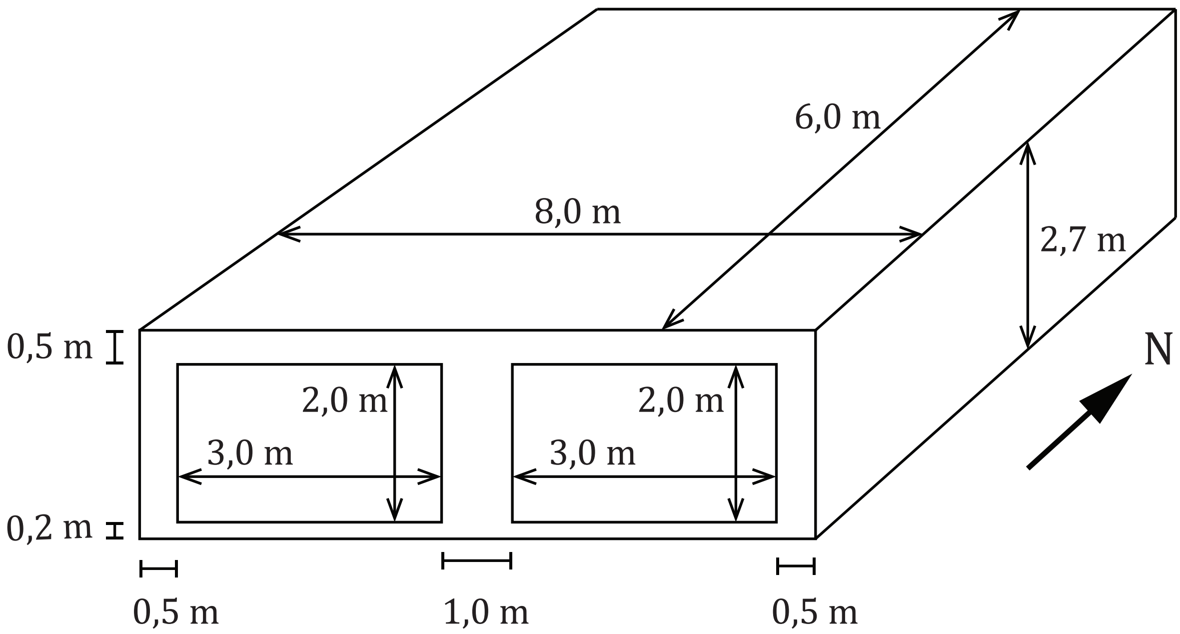


Figure 2 — Geometry of the test room

Table 22 — Room data

Component	Area [m²]
Wall (front)	9,6
(left)	16,2
(right)	16,2
(back)	21,6
Window	12,0
Floor	48,0
Ceiling	48,0
Volume [m³]	
129,6	

7.2.2.3 Thermophysical properties of opaque elements

The thermophysical characteristics of the walls, ceiling and floor are given in Table 23 for the lightweight case and in Table 24 for the heavyweight case.

To reduce uncertainty regarding testing the other aspects of simulating the building envelope, the floor insulation has been made very thick to effectively decouple the floor thermally from the ground.

For the application of this document this means that the thermal resistance of the floor can be used in the calculations instead of the effective thermal resistance ($R_{c;f;eff}$), with the outdoor air as external environment.

Table 23 — Thermophysical properties of the opaque components for the lightweight case

Structure	D m	λ W/(m·K)	R m²·K/W	$\kappa_{m;op}$ J/(m²·K)	ρ kg/m³	c J/(kg·K)
External wall (inside to outside)						
Plasterboard	0,012	0,160	0,075	9576	950	840
Fiberglass quilt	0,066	0,040	1,650	665	12	840
Wood siding	0,009	0,140	0,064	4293	530	900
Total surf-surf			1,789			
For application of ISO 52016-1: - Class specific heat capacity - Class of distribution				Very light Evenly (D)		
Floor (inside to outside)						
Timber flooring	0,025	0,140	0,179	19500	650	1200
Insulation [a]	1,003	0,040	25,075	0 [b]	0 [b]	0 [b]
Total surf-surf			25,254			
For application of ISO 52016-1: - Class specific heat capacity - Class of distribution				Very light Internal (I)		
Roof (inside to outside)						
Plasterboard	0,010	0,160	0,063	7980	950	840
Fiberglass quilt	0,1118	0,040	2,794	1127	12	840
Roofdeck	0,019	0,140	0,136	9063	530	900
Total surf-surf			2,992			
For application of ISO 52016-1: - Class specific heat capacity - Class of distribution				Very light Evenly (D)		

[a] To reduce uncertainty regarding testing the other aspects of simulating the building envelope, the floor insulation (below the actual floor construction) has been made very thick in the test case description, with the purpose to effectively decouple the floor thermally from the ground.

For the application of this document this means that the floor plus insulation is modelled as an opaque construction to outdoor air; this implies that the thermal resistance of the floor has to be used in the calculations instead of the effective thermal resistance ($R_{c;f;eff}$) in case of a ground coupled floor. To ensure that the thermal mass of the actual floor is modelled as part of the actual floor and not distributed over the actual floor and the artificial thick thermal insulation layer, the thermal resistance of the thick thermal insulation layer is imposed on the first (most outdoor) conductance which does not take part in the attribution of the thermal mass of the Class I type of construction (see 5.6.7.2); so: $\boldsymbol{h_1}$ **= 0,04 W/(m²·K)**.

[b] Underfloor insulation has the minimum density and specific heat the program being tested will allow, but not < 0. For the application of this document the density, specific heat and specific heat capacity of the underfloor insulation are assumed to be zero.

Table 24 — Thermophysical properties of the opaque components for the heavyweight case

Structure	D m	λ W/(m·K)	R m²·K/W	$\kappa_{m;op}$ J/(m²·K)	ρ kg/m³	c J/(kg·K)
External wall (inside to outside)						
Concrete block	0,100	0,510	0,196	140000	1400	1000
Foam insulation	0,0615	0,040	1,537	861	10	1400
Wood siding	0,009	0,140	0,064	4293	530	900
Total surf-surf			1,797			
For application of ISO 52016-1: - Class specific heat capacity - Class of distribution				Heavy Internal (I)		
Floor (inside to outside)						
Concrete slab	0,080	1,130	0,071	112000	1400	1000
Insulation [a]	1,007	0,040	25,175	0 [b]	0 [b]	0 [b]
Total surf-surf			25,246			
For application of ISO 52016-1: - Class specific heat capacity - Class of distribution				Medium Internal (I)		
Roof (inside to outside) [c]						
Plasterboard	0,010	0,160	0,063	7980	950	840
Fiberglass quilt	0,1118	0,040	2,794	1127	12	840
Roofdeck	0,019	0,140	0,136	9063	530	900
Total surf-surf			2,992			
For application of ISO 52016-1: - Class specific heat capacity - Class of distribution				Very light Evenly (D)		

[a] To reduce uncertainty regarding testing the other aspects of simulating the building envelope, the floor insulation has been made very thick to effectively decouple the floor thermally from the ground. For the application of this document this means that the thermal resistance of the floor can be used in the calculations instead of the effective thermal resistance ($R_{c;f;eff}$) and the external environment of the construction is assumed to be the outdoor air. But to ensure that the thermal mass is modelled as part of the actual floor and not as part of the artificial thick thermal insulation layer, the thermal resistance of the thick thermal insulation layer is imposed on the first (most outdoor) conductance, $\boldsymbol{h_1}$ **= 0,04 W/(m²·K)**.

[b] Underfloor insulation has the minimum density and specific heat the program being tested will allow, but not < 0.

For the application of this document the density, specific heat and specific heat capacity of the underfloor insulation are assumed to be zero.

[c] For the heavyweight case wall and floor properties are more massive and the roof properties are unchanged.

7.2.2.4 Internal heat capacity of a zone

Monthly calculation method:

For the application of the monthly calculation method in this document the internal heat capacity of the zone is calculated on the basis of the simplified method, using default values for the internal heat capacity (Table 21).

— For the lightweight case: class “very light” (80 000 A_{use})

— For the heavyweight case: class “heavy” (260 000 A_{use})

This leads to

— For the lightweight case: C_m = 3,84 MJ/K;

— For the heavyweight case: C_m = 12,48 MJ/K.

7.2.2.5 Specific heat capacity of air and furniture

Hourly calculation method

For the application of this document the specific heat capacity of air and furniture shall be $\kappa_{m;int}$ = 10 000 J/(m²·K).

7.2.2.6 Properties of glazing

The window consists of double pane glazing, with the following properties:

— $g_{g;n}$=0,789;

F_W=0.9 (correction factor for non-scattering glazing) Consequently: g_g=0,71

NOTE In ANSI/ASHRAE 140[8] a value is given for double pane shading reduction factor (0,907). Therefore the U_W value is adapted to obtain the same R_c value for the window.

For the application of this document the following input data are adapted:

— U_W=2,984 W/(m²·K);

— $R_{se;v}$=0,04 m²K/W; (see Table 25)

— $R_{si;v}$=0,13 m²K/W; (see Table 25)

— F_{fr}=0.

The values for $R_{se;v}$ and $R_{si;v}$ in this document are different from the values in ANSI/ASHRAE 140[8]. In ASHRAE 140 values are given for the hemispherical infrared emittance of ordinary uncoated glass (0,84 or 0,9), which should lead to similar coefficients. Therefore the U_W value is adapted to obtain the same R_c value for the window.

7.2.2.7 Solar absorption coefficient

The solar absorption coefficient of all opaque surfaces α_{sol} = 0,6.

7.2.2.8 View factor to the sky

For the application of this document the view factor to the sky shall be:

— F_{sky} = 1,0 for the roof;

— F_{sky} = 0,5 for the walls.

NOTE The infrared emittance of exterior opaque surfaces as given in ANSI/ASHRAE 140[8] is not used as a variable in this document; a standard emittance value is implicitly assumed.

7.2.2.9 Convective fractions

The following convective fractions shall be used:

— $f_{int;c}$ = 0,40;

— $f_{sol;c}$ = 0,10;

— $f_{H;c}$ = 1,00;

— $f_{C;c}$ = 1,00.

NOTE 1 The convective heating and cooling can have a significant effect on the results and is closely linked to the assumed thermostat setting, as discussed in ANSI/ASHRAE 140[8], B11.1. See discussion in ISO/TR 52016-2 [1].

The fraction of solar radiation lost through re-reflection out through the window are not taken into account (so assumed to be zero).

NOTE 2 In ANSI/ASHRAE 140[8] this fraction is 0,03.

7.2.2.10 Boundary conditions

For the application of this document the values for the heat transfer coefficient are adapted and given in Table 25.

Table 25 — Conventional heat transfer coefficients

Heat transfer coefficient W/(m²·K)	**Symbol**	**Direction of heat flow**		
		Upwards	**Horizontal**	**Downwards**
convective coefficient; internal surface	$h_{c;i}$	5,0	2,5	0,7
convective coefficient; external surface	$h_{c;e}$	20	20	20
radiative coefficient; internal surface	$h_{lr;i}$	5,13	5,13	5,13
radiative coefficient; external surface	$h_{lr;e}$	4,14	4,14	4,14

NOTE These values for the heat transfer coefficients are given in ISO 13789.

7.2.2.11 Utilization factors

For the application of the monthly calculation method in this document the gain utilization factor for heating and the loss utilization factor for cooling are calculated based on the following values for the reference numerical parameter and the reference time constant:

— $a_{H,0}$ = 1,0;

— $a_{C,0}$ = 1,0;

— $\tau_{H,0}$ = 15 h;

— $\tau_{C,0}$ = 15 h.

7.2.2.12 Climatic data

The available measured hourly solar radiation data (global radiation, horizontal diffuse radiation and beam normal radiation) have been converted in accordance with ISO 52010-1.

The hourly values for the external air temperature and the total direct and total diffuse solar radiation for each orientation (vertical positions and horizontal), with the solar height and azimuth angle are given in the accompanying spreadsheet to this document, which is available at the following URL: http://standards.iso.org/iso/52016/-1/ed-1.

The monthly values for the external air temperature and the total, total direct and total diffuse solar radiation for the main orientations are given in Table 26.

Table 26 — Monthly values for the external air temperature and direct and diffuse solar irradiation

a) External air temperature and total solar irradiation

Month	θ_e °C	$H_{sol;tot}$ kWh/m²				
		N	E	S	W	H
1	-1,7	16,5	60,1	159,9	56,3	82,5
2	-0,6	21,2	66,1	132,7	58,8	96,8
3	3,6	35,5	107,9	151,4	90,3	159,8
4	9,3	42,5	112,5	114,4	98,7	183,0
5	14,0	56,4	128,5	97,1	112,6	218,0
6	18,2	59,4	126,7	82,8	112,7	223,8
7	22,7	57,7	139,0	91,9	109,9	230,5
8	21,2	44,7	120,3	109,0	103,3	199,1
9	16,8	34,8	101,7	138,6	97,7	168,8
10	9,5	26,3	81,1	165,6	89,6	130,4
11	3,5	18,9	55,1	146,6	61,4	83,0
12	-0,7	15,9	51,1	157,2	55,1	72,8
Annual	9,6	429,7	1150,0	1547,1	1046,6	1848,5

b) Total diffuse solar irradiation

Month	$H_{sol;dif;tot}$ kWh/m²				
	N	E	S	W	H
1	16,5	16,5	16,5	16,5	14,1
2	21,2	21,2	21,2	21,2	20,4
3	35,5	35,5	35,5	35,5	31,2
4	41,2	41,2	41,2	41,2	35,1
5	48,8	48,8	48,8	48,8	41,2
6	46,9	46,9	46,9	46,9	35,5
7	46,6	46,6	46,6	46,6	32,5
8	42,2	42,2	42,2	42,2	31,8
9	34,7	34,7	34,7	34,7	24,8
10	26,3	26,3	26,3	26,3	17,5
11	18,9	18,9	18,9	18,9	14,9
12	15,9	15,9	15,9	15,9	11,8
Annual	394,6	394,6	394,6	394,6	310,8

c) Total direct solar irradiation

Month	$H_{sol;dir;tot}$ kWh/m²				
	N	E	S	W	H
1	0,0	43,5	143,4	39,7	68,5
2	0,0	44,9	111,5	37,6	76,5
3	0,0	72,4	115,9	54,9	128,7

c) Total *(continued)*

Month	$H_{sol;dir;tot}$ kWh/m²				
	N	E	S	W	H
4	1,3	71,3	73,2	57,5	148,0
5	7,6	79,7	48,3	63,8	176,7
6	12,5	79,9	35,9	65,9	188,3
7	11,1	92,5	45,4	63,4	198,0
8	2,5	78,1	66,8	61,1	167,2
9	0,1	67,0	103,9	63,0	144,0
10	0,0	54,8	139,3	63,3	112,9
11	0,0	36,2	127,7	42,5	68,1
12	0,0	35,2	141,3	39,2	61,0
Annual	35,1	755,4	1152,5	651,9	1537,7

For the application of this document it is assumed that the ground temperature is equal to the external air temperature. Instead of the virtual temperature of the ground ($\theta_{gr;vi;m}$) the external air temperature shall be used in the calculation.

NOTE 1 To reduce uncertainty regarding testing the other aspects of simulating the building envelope, the floor insulation has been made very thick to effectively decouple the floor thermally from the ground. Therefore the influence of the ground temperature is limited.

For the application of this document the difference between the external air temperature and the apparent sky temperature is a fixed value, $\Delta\theta_{sky;t}$ = 11 K for all time intervals t throughout the year.

NOTE 2 This could be subject to discussion: if this heat flow is ignored in the original cases (which is not easy to find out) then, this addition here could result in serious deviations. See more information in ISO/TR 52016-2[1].

7.2.2.13 Internal heat flow rates

The total internal heat flow rate shall be 200 W continuously (24 hours per day for the full year), which results in a specific internal heat flow rate q_{int}= 1,453 W/m².

7.2.2.14 Ventilation

The infiltration rate shall be 0,41 air changes/h continuously (24 hours per day for the full year), which results in an air flow rate q_V = 0,0148 m³/s. This is equal to 1,107 m³/(m²·h). There is no ventilation system.

The infiltration rate shall be independent of wind speed, indoor/outdoor temperature difference, and other variables.

The specified infiltration rates have been adjusted with factor 0,822 to yield mass flows equivalent to those occurring at the specified altitude of the weather station at 1 609 m altitude (Air density at 1 609 m altitude is roughly 80% of that at sea level).

7.2.2.15 Thermostat control strategy

Two different thermostat control strategies are considered:

— Continuous:

  — $\theta_{int;set;H}$=20 °C;

  — $\theta_{int;set;C}$=27 °C.

— Intermittent:

  — From 07:00h to 23:00h: $\theta_{int;set;H}$=20 °C and $\theta_{int;set;C}$=27 °C.

  — From 23:00h to 07:00h: $\theta_{int;set;H}$=10 °C and $\theta_{int;set;C}$=27 °C

  (no night time set back for cooling).

7.2.2.16 Available heating and cooling capacity

The maximum available heating and cooling capacity is effectively infinite:

— $\Phi_{H;avail}$=1000 kW (1 000 000 W);

— $\Phi_{C;avail}$=1000 kW (1 000 000 W).

7.2.3 Description of the verification test cases

Four tests shall be carried out as shown in Table 27.

Table 27 — Test cases

Test No.	BESTEST case identifier	Type of construction	Thermostat control strategy
1	600	Lightweight	Continuous
2	640	Lightweight	Intermittent
3	900	Heavyweight	Continuous
4	940	Heavyweight	Intermittent
5	600FF	Lightweight	Free floating
6	900FF	Heavyweight	Free floating

7.2.4 Results of the verification test cases

For each test the following data shall be calculated and reported:

— monthly and annual sensible energy needs for heating, $Q_{H;nd}$;

— monthly and annual sensible energy needs for cooling, $Q_{C;nd}$.

For the hourly calculation method also the following data shall be calculated and reported:

— monthly average values of the operative temperature, $\theta_{op,av}$;

— hourly sensible energy needs for heating and cooling and operative temperatures for January 4;

— hourly sensible energy needs for heating and cooling and operative temperatures for July 27.

NOTE 1 ASHRAE[8] also asks for the hourly unshaded solar radiation on specific orientations, but in our case this is already an input. These are already available as part of the validation of ISO 52010-1.

For each case the results can be compared to the values reported in Table 28 to 34.

Table 28 — Test results sensible energy needs for heating,

Month	$0{,}001\ \Phi_{H;ld}$ kWh			
Case id.	600	640	900	940
1	1005	718	84	350
2	849	591	53	333
3	636	358	121	118
4	358	169	147	69
5	154	47	175	4
6	63	22	308	8
7	6	0	638	0
8	11	0	656	0
9	95	19	626	0
10	375	151	418	27
11	644	389	84	120
12	938	646	48	272
Annual	5133	3112	3360	1303

Table 29 — Test results sensible energy needs for cooling

Month	$0{,}001\ \Phi_{C;ld}$ kWh			
Case id.	600	640	900	940
1	640	586	16	63
2	498	451	14	34
3	601	537	13	108
4	464	421	5	141
5	404	380	2	173
6	456	446	0	306
7	722	720	0	638
8	778	775	0	656
9	862	835	2	625
10	876	812	6	412
11	589	538	5	68
12	614	557	13	36
Annual	7503	7057	76	3261

Table 30 — Test results average operative temperature

Month	θint;op °C					
Case id.	600	640	900	940	600FF	900FF
1	22,0	19,0	22,3	21,2	17,3	17,6
2	22,0	18,9	22,2	20,9	16,7	16,4
3	22,6	19,8	23,1	22,3	22,1	21,9
4	22,9	20,9	23,9	23,5	24,3	24,7
5	23,5	22,4	24,5	24,4	26,7	26,6
6	24,4	24,0	25,7	25,7	29,6	29,3

Table 30 *(continued)*

Month	θint;op °C					
Case id.	**600**	**640**	**900**	**940**	**600FF**	**900FF**
7	25,6	25,6	26,6	26,6	35,0	34,9
8	25,2	25,1	26,6	26,6	35,2	35,2
9	24,2	23,6	26,1	26,1	34,6	34,7
10	23,0	20,9	24,8	24,7	29,7	30,3
11	22,2	19,4	22,8	22,1	21,4	21,3
12	22,1	19,0	22,2	21,1	17,9	18,0
Annual	23,3	21,5	24,2	23,8	25,9	25,9

Table 31 — Test results annual hourly integrated peak heating and cooling load

Month	0,001 $\Phi_{H/C;ld}$ kWh (peak)			
Case id.	**600**	**640**	**900**	**940**
Heating	4,351	6,690	4,067	9,793
Cooling	6,363	6,233	4,043	4,047

NOTE 2 For the cases with night time temperature set back, these peak loads highly depend whether the air temperature has to meet the set point, or the operative temperature. In this document the operative temperature is chosen, because that is more close to what the occupants feel than only the air temperature (ignoring the cold mass).

Table 32 — Test results annual hourly maximum, minimum and average operative temperature

Month	θint;op °C	
Case id.	**600FF**	**900FF**
Max.	63,5	44,4
Min.	-16,9	-2,4
Average	25,9	26,0

Table 33 — Test results hourly sensible heating (+) and cooling (-) load, January 4

Hour	0,001 $\Phi_{H/C;ld}$ kWh			
Case id.	**600**	**640**	**900**	**940**
1	4189	2380	3663	0
2	4287	2677	3805	0
3	4254	2779	3826	0
4	4289	2910	3900	0
5	4314	3004	3962	0
6	4334	3076	4017	588
7	4351	3131	4067	914
8	4008	6690	3994	9793
9	1678	2360	3069	5425
10	0	13	1890	3848
11	-1478	-849	89	1791
12	-2916	-2601	0	810

Table 33 *(continued)*

Hour	**0,001 $\Phi_{H/C;ld}$ kWh**			
Case id.	**600**	**640**	**900**	**940**
13	-3028	-2783	0	145
14	-2620	-2426	0	0
15	-1330	-1173	0	0
16	0	0	0	336
17	1170	1344	0	1705
18	3047	3143	1233	2391
19	3194	3275	1652	2614
20	3347	3416	1913	2762
21	3529	3588	2189	2943
22	3602	3654	2369	3040
23	3661	3707	2530	3128
24	3729	0	2694	0
Day, heating	**60983**	**51147**	**50862**	**42233**
Day, cooling	**11372**	**9832**	**0**	**0**

Table 34 — Test results hourly operative temperature, January 4

Hour	**θint;op °C**	
Case id.	**600FF**	**900FF**
1	-12,7	0,69
2	-13,8	0,13
3	-14,5	-0,31
4	-15,2	-0,77
5	-15,8	-1,22
6	-16,4	-1,66
7	-16,9	-2,09
8	-16,4	-2,38
9	-10,3	-1,63
10	-1,6	-0,15
11	12,1	2,42
12	20,5	4,39
13	26,0	5,94
14	28,8	7,13
15	27,9	7,55
16	23,7	7,26
17	13,8	5,82
18	7,1	4,54
19	3,2	3,74
20	0,4	3,17
21	-1,9	2,63

Table 34 *(continued)*

Hour	θint;op °C	
Case id.	600FF	900FF
22	-3,7	2,18
23	-5,2	1,77
24	-6,6	1,36

NOTE 3 ASHRAE[8] asks in Table 6.1 for air temperature. See also NOTE 2.

7.3 Hourly method: validation in case of specific alternative calculation procedures

The following alternative methods are allowed, as given by the normative template in Table A.10, with informative default choices in Table B.10, provided that the verification cases in 7.2 are applied to validate the application of the alternative method, and the deviations with the reference results are reported:

— an alternative solution technique to calculate the actual temperatures and loads, as given in 6.5.5.2;

— an alternative option for the subdivision of each construction element into a number of nodes of thermal resistances and capacitances, as described in 6.5.6.3.are allowed.

— an alternative method for the calculation of the thermal (longwave) radiation exchange (based on approximation for the view factors) between the surfaces in the thermal zone, as described in 6.5.7.1.

8 Compliance check

The aim of this clause is to provide procedures that enable to check if the calculation procedure is applicable and/or has been applied correctly and that the calculation assumptions, in particular the input data, are correct.

In this document, most of the input is gathered through other EPB standards, relevant procedures for compliance check are provided in those standards.

Annex A
(normative)

Input and method selection data sheet — Template

A.1 General

The template in Annex A of this document shall be used to specify the choices between methods, the required input data and references to other standards.

NOTE 1 Following this template is not enough to guarantee consistency of data.

NOTE 2 Informative default choices are provided in Annex B. Alternative values and choices can be imposed by national/regional regulations. If the default values and choices of Annex B are not adopted because of the national/regional regulations, policies or national traditions, it is expected that:

— national or regional authorities prepare data sheets containing the national or regional values and choices, in line with the template in Annex A; or

— by default, the national standards body will add or include a national annex (Annex NA) to this document, in line with the template in Annex A, giving national or regional values and choices in accordance with their legal documents.

NOTE 3 The template in Annex A is applicable to different applications (e.g. the design of a new building, certification of a new building, renovation of an existing building and certification of an existing building) and for different types of buildings (e.g. small or simple buildings and large or complex buildings). A distinction in values and choices for different applications or building types could be made:

— by adding columns or rows (one for each application), if the template allows;

— by including more than one version of a Table (one for each application), numbered consecutively as a, b, c, ... For example: Table NA.3a, Table NA.3b.

— by developing different national/regional data sheets for the same standard. In case of a national annex to the standard these will be consecutively numbered (Annex NA, Annex NB, Annex NC, ...).

NOTE 4 In the section “Introduction” of a national/regional data sheet information can be added, for example about the applicable national/regional regulations.

NOTE 5 For certain input values to be acquired by the user, a data sheet following the template of Annex A, could contain a reference to national procedures for assessing the needed input data. For instance, reference to a national assessment protocol comprising decision trees, tables and pre-calculations.

The shaded fields in the tables are part of the template and consequently not open for input.

A.2 References

The references, identified by the EPB module code number, are given in Table A.1.

Table A.1 — References

Reference	Reference document [a]	
	Number	Title
M1-4		
M1-6		
M1-8		
M1-13		
M2-4		
M2-5		
M2-8		
M3-1		
M3-4 [b]		
M3-5		
M4-1		
M4-4 [b]		
M4-5		
M5-1		
M5-5		
M5-6		
M6-1		
M6-4 [b]		
M6-5		
M7-1		
M7-4 [b]		
M7-5		
M9-1		
M10-1		

[a] If a reference comprises more than one document, the references can be differentiated.

[b] Informative.

A.3 Selection of main method

Table A.2 — Choice between hourly or monthly calculation method (see 5.2)

Type of object and/or application	..... [b]	.... [b]
Description	Choice [a]	Choice [a]
Only hourly method allowed	Yes/No	Yes/No
Only monthly method allowed	Yes/No	Yes/No
Both methods are allowed	Yes/No	Yes/No

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between type of object, type of building or space, type of application or type of assessment. Use the list of identifiers from ISO 52000-1:2017, Tables A.2 to A.7 (normative template, with informative default choices in Tables B.2 to B.7).

A.4 Zoning

Table A.3 — Thermal zoning rules (see 6.4.2.12)

	Application: ..... [a]	
Description [b]	**Apply the described method?**	**If "No": Alternative method** If the described method is not used, describe details of the alternative method or give reference to source document
Zoning step 1. Assessment of thermal envelope	Yes/No	<free text>
Zoning step 2. Grouping according to space category	Yes/No	<free text>
Zoning step 3. Grouping in case of large openings	Yes/No	<free text>
Zoning step 4. Split to have same combination of services	Yes/No	<free text>
Zoning step 5. Further grouping according to similar thermal conditions of use	Yes/No	<free text>
Zoning step 6. Split according to specific system or subsystem properties	Yes/No	<free text>
Zoning step 7. (Further) split to have sufficient homogeneity in thermal balance	Yes/No	<free text>
Zoning step 8. (Further) grouping of thermally unconditioned zones	Yes/No	<free text>
Zoning step 9. Simplification in case of small thermal zones	Yes/No	<free text>
Zoning step 10. Simplification in case of very small thermal zones	Yes/No	<free text>

[a] Add more columns to differentiate per application, if needed.

[b] Additional rows may be added for alternative steps.

Table A.4 — Options of thermally unconditioned zone types and default values (see 6.4.5)

Situation	**Default value of $b_{ztu;m}$ in case of a thermally unconditioned zone, type: external** [a]
<free text>	0 to 1
<free text>	0 to 1
<free text>	0 to 1
Internal thermally unconditioned zone type allowed?	
Choice	Yes/No
If Yes: (optionally) specify default values for the adjustment factor (free text)	
Situation	**Default value of $b_{ztu;m}$ in case of a thermally unconditioned zone, type: internal** [a]
<free text>	0 to 1
<free text>	0 to 1
<free text>	0 to 1

[a] Add more rows if needed.

Table A.5 — Default contribution of ventilation in external construction of a thermally unconditioned zone (see 6.4.5.4)

Application	..... [a]	.... [a]
Description	**Choice**	**Choice**
Default allowed?	Yes/No	Yes/No
If Yes:		
Coefficient for default contribution of ventilation, $c_{ztu;ve}$	0 to 1	0 to 1

[a] Add more columns if needed.

Table A.6 — Choice of spatial temperature averaging in residential buildings (see 6.4.6)

Description		**Choice [a]**
Application of the given formula for spatial temperature averaging		Yes/No
If No:		
No application of the given formula for spatial temperature averaging	It is assumed that the same temperature set-point for heating applies also to partly or moderately thermally conditioned residential spaces.	Yes/No
	Calculate the fully and partly or moderately thermally conditioned residential spaces as separate, thermally uncoupled thermal zones.	Yes/No
	Calculate the fully and partly or moderately thermally conditioned residential spaces as separate, thermally coupled thermal zones.	Yes/No

[a] Only one Yes possible.

In case of application of the formula	**Value**
$f_{mod;t}$	0 to 1
$f_{mod;sp}$	0 to 1
$H_{int;spec}$ (W/K)	0 to ∞

Table A.7 — Choice between calculations with thermally coupled or uncoupled thermal zones (see 6.4.7)

Application	..... [b]	.... [b]
Description	**Choice [a]**	**Choice [a]**
Thermally uncoupled calculations	Yes/No	Yes/No
Thermally coupled calculations	Yes/No	Yes/No
Both methods are allowed	Yes/No	Yes/No

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.). Note the link with the choice in Table A.9

Table A.8 — Default thermal coupling properties in case of thermally coupled zones (see 6.4.7)

		Choice	
Heat transfer part	**Quantity**	**Default value**	**Unit**
Transmission heat transfer between zones z and y	<free text>	0 to ∞	...
ventilation heat transfer from zone z to zone y		0 to ∞	...
ventilation heat transfer from zone y to zone z		0 to ∞	...[a]
[a] Add more rows if needed.			

A.5 Hourly calculation procedures

Table A.9 — Factor for consideration of internal heat gains in design heat load calculation (see 6.5.4.5.2)

Application	..... [a]	.... [a]
Description	**Choice**	**Choice**
Value for factor $f_{H;ig}$	0 to 1	0 to 1
[a] Add more rows if needed.		

Table A.10 — Alternative choices in modelling (see 6.5.5.2, 6.5.6.3.1 and 6.5.7.1)

Description	**Choice**	**If choice is No, describe or give reference to the applied alternative method**
Use the method in 6.5.5.2 to calculate the actual temperatures and loads	Yes/No	*<free text>*
Use method in 6.5.6.3.1 for the calculation of the thermal (longwave) radiation exchange	Yes/No	*<free text>*
Use method in 6.5.7.1 for the conversion of physical properties of building elements into properties per layer (node)	Yes/No	*<free text>*
NOTE In case of one or more “No”, the procedures are validated using the validation cases in 7.2, as described in that subclause.		

Table A.11 — Convective fractions (see 6.5.6.2)

$f_{int;c}$ [a]	$f_{sol;c}$	$f_{H;c}$	$f_{C;c}$
[a] Can be differentiated per source type.			

Table A.12 — Specification of internal partitions (see 6.5.6.3.1)

	Choice
Internal partitions need to be specified?	Yes / Ignore internal partitions / By default
If By default: specify the default thermal characteristics	
Default characteristics	**Specification** [a]
[free text]	[free text]
[a] Add more rows if needed.	

Table A.13 — Distribution of mass of opaque and ground floor elements (see 6.5.7.2 and 6.5.7.3)

Class	Specification of the class
Class I (mass concentrated at internal side)	<free text>
Class E (mass concentrated at external side)	<free text>
Class IE (mass divided over internal and external side)	<free text>
Class D (mass equally distributed)	<free text>

Table A.14 — Specific heat capacity of opaque and ground floor elements (see 6.5.7.2 and 6.5.7.3)

Class	$\kappa_{m;op}$ J/(m²·K)	Specification of the class
Very light	50 000	<free text>
Light	75 000	<free text>
Medium	110 000	<free text>
Heavy	175 000	<free text>
Very heavy	250 000	<free text>

Table A.15 — Solar absorption coefficient of external opaque surfaces (see 6.5.7.2)

	Choice
Differentiation in solar absorption coefficient?	Yes/No
If Yes: specify the procedure to classify the three categories (free text)	
Category	**Specification**
Category 1 α_{sol} **= 0,3** **(light colour)**	[free text]
Category 2 α_{sol} **= 0,6** **(intermediate colour)**	[free text]
Category 3 α_{sol} **= 0,9** **(dark colour)**	[free text]
	Choice
If No: choose the default category	1, 2 or 3

Table A.16 — Coefficient to limit assumed temperature in adjacent thermally unconditioned zone (see 6.5.9)

Application	..... [a]	.... [a]
	$c_{ztu,h;max}$	$c_{ztu,h;max}$
Value	0 to ∞	0 to ∞

[a] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table A.17 — Specific heat capacity of air and furniture (see 6.5.11)

$\kappa_{m;int}$ J/(m²·K)

Table A.18 — View factor to the sky (see 6.5.13.3)

	Unshaded horizontal roof	Unshaded vertical wall
F_{sky}		

Table A.19 — Difference between external air temperature and sky temperature (see 6.5.13.3)

Climatic region [a]	...
$\Delta\theta_{sky;t}$ (K)	
[a] Add more columns if needed to differentiate between climatic regions.	

Table A.20 — Choice of method for moisture absorption and desorption in materials (see 6.5.14.1)

Application	..... [a]	.... [a]
Description	**Choice**	**Choice**
Moisture absorption and desorption calculated?	Yes/No	Yes/No
If No:	$G_{abs;zt;t} = 0$	$G_{abs;zt;t} = 0$
If Yes: give reference to method	<free text>	<free text>
[a] Add more columns if needed.		

Table A.21 — Choice of glazing area or frame area fraction (see E.2.1)

Description	Choice [a]
For each window: free choice between glazing area or fixed frame fraction	Yes/No
For all windows the same choice: either glazing area or fixed frame fraction	Yes/No
For all windows: only glazing area allowed	Yes/No
For all windows: only fixed frame fraction	Yes/No
[a] Only one Yes per column possible.	
In case of frame fraction:	F_{fr}
Frame fraction fixed value	(value between 0 and 1)

Table A.22 — Factors related to the solar energy transmittance (see E.2.2.1)

Correction and weighting factor for *g*-value non-scattering and scattering transparent glazings and blinds:				
F_W		a_g		alt_g °
0 to 1		0 to 1		0 to 80
Default values of the total solar energy transmittance at normal incidence, g_n, for typical types of glazing [a]				
Type				g_n
<free text>				0 to 1
<free text>				0 to 1
Default values of the reduction factor, for typical types of blinds [a]				
Blind type	Optical properties of blind		Reduction factor with	
	absorption	transmission	blind inside	blind outside
<free text>	0 to 1	0 to 1	0 to 1	0 to 1
<free text>	0 to 1	0 to 1	0 to 1	0 to 1
[a] Add more rows or columns if needed.				

Table A.23 — Rules for operation of shutters (see G.2.2.1.2)

Application	..... [a]	.... [a]
Control level	Rules	Rules
0 Manual operation	<free text>	<free text>
1 Motorized operation with manual control	<free text>	<free text>
2 Motorized operation with automatic control	<free text>	<free text>
3 Combined light/blind/HVAC control	<free text>	<free text>
[a] Add more columns if needed.		

Table A.24 — Rules for operation of solar shading devices (see G.2.2.1.2)

Application	..... [a]	.... [a]
Control level	Rules	Rules
0 Manual operation	<free text>	<free text>
1 Motorized operation with manual control	<free text>	<free text>
2 Motorized operation with automatic control	<free text>	<free text>
3 Combined light/blind/HVAC control	<free text>	<free text>
[a] Add more columns if needed.		

Table A.25 — Choices between options and methods for calculation of shading by external objects (see F.1)

Application [b]	.....			....		
Description	**Choice**			**Choice**		
Calculation of the effect of shading by distant objects included in this document?	Yes/No			Yes/No		
When calculating solar shading on building elements: which types of distant shading objects (not on site) may or shall be taken into account or ignored NOTE For instance landscape (such as hills or dikes), vegetation (such as trees), other constructions (such as buildings)	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	<free text>	<free text>	<free text>	<free text>	<free text>	<free text>
When calculating solar shading on opaque building elements such as roofs or facades: which types of on site shading objects can or shall be ignored NOTE For instance rebates, overhangs or other shading objects from the own building(s) on site	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	<free text>	<free text>	<free text>	<free text>	<free text>	<free text>
When calculating solar shading on transparent building elements: NOTE For instance window rebates, overhangs and side fins	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	<free text>	<free text>	<free text>	<free text>	<free text>	<free text>
Specific subdivision rules for the calculation of solar shading on building elements	<free text>			<free text>		
Choice between the two methods for the solar shading calculation:	Choice [a]			Choice [a]		
Method 1, Shading of direct radiation	Yes/No			Yes/No		
Method 2, Shading of direct and diffuse radiation	Yes/No			Yes/No		
In case of method 2: give reference to calculation procedure	<Reference>			<Reference>		

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.)

Table A.26 — Number of skyline segments, $n_{sh;segm}$ for input solar shading objects (see F.3.3)

Application [b]	**.....**	**....**
Description	Value of $n_{sh;segm}$ [a]	Value of $n_{sh;segm}$ [a]
Maximum number of segments over 360 degrees	8 to 36	8 to 36
Fixed width (= 360 / $n_{sh;segm}$) [c]	Yes/No	Yes/No

[a] Practical range, informative.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

[c] f not fixed, the width of each segment can be adapted to the width of the shading object, with limitation of maximum number of segments $n_{sh;segm}$.

A.6 Monthly calculation procedures

Table A.27 — Monthly ventilation heat transfer coefficient (see 6.6.6.2)

Application	..... [b]	.... [b]
Description	Choice [a]	Choice [a]
Method A		
Method B [c]		
Both methods [c]		

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

[c] Method B is only allowed outside the CEN area.

Table A.28 — Dynamics correction factor for ventilation (see 6.6.6.2)

Dynamics correction factor for monthly mean air flow	**Value**
$f_{ve;dyn;k}$	

Table A.29 — Solar absorption coefficient of external opaque surfaces (see 6.6.8.2)

	Choice
Differentiation in solar absorption coefficient?	Yes/No
If Yes: specify the procedure to classify the three categories (free text)	
Category	**Specification**
Category 1 α_{sol} **= 0,3** **(light colour)**	[free text]
If No: choose the default category 1, 2 or 3	

Table A.29 *(continued)*

	Choice
Differentiation in solar absorption coefficient?	Yes/No
Category 2 α_{sol} **= 0,6** **(intermediate colour)**	[free text]
Category 3 α_{sol} **= 0,9** **(dark colour)**	[free text]
	Choice
If No: choose the default category 1, 2 or 3	

Table A.30 — View factor to the sky (see 6.6.8.3)

	Unshaded horizontal roof	Unshaded vertical wall
F_{sky}		

Table A.31 — Difference between external air temperature and sky temperature (see 6.6.8.3)

Climatic region [a]	...
$\Delta\theta_{sky;m}$ (K)	

[a] Add more columns if needed to differentiate between climatic regions.

Table A.32 — Choice between detailed or simple method to determine the internal effective heat capacity (see 6.6.9)

Application	..... [b]	.... [b]
Description	Choice [a]	Choice [a]
Only detailed method allowed	Yes/No	Yes/No
Only simple method allowed	Yes/No	Yes/No
Both methods allowed	Yes/No	Yes/No

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. construction types or building categories).

Table A.33 — Simple method to determine the internal effective heat capacity. Specification of the classes (see 6.6.9)

Class	Specification of the class
Very light	<free text>
Light	<free text>
Medium	<free text>
Heavy	<free text>
Very heavy	<free text>

Table A.34 — Values of the reference numerical parameter $a_{H,0}$ and the reference time constant $\tau_{H,0}$ for the gain utilization factor (see 6.6.10.2)

$a_{H,0}$	$\tau_{H,0}$ h

Table A.35 — Values of the reference numerical parameter $a_{C,0}$ and the reference time constant $\tau_{C,0}$ for the loss utilization factor (see 6.6.10.3)

$a_{C,0}$	$\tau_{C,0}$ h

Table A.36 — Choice between methods A and B for heating intermittency (see 6.6.11.3)

Application	..... [b]	.... [b]
Description	**Choice [a]**	**Choice [a]**
Only Method A	Yes/No	Yes/No
Only Method B	Yes/No	Yes/No
Both methods are allowed	Yes/No	Yes/No

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table A.37 — Choice between methods A and B for cooling intermittency (see 6.6.11.4)

Application	..... [b]	.... [b]
Description	**Choice [a]**	**Choice [a]**
Only Method A	Yes/No	Yes/No
Only Method B	Yes/No	Yes/No
Both methods are allowed	Yes/No	Yes/No
[a] Only one Yes per column possible. [b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).		
If Method A applies		
Correlation factor for method A for intermittent cooling	**Value**	
$b_{C;red}$	(value between 0 and 1)	

Table A.38 — Choice between methods A and B for overheating indicator (see 6.6.12)

Application	..... [b]	.... [b]
Description	Choice [a]	Choice [a]
Method A	Yes/No	Yes/No
Method B	Yes/No	Yes/No
[a] Only one Yes per column possible. [b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).		
If Method B applies		
Provide details or reference to details	<free text>	

Table A.39 — The monthly fraction of energy need for humidification (see 6.6.14)

	Monthly fraction of energy need for humidification $f_{HU;m}$		
Formula?	Yes/No		
If Yes, give formula	<free text>		
If No, give fraction for each month (total = 1)	**Monthly fraction of energy need for humidification $f_{HU;m}$**		
January	0 to 1	July	0 to 1
February	0 to 1	August	0 to 1
March	0 to 1	September	0 to 1
April	0 to 1	October	0 to 1
May	0 to 1	November	0 to 1
June	0 to 1	December	0 to 1

Table A.40 — Efficiency of latent heat recovery (see 6.6.14)

Type of heat recovery unit	Efficiency of latent heat recovery $\eta_{HU;rvd}$
<Type>	0 to 1
<Type>	0 to 1
a	
a Add more rows if needed to differentiate between types.	

Table A.41 — Annually accumulated amount of moisture to be supplied per kg dry air supply (see 6.6.14)

Space category [a]	Annually accumulated amount of moisture to be supplied per kg dry air supply $\Delta x \cdot t_{a;sup}$ (kg h/kg)
<SPACECAT_TYPE_XXX identifier in capitals>	0 to ∞
<SPACECAT_TYPE_XXX identifier in capitals>	0 to ∞
a	
a Add more rows if needed to differentiate between types.	

Table A.42 — Choice of glazing area or frame area fraction (see E.2.1)

Description	Choice [a]
For each window: free choice between glazing area or fixed frame fraction	Yes/No
For all windows the same choice: either glazing area or fixed frame fraction	Yes/No
For all windows: only glazing area allowed	Yes/No
For all windows: only fixed frame fraction	Yes/No

Table A.42 *(continued)*

Description	Choice [a]
[a] Only one Yes per column possible.	
In case of frame fraction:	F_{fr}
Frame fraction fixed value	(value between 0 and 1)

Table A.43 — Factors related to the solar energy transmittance (see E.2.2.1)

Correction and weighting factor for *g*-value non-scattering and scattering transparent glazings and blinds:				
F_W		a_g		alt_g
0 to 1		0 to 1		0 to 80
Default values of the total solar energy transmittance at normal incidence, g_n, for typical types of glazing [a]				
Type				g_n
<free text>				0 to 1
<free text>				0 to 1
Default values of the reduction factor, for typical types of blinds [a]				
Blind type	**Optical properties of blind**		**Reduction factor with**	
	absorption	**transmission**	**blind inside**	**blind outside**
<free text>	0 to 1	0 to 1	0 to 1	0 to 1
<free text>	0 to 1	0 to 1	0 to 1	0 to 1
[a] Add more rows or columns if needed.				

Table A.44 — Movable shutter reduction factor, $f_{sht;with}$, and movable solar shading reduction factor $f_{sh;with}$ (see G.2.2.2.2)

Month	Location				
	*f*sht;with [a]	*f*sh;with [a]			
		N	**E**	**S**	**W**
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
Annual					
[a] Add more columns or rows if needed to differentiate between e.g. applications (e.g. building categories, new or existing buildings, etc.), orientations or climates.					

Table A.45 — Choices between options and methods for calculation of shading by external objects (see F.1)

<table>
<tr><th>Application [b]</th><th colspan="3">.....</th><th colspan="3">....</th></tr>
<tr><th>Description</th><th colspan="3">Choice</th><th colspan="3">Choice</th></tr>
<tr><td>Calculation of the effect of shading by distant objects included in this document?</td><td colspan="3">Yes/No</td><td colspan="3">Yes/No</td></tr>
<tr><td rowspan="2">When calculating solar shading on building elements: which types of distant shading objects (not on site) may or shall be taken into account or ignored
NOTE For instance landscape (such as hills or dikes), vegetation (such as trees), other constructions (such as buildings)</td><td>Shall be taken into account:</td><td>May be taken into account:</td><td>Shall be ignored:</td><td>Shall be taken into account:</td><td>May be taken into account:</td><td>Shall be ignored:</td></tr>
<tr><td><free text></td><td><free text></td><td><free text></td><td><free text></td><td><free text></td><td><free text></td></tr>
<tr><td rowspan="2">When calculating solar shading on opaque building elements such as roofs or facades: which types of on site shading objects can or shall be ignored
NOTE For instance rebates, overhangs or other shading objects from the own building(s) on site</td><td>Shall be taken into account:</td><td>May be taken into account:</td><td>Shall be ignored:</td><td>Shall be taken into account:</td><td>May be taken into account:</td><td>Shall be ignored:</td></tr>
<tr><td><free text></td><td><free text></td><td><free text></td><td><free text></td><td><free text></td><td><free text></td></tr>
<tr><td rowspan="2">When calculating solar shading on transparent building elements:
NOTE For instance window rebates, overhangs and side fins</td><td>Shall be taken into account:</td><td>May be taken into account:</td><td>Shall be ignored:</td><td>Shall be taken into account:</td><td>May be taken into account:</td><td>Shall be ignored:</td></tr>
<tr><td><free text></td><td><free text></td><td><free text></td><td><free text></td><td><free text></td><td><free text></td></tr>
<tr><td>Specific subdivision rules for the calculation of solar shading on building elements</td><td colspan="3"><free text></td><td colspan="3"><free text></td></tr>
<tr><td>Choice between the two methods for the solar shading calculation:</td><td colspan="3">Choice [a]</td><td colspan="3">Choice [a]</td></tr>
<tr><td>Method 1, Shading of direct radiation</td><td colspan="3">Yes/No</td><td colspan="3">Yes/No</td></tr>
<tr><td>Method 2, Shading of direct and diffuse radiation</td><td colspan="3">Yes/No</td><td colspan="3">Yes/No</td></tr>
<tr><td>In case of method 2: give reference to calculation procedure</td><td colspan="3"><Reference></td><td colspan="3"><Reference></td></tr>
<tr><td colspan="7">[a] Only one Yes per column possible.
[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).</td></tr>
</table>

Table A.46 — Parameters for monthly solar shading due to overhangs (See F.3.5.1.2)

<table>
<tr><th colspan="2">Period:</th><td colspan="4"><month or months></td></tr>
<tr><th colspan="2">Orientation</th><th>A_1</th><th>B_1</th><th>A_2</th><th>B_2</th></tr>
<tr><th>North hemisphere</th><th>South hemisphere</th><td></td><td></td><td></td><td></td></tr>
<tr><td>S</td><td>N</td><td></td><td></td><td></td><td></td></tr>
<tr><td>SE-SW</td><td>NE-NW</td><td></td><td></td><td></td><td></td></tr>
<tr><td>E-W</td><td>E-W</td><td></td><td></td><td></td><td></td></tr>
<tr><td>NE-NW</td><td>SE-SW</td><td></td><td></td><td></td><td></td></tr>
<tr><td>N</td><td>S</td><td></td><td></td><td></td><td></td></tr>
</table>

Table A.47 — Parameters for monthly solar shading due to fins (See F.3.5.1.2)

Period:	<month or months>			
Orientation	A_1	B_1	A_2	B_2
North hemisphere	**South hemisphere**			
S	N			
SE-SW	NE-NW			
E-W	E-W			
NE-NW	SE-SW			

Table A.48 — Parameters for monthly solar shading by obstacles or overhangs; more detailed method (See F.3.1.2 and F.3.5.2.2)

Location:	<latitude>								
Period:	<month or months>								
Orientation	**Weight, $w_{obst;m;i}$ per sector**				**Solar altitude, $\alpha_{sol;m;i}$ per sector**				**Fraction direct solar irradiation $f_{sol;dir;m}$**
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	
N	0 to 1				0 to 90				0 to 1
NE									
E									
SE									
S									
SW									
W									
NW									

Annex B
(informative)

Input and method selection data sheet — Default choices

B.1 General

The template in Annex A of this document shall be used to specify the choices between methods, the required input data and references to other documents.

NOTE 1 Following this template is not enough to guarantee consistency of data.

NOTE 2 Informative default choices are provided in Annex B. Alternative values and choices can be imposed by national/regional regulations. If the default values and choices of Annex B are not adopted because of the national/regional regulations, policies or national traditions, it is expected that:

— national or regional authorities prepare data sheets containing the national or regional values and choices, in line with the template in Annex A; or

— by default, the national standards body will add or include a national annex (Annex NA) to this document, in line with the template in Annex A, giving national or regional values and choices in accordance with their legal documents.

NOTE 3 The template in Annex A is applicable to different applications (e.g. the design of a new building, certification of a new building, renovation of an existing building and certification of an existing building) and for different types of buildings (e.g. small or simple buildings and large or complex buildings). A distinction in values and choices for different applications or building types could be made:

— by adding columns or rows (one for each application), if the template allows;

— by including more than one version of a Table (one for each application), numbered consecutively as a, b, c, ... For example: Table NA.3a, Table NA.3b.

— by developing different national/regional data sheets for the same standard. In case of a national annex to the standard these will be consecutively numbered (Annex NA, Annex NB, Annex NC, ...).

NOTE 4 In the section "Introduction" of a national/regional data sheet information can be added, for example about the applicable national/regional regulations.

NOTE 5 For certain input values to be acquired by the user, a data sheet following the template of Annex A, could contain a reference to national procedures for assessing the needed input data. For instance, reference to a national assessment protocol comprising decision trees, tables and pre-calculations.

The shaded fields in the tables are part of the template and consequently not open for input.

B.2 References

The references, identified by the EPB module code number, are given in Table B.1.

Table B.1 — References

Reference	Reference document [a]	
	Number	**Title**
M1-4	ISO 52003-1	*Energy performance of buildings – Indicators, requirements, ratings and certificates – Part 1: General aspects and application to the overall energy performance*
M1-6	ISO 17772-1 EN 16798-1	*Energy performance of buildings - Indoor environmental Quality - part 1: Indoor environmental input parameters for the design and assessment of energy performance of buildings* *Energy performance of buildings – Ventilation for buildings – Part 1: Indoor environmental input parameters for design and assessment of energy performance of buildings addressing indoor air quality, thermal environment, lighting and acoustics (Module M1-6)*
M1-8	ISO 52000-1	*Energy performance of buildings – Overarching EPB assessment – Part 1: General framework and procedures*
M1-13	ISO 52010-1	*Energy performance of buildings - External climatic conditions - Part 1: Conversion of climatic data for energy calculations*
M2-4	ISO 52018-1	*Energy performance of buildings — Indicators for partial EPB requirements related to thermal energy balance and fabric features — Part 1: Overview of options*
M2-5.1	ISO 13789	*Thermal performance of buildings - Transmission and ventilation heat transfer coefficients - Calculation method*
M2-5.2	ISO 13370	*Thermal performance of buildings – Heat transfer via the ground – Calculation methods*
M2-5.3	ISO 6946	*Building components and building elements – Thermal resistance and thermal transmittance – Calculation method*
M2-5.4	ISO 10211	*Thermal bridges in building construction – Heat flows and surface temperatures – Detailed calculations*
M2-5.5	ISO 14683	*Thermal bridges in building construction – Linear thermal transmittance – Simplified methods and default values*
M2-5.6	ISO 10077-1	*Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 1: General*
M2-5.7	ISO 10077-2	*Thermal performance of windows, doors and shutters – Calculation of thermal transmittance – Part 2: Numerical method for frames*
M2-8	ISO 9050 ISO 15099 ISO 52022-3	*Glass in building – Determination of light transmittance, solar direct transmittance, total solar energy transmittance, ultraviolet transmittance and related glazing factors* [for non-scattered glazings] *Thermal performance of windows, doors and shading devices – Detailed calculations* [for windows with scattering glazing and/or solar shading devices] *Energy performance of buildings – Thermal, solar and daylight properties of building components and elements – Part 3: Detailed calculation method of the solar and daylight characteristics for solar protection devices combined with glazing* [for normal incidence angle] (or see Subjects 4, 5 and 6 in Table C.1)
M3-1	EN 15316-1	*Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 1: General and Energy performance expression, Module M3–1, M3–4, M3–9, M8–1, M8–4*
M3-4[b]	EN 15316-1	See M3-1
M3-5	EN 15316-2	*Energy performance of buildings – Method for calculation of system energy requirements and system efficiencies – Part 2: Space emission systems (heating and cooling), Module M3–5, M4–5*

a If a reference comprises more than one document, the references can be differentiated.

b Informative.

Table B.1 *(continued)*

Reference	Reference document [a]	
	Number	**Title**
M4-1	EN 16798-9	*Energy performance of buildings — Ventilation for buildings — Part 9: Calculation methods for energy requirements of cooling systems (Modules M4-1, M4-4, M4-9) — General*
M4-4[b]	EN 16798-9	See M4-1
M4-5	EN 15316-2	See M3-5
M5-1	EN 16798-3	*Energy performance of buildings — Ventilation for buildings — Part 3:For non-residential buildings – Performance requirements for ventilation and room-conditioning systems (Modules M5-1, M5-4)*
M5-5	EN 16798-7	*Energy performance of buildings — Ventilation for buildings — Part 7: Calculation methods for the determination of air flow rates in buildings including infiltration (Module M5-5)*
M5-6	EN 16798-5-1	*Energy performance of buildings — Ventilation for buildings – Part 5-1: Calculation methods for energy requirements of ventilation and air conditioning systems (Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8) -- Method 1: Distribution and generation*
	EN 16798-5-2	*Energy performance of buildings — Ventilation for buildings — Part 5-2: Calculation methods for energy requirements of ventilation systems (Modules M5-6, M5-8, M6-5, M6-8, M7-5, M7-8) — Method 2: Distribution and generation*
M6-1	EN 16798-3	See M5-1
M6-4[b]	EN 16798-3	See M5-1
M6-5	EN 16798-5-1 EN 16798-5-2	See M5-6
M7-1	EN 16798-3	See M5-1
M7-4[b]	EN 16798-3	See M5-1
M7-5	EN 16798-5-1 EN 16798-5-2	See M5-6
M9-1	EN 15193-1	*Energy performance of buildings - Energy requirements for lighting - Part 1: Specifications, Module M9*
M10-1	EN 15232-1	*Energy performance of buildings – Part 1: Impact of Building Automation, Controls and Building Management - Modules M10-4,5,6,7,8,9,10*

a If a reference comprises more than one document, the references can be differentiated.

b Informative.

B.3 Selection of main method

Table B.2 — Choice between hourly or monthly calculation method (see 5.2)

Type of object and/or application	All applications	b
Description	Choice [a]	
Only hourly method allowed	Yes	
Only monthly method allowed	No	
Both methods are allowed	No	

a Only one Yes per column possible.

b Add more columns if needed to differentiate between type of object, type of building or space, type of application or type of assessment. Use the list of identifiers from ISO 52000-1:2017, Tables A.2 to A.7 (normative template, with informative default choices in Tables B.2 to B.7).

B.4 Zoning

Table B.3 — Thermal zoning rules (see 6.4.2.12)

	Application: ..... [a]	
Description [b]	**Apply the described method?**	**If "No": Alternative method** If the described method is not used, describe details of the alternative method or give reference to source document
Zoning step 1. Assessment of thermal envelope	Yes	Not applicable
Zoning step 2. Grouping according to space category	Yes	Not applicable
Zoning step 3. Grouping in case of large openings	Yes	Not applicable
Zoning step 4. Split to have same combination of services	Yes	Not applicable
Zoning step 5. Further grouping according to similar thermal conditions of use	Yes	Not applicable
Zoning step 6. Split according to specific system or subsystem properties	Yes	Not applicable
Zoning step 7. (Further) split to have sufficient homogeneity in thermal balance	Yes	Not applicable
Zoning step 8. (Further) grouping of thermally unconditioned zones	Yes	Not applicable
Zoning step 9. Simplification in case of small thermal zones	Yes	Not applicable
Zoning step 10. Simplification in case of very small thermal zones	Yes	Not applicable

[a] Add more columns to differentiate per application, if needed.

[b] Additional rows may be added for alternative steps.

Table B.4 — Choice of method for thermally unconditioned zones (see 6.4.5)

Situation	**Default value of $b_{\text{ztu};m}$ in case of a thermally unconditioned zone, type: external** [a]
	No default values provided
Internal thermally unconditioned zone type allowed?	
Choice	Yes
If Yes: (optionally) specify default values for the adjustment factor (free text)	
Situation	**Default value of $b_{\text{ztu};m}$ in case of a thermally unconditioned zone, type: internal** [a]
	No default values provided

[a] Add more rows if needed.

Table B.5 — Default contribution of ventilation in external construction of a thermally unconditioned zone (see 6.4.5.4)

Application	All applications [a]	
Description	**Choice**	
Default allowed?	Yes	
If Yes:		
Coefficient for default contribution of ventilation, $c_{ztu;ve}$	0,5	
[a] Add more columns if needed.		

Table B.6 — Choice of spatial temperature averaging in residential buildings (see 6.4.6)

Description		**Choice** [a]
Application of the given formula for spatial temperature averaging		Yes
If No:		
No application of the given formula for spatial temperature averaging	It is assumed that the same temperature set-point for heating applies also to partly or moderately thermally conditioned residential spaces.	Not applicable
	Calculate the fully and partly or moderately thermally conditioned residential spaces as separate, thermally uncoupled thermal zones.	Not applicable
	Calculate the fully and partly or moderately thermally conditioned residential spaces as separate, thermally coupled thermal zones.	Not applicable
[a] Only one Yes possible.		
In case of application of the formula		**Value**
$f_{mod;t}$		0,8
$f_{mod;sp}$		0,5
$H_{int;spec}$ (W/K)		2,0

Table B.7 — Choice between calculations with thermally coupled or uncoupled thermal zones (see 6.4.7)

Application	**All applications**	
Description	Choice [a]	[b]
Thermally uncoupled calculations	Yes	
Thermally coupled calculations	No	
Both methods are allowed	No	

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.). Note the link with the choice in Table A.9.

Table B.8 — Default thermal coupling properties in case of thermally coupled zones (see 6.4.7)

		Choice	
Heat transfer part	**Quantity**	**Default value**	**Unit**
Transmission heat transfer between zones *z* and *y*	Not applicable	Not applicable	...
ventilation heat transfer from zone *z* to zone *y*	Not applicable	Not applicable	...
ventilation heat transfer from zone *y* to zone *z*	Not applicable	Not applicable	...[a]

[a] Add more rows if needed.

B.5 Hourly calculation procedures

Table B.9 — Factor for consideration of internal heat gains in design heat load calculation (see 6.5.5.5)

Application	**All applications**	.... [a]
Description	**Choice**	**Choice**
Value for factor $f_{H;ig}$	0,5	Not applicable

[a] Add more rows if needed.

Table B.10 — Alternative choices in modelling (see 6.5.5.2, 6.5.6.3.1 and 6.5.7.1)

Description	**Choice**	**If choice is No, describe or give reference to the applied alternative method**
Use the method in 6.5.5.2 to calculate the actual temperatures and loads	Yes	Not applicable
Use method in 6.5.6.3.1 for the calculation of the thermal (longwave) radiation exchange	Yes	Not applicable
Use method in 6.5.7.1 for the conversion of physical properties of building elements into properties per layer (node)	Yes	Not applicable

NOTE In case of one or more “No”, the procedures are validated using the validation cases in 7.2, as described in that subclause.

Table B.11 — Convective fractions (see 6.5.6.2)

$f_{int;c}$ [a]	$f_{sol;c}$	$f_{H;c}$	$f_{C;c}$
0,40 for all source types	0,10	0,40	0,40

[a] Can be differentiated per source type.

Table B.12 — Specification of internal partitions (see 6.5.6.3.1)

	Choice
Internal partitions need to be specified?	No
If by default: specify the default thermal characteristics	
Default characteristics	**Specification** [a]
Not applicable	Not applicable

[a] Add more rows if needed.

Table B.13 — Distribution of mass of opaque and ground floor elements (see 6.5.7.2 and 6.5.7.3)

Class	Specification of the class
Class I (mass concentrated at internal side)	Construction with external thermal insulation (main mass component near inside surface) , or equivalent
Class E (mass concentrated at external side)	Construction with internal thermal insulation (main mass component near outside surface) , or equivalent
Class IE (mass divided over internal and external side)	Construction with thermal insulation in between two main mass components, or equivalent
Class D (mass equally distributed)	Uninsulated construction (e.g. solid or hollow bricks, heavy or lightweight concrete, or lightweight construction with negligible mass (e.g. steel sandwich panel), or equivalent

Table B.14 — Specific heat capacity of opaque and ground floor elements (see 6.5.7.2 and 6.5.7.3)

Class	$\kappa_{m;op}$ J/(m²·K)	Specification of the class
Very light	50 000	Construction containing no mass components, other than e.g. plastic board and/or wood siding, or equivalent
Light	75 000	Construction containing no mass components other than 5 to 10 cm lightweight brick or concrete, or equivalent
Medium	110 000	Construction containing no mass components other than 10 to 20 cm lightweight brick or concrete, or less than 7 cm solid brick or heavy weight concrete, or equivalent
Heavy	175 000	Construction containing 7 to 12 cm solid brick or heavy weight concrete, or equivalent
Very heavy	250 000	Construction containing more than 12 cm solid brick or heavy weight concrete, or equivalent

Table B.15 — Solar absorption coefficient of external opaque surfaces (see 6.5.7.2)

	Choice
Differentiation in solar absorption coefficient?	No
If Yes: specify the procedure to classify the three categories (free text)	
Category	**Specification**
Category 1 α_{sol} **= 0,3** **(light colour)**	Not applicable
Category 2 α_{sol} **= 0,6** **(intermediate colour)**	Not applicable
Category 3 α_{sol} **= 0,9** **(dark colour)**	Not applicable
	Choice
If No: choose the default category	2

Table B.16 — Coefficient to limit assumed temperature in adjacent thermally unconditioned zone (see 6.5.9)

Application	All applications	.... [a]
	$c_{ztu,h;max}$	$c_{ztu,h;max}$
Value	1,0	Not applicable
a Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).		

Table B.17 — Specific heat capacity of air and furniture (see 6.5.11)

$\kappa_{m;int}$ J/(m²·K)
10 000

Table B.18 — View factor to the sky (see 6.5.13.3)

	Unshaded horizontal roof	Unshaded vertical wall
F_{sky}	1,0	0,5

Table B.19 — Difference between external air temperature and sky temperature (see 6.5.13.3)

Climatic region [a]	Sub-polar areas	Tropics	Intermediate zones
$\Delta\theta_{sky;t}$ (K)	9 (fixed value)	13 (fixed value)	11 (fixed value)
a Add more columns if needed to differentiate between climatic regions.			

Table B.20 — Choice of method for moisture absorption and desorption in materials (see 6.5.14.1)

Application	All applications	.... [a]
Description	**Choice**	**Choice**
Moisture absorption and desorption calculated?	No	Not applicable
If No:	$G_{abs;zt;t}$ = 0	$G_{abs;zt;t}$ = 0
If Yes: give reference to method	Not applicable	Not applicable
a Add more columns if needed.		

Table B.21 — Choice of glazing area or frame area fraction (see E.2.1)

Description	Choice [a]
For each window: free choice between glazing area or fixed frame fraction	No
For all windows the same choice: either glazing area or fixed frame fraction	Yes
For all windows: only glazing area allowed	No
For all windows: only fixed frame fraction	No

Table B.21 *(continued)*

Description	Choice [a]
[a] Only one Yes per column possible.	
In case of frame fraction:	F_{fr}
Frame fraction fixed value	0,25

Table B.22 — Factors related to the solar energy transmittance (see E.2.2.1)

Correction and weighting factor for g-value non-scattering and scattering transparent glazings and blinds:		
F_w	a_g	alt_g °
0,90	0,75	45

Default values of the total solar energy transmittance at normal incidence, g_n, for typical types of glazing [a]	
Type	g_n
Single glazing	0,85
Double glazing	0,75
Double glazing with selective low-emissivity coating	0,67
Triple glazing	0,7
Triple glazing with two selective low-emissivity coatings	0,5
Double window	0,75
[a] Assuming a clean surface and normal, untainted and non-scattering glazing.	

Default values of the reduction factor, for typical types of blinds [a]				
Blind type	**Optical properties of blind**		**Reduction factor with**	
	absorption	**transmission**	**blind inside**	**blind outside**
White venetian blinds	0,1	0,05	0,25	0,10
		0,1	0,30	0,15
		0,3	0,45	0,35
White curtains	0,1	0,5	0,65	0,55
		0,7	0,80	0,75
		0,9	0,95	0,95
Coloured textiles	0,3	0,1	0,42	0,17
		0,3	0,57	0,37
		0,5	0,77	0,57
Aluminium-coated textiles	0,2	0,05	0,20	0,08
[a] Add more rows or columns if needed.				

Table B.23 — Rules for operation of shutters (see G.2.2.1.2)

Application	All applications [a]	.... [a]
Control level	**Rules**	**Rules**
0 Manual operation	Closed: after sunset, if occupied Open: after sunrise, if occupied, but not during sleeping hours	Not applicable
1 Motorized operation with manual control	Same	Not applicable
2 Motorized operation with automatic control	Closed: after sunset Open: after sunrise	Not applicable
3 Combined light/blind/HVAC control	Same [b]	Not applicable

[a] Add more columns if needed.

[b] Conservative rule; a level 3 combined control is not covered in this table.

Table B.24 — Rules for operation of solar shading devices (see G.2.2.1.2)

Application	All applications [a]	.... [a]
Control level	**Rules**	**Rules**
0 Manual operation	Closed: if solar irradiance > 300 W/m^2 Open: if solar irradiance < 200 W/m^2	Not applicable
1 Motorized operation with manual control	Same	Not applicable
2 Motorized operation with automatic control	Closed: if solar irradiance > 200 W/m^2 Open: if solar irradiance < 200 W/m^2 and ≥ 2 hours passed since closing	Not applicable
3 Combined light/blind/HVAC control	Same [b]	Not applicable

[a] Add more columns if needed.

[b] Conservative rule; a level 3 combined control is not covered in this table.

Table B.25 — Choices between options and methods for calculation of shading by external objects (see F.1)

Application [b]	**All applications**			**Not applicable**		
Description	**Choice**			**Choice**		
Calculation of the effect of shading by distant objects included in this document?	Yes			n.a.		
When calculating solar shading on building elements: which types of distant shading objects (not on site) may or shall be taken into account or ignored NOTE For instance landscape (such as hills or dikes), vegetation (such as trees), other constructions (such as buildings)	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	Landscape (such as hills or dikes), other constructions (such as buildings)	Vegetation (such as trees)	-	n.a.	n.a.	n.a.

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table B.25 *(continued)*

Application [b]	All applications			Not applicable		
Description	**Choice**			**Choice**		
When calculating solar shading on opaque building elements such as roofs or facades: which types of on site shading objects can or shall be ignored NOTE For instance rebates, overhangs or other shading objects from the own building(s) on site	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	-	-	Rebates, overhangs or other shading objects from the own building(s) on site	n.a.	n.a.	n.a.
When calculating solar shading on transparent building elements: NOTE For instance window rebates, overhangs and side fins	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	Window rebates, overhangs and side fins if depth larger than 20% of window height resp. width	Other window rebates, overhangs and side fins	-	n.a.	n.a.	n.a.
Specific subdivision rules for the calculation of solar shading on building elements	None			n.a.		
Choice between the two methods for the solar shading calculation:	Choice [a]			Choice [a]		
Method 1, Shading of direct radiation	Yes			n.a.		
Method 2, Shading of direct and diffuse radiation	No			n.a.		
In case of method 2: give reference to calculation procedure	n.a.			n.a.		

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table B.26 — Number of skyline segments, $n_{sh;segm}$ for input solar shading objects (see F.3.3)

Application [b]	All applications	....
Description	Value of $n_{sh;segm}$ [a]	Value of $n_{sh;segm}$ [a]
Maximum number of segments over 360 degrees	15	
Fixed width (= 360 / $n_{sh;segm}$) [c]	No	

[a] Practical range, informative.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

[c] If not fixed, the width of each segment can be adapted to the width of the shading object, with limitation of maximum number of segments $n_{sh;segm}$.

B.6 Monthly calculation procedures

Table B.27 — Monthly ventilation heat transfer coefficient (see 6.6.6.2)

Application	All applications	.... [b]
Description	Choice [a]	Choice [a]
Method A	Yes	Not applicable
Method B [c]	No	Not applicable
Both methods [c]	No	Not applicable

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

[c] Method B is only allowed outside the CEN area.

Table B.28 — Dynamics correction factor for ventilation (see 6.6.6.2)

Dynamics correction factor for monthly mean air flow	Value
$f_{ve;dyn;k}$	1,0

Table B.29 — Solar absorption coefficient of external opaque surfaces (see 6.6.8.2)

	Choice
Differentiation in solar absorption coefficient?	No
If Yes: specify the procedure to classify the three categories (free text)	
Category	**Specification**
Category 1 α_{sol} **= 0,3** **(light colour)**	Not applicable
Category 2 α_{sol} **= 0,6** **(intermediate colour)**	Not applicable
Category 3 α_{sol} **= 0,9** **(dark colour)**	Not applicable
	Choice
If No: choose the default category	2

Table B.30 — View factor to the sky (see 6.6.8.3)

	Unshaded horizontal roof	Unshaded vertical wall
F_{sky}	1,0	0,5

Table B.31 — Difference between external air temperature and sky temperature (see 6.6.8.3)

Climatic region [a]	Sub-polar areas	Tropics	Intermediate zones
$\Delta\theta_{sky;m}$ (K)	9 (fixed value)	13 (fixed value)	11 (fixed value)

[a] Add more columns if needed to differentiate between climatic regions.

Table B.32 — Choice between detailed or simple method to determine the internal effective heat capacity (monthly method; see 6.6.9)

Application	All applications	
Description	Choice [a]	[b]
Only detailed method allowed	No	
Only simple method allowed	Yes	
Both methods allowed	No	

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. construction types or building categories).

Table B.33 — Simple method to determine the internal effective heat capacity. Specification of the classes (monthly method; see 6.6.9)

Class	Specification of the class
Very light	Construction type is dominated by very light constructions as specified in Table B.14
Light	Construction type is dominated by light constructions as specified in Table B.14
Medium	Construction type is dominated by medium constructions as specified in Table B.14
Heavy	Construction type is dominated by heavy constructions as specified in Table B.14
Very heavy	Construction type is dominated by very heavy constructions as specified in Table B.14

Table B.34 — Values of the reference numerical parameter $a_{H,0}$ and the reference time constant $\tau_{H,0}$ for the gain utilization factor (see 6.6.10.2)

$a_{H,0}$	$\tau_{H,0}$ h
1,0	15

Table B.35 — Values of the reference numerical parameter $a_{C,0}$ and the reference time constant $\tau_{C,0}$ for the loss utilization factor (see 6.6.10.3)

$a_{C,0}$	$\tau_{C,0}$ h
1,0	15

Table B.36 — Choice between methods A and B for heating intermittency (see 6.6.11.3)

Application	All applications	
Description	**Choice** [a]	[b]
Only Method A	Yes	
Only Method B	No	
Both methods are allowed	No	

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table B.37 — Choice between methods A and B for cooling intermittency (see 6.6.11.4)

Application	All applications	
Description	**Choice** [a]	[b]
Only method A	Yes	
Only method B	No	
Both methods are allowed	No	

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

If method A applies	
Correlation factor for method A for intermittent cooling	**Value**
$b_{C;red}$	0,3

Table B.38 — Choice between methods A and B for overheating indicator (see 6.6.12)

Application	..... [b]	.... [b]
Description	**Choice** [a]	**Choice** [a]
Method A	Yes/No	Yes/No
Method B	Yes/No	Yes/No

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

If method B applies	
Provide details or reference to details	<free text>

Table B.39 — The monthly fraction of energy need for humidification (see 6.6.14)

	Monthly fraction of energy need for humidification $f_{HU;m}$		
Formula?	Yes		
If Yes, give formula	for each month m: $f_{HU;m} = Q_{H;nd;m}/Q_{H;nd;an}$ where $Q_{H;nd;m/an}$ is the monthly / annual energy need for heating, as determined in 6.5.4.1, in kWh		
If No, give fraction for each month (total = 1)	**Monthly fraction of energy need for humidification $f_{HU;m}$**		
January	Not applicable	July	Not applicable
February	Not applicable	August	Not applicable

Table B.39 *(continued)*

	Monthly fraction of energy need for humidification $f_{HU;m}$		
March	Not applicable	September	Not applicable
April	Not applicable	October	Not applicable
May	Not applicable	November	Not applicable
June	Not applicable	December	Not applicable

Table B.40 — Efficiency of latent heat recovery (see 6.6.14)

Type of heat recovery unit	Efficiency of latent heat recovery $\eta_{HU;rvd}$
Provisions specifically made for transporting moisture from exhaust to supply air (such as a heat recovery wheel with moisture absorbing surface)	0,55
Other provisions	0
-	-
- [a]	-

[a] Add more rows if needed to differentiate between types.

Table B.41 — Annually accumulated amount of moisture to be supplied per kg dry air supply (monthly method; see 6.6.14)

Space category [a]	Annually accumulated amount of moisture to be supplied per kg dry air supply $\Delta x \cdot t_{a;sup}$ (kg h/kg)
SPACECAT_RES_LIV	0,17
SPACECAT_RES_INDIV_OTHER	0,17
SPACECAT _RES_COLL	0,17
SPACECAT_TH.UNCOND_OTHER	0
SPACECAT_TH.UNCOND_SUN	0
SPACECAT_TH.UNCOND_CORR	0
SPACECAT_OFF	4,2
SPACECAT_ EDUC	4,2
SPACECAT_HOSP_BED	4,2
SPACECAT_HOSP_OTHER	4,2
SPACECAT_HOTEL	0,17
SPACECAT_REST	0,17
SPACECAT_REST_KITCH	0
SPACECAT_MEET	0,17
SPACECAT_AUDIT	0,17
SPACECAT_THEAT	0,17

[a] Add more rows if needed to differentiate between types.

NOTE The space categories are inherited from ISO 52000-1:2017, Annex B.

The values are based on NEN 7120 [N2] (The Netherlands).

N2) National footnote: Obtainable from: Netherlands Standardization Institute (NEN) (www.nen.nl).

Table B.41 *(continued)*

Space category [a]	Annually accumulated amount of moisture to be supplied per kg dry air supply $\Delta x{\cdot}t_{a;sup}$ (kg h/kg)
SPACECAT_SERVER	0
SPACECAT_SPORT_TH.COND	0,17
SPACECAT_SPORT_TH.UN-COND	0
SPACECAT_RETAIL	0,17
SPACECAT_NONRES_BATH	0
SPACECAT_STOR_HEAT	0
SPACECAT_STOR_COOL	0
SPACECAT ENGINE	0
SPACECAT_CAR	0
SPACECAT _BARN	0

[a] Add more rows if needed to differentiate between types.

NOTE The space categories are inherited from ISO 52000-1:2017, Annex B.

The values are based on NEN 7120 (The Netherlands).

Table B.42 — Choice of glazing area or frame area fraction (see E.2.1)

Description	Choice [a]
For each window: free choice between glazing area or fixed frame fraction	Yes/No
For all windows the same choice: either glazing area or fixed frame fraction	Yes/No
For all windows: only glazing area allowed	Yes/No
For all windows: only fixed frame fraction	Yes/No
[a] Only one Yes per column possible.	
In case of frame fraction:	F_{fr}
Frame fraction fixed value	0,25

Table B.43 — Factors related to the solar energy transmittance (see E.2.2.1)

Correction and weighting factor for *g*-value non-scattering and scattering transparent glazings and blinds:		
F_w	a_g	alt_g °
0,90	0,75	45

Default values of the total solar energy transmittance at normal incidence, g_n, for typical types of glazing [a]	
Type	g_n
Single glazing	0,85

[b] Add more rows or columns if needed.

Table B.43 *(continued)*

Correction and weighting factor for *g*-value non-scattering and scattering transparent glazings and blinds:				
F_w	a_g		alt_g °	
Double glazing			0,75	
Double glazing with selective low-emissivity coating			0,67	
Triple glazing			0,7	
Triple glazing with two selective low-emissivity coatings			0,5	
Double window			0,75	
[a] Assuming a clean surface and normal, untainted and non-scattering glazing.				
Default values of the reduction factor, for typical types of blinds [b]				
Blind type	**Optical properties of blind**		**Reduction factor with**	
	absorption	**transmission**	**blind inside**	**blind outside**
		0,05	0,25	0,10
White venetian blinds	0,1	0,1	0,30	0,15
		0,3	0,45	0,35
		0,5	0,65	0,55
White curtains	0,1	0,7	0,80	0,75
		0,9	0,95	0,95
		0,1	0,42	0,17
Coloured textiles	0,3	0,3	0,57	0,37
		0,5	0,77	0,57
Aluminium-coated textiles	0,2	0,05	0,20	0,08
[b] Add more rows or columns if needed.				

Table B.44a — Movable shutter reduction factor, $f_{sht;with}$, and movable solar shading reduction factor $f_{sh;with}$ (see G.2.2.2.2)

Month	**Paris (France)**				
	***f*sht;with** [a]	***f*sh;with** [a]			
		N	**E**	**S**	**W**
1	0,5	0,00	0,15	0,58	0,09
2	0,5	0,00	0,19	0,52	0,13
3	0,5	0,00	0,53	0,76	0,44
4	0,5	0,00	0,32	0,50	0,26
5	0,5	0,00	0,31	0,44	0,27
6	0,5	0,00	0,42	0,47	0,38
7	0,5	0,00	0,51	0,59	0,40
8	0,5	0,00	0,37	0,54	0,31
9	0,5	0,00	0,28	0,52	0,20
10	0,5	0,00	0,13	0,53	0,16
[a] Add more columns or rows if needed to differentiate between e.g. applications (e.g. building categories, new or existing buildings, etc.), space categories, orientations or climates.					

Table B.44a *(continued)*

Month	Paris (France)				
	$f_{sht;with}$ [a]	$f_{sh;with}$ [a]			
11	0,5	0,00	0,08	0,47	0,09
12	0,5	0,00	0,07	0,46	0,08
Annual	0,5	0,00	0,36	0,55	0,30

[a] Add more columns or rows if needed to differentiate between e.g. applications (e.g. building categories, new or existing buildings, etc.), space categories, orientations or climates.

Table B.44b — Movable shutter reduction factor, $f_{sht;with}$, and movable solar shading reduction factor $f_{sh;with}$ (see G.2.2.2.2)

Month	Rome (Italy)				
	$f_{sht;with}$ [a]	$f_{sh;with}$ [a]			
		N	E	S	W
1	0,5	0,00	0,52	0,81	0,39
2	0,5	0,00	0,48	0,82	0,55
3	0,5	0,00	0,66	0,81	0,63
4	0,5	0,00	0,71	0,74	0,62
5	0,5	0,00	0,71	0,62	0,64
6	0,5	0,00	0,75	0,56	0,68
7	0,5	0,00	0,74	0,62	0,73
8	0,5	0,00	0,75	0,76	0,72
9	0,5	0,00	0,73	0,82	0,67
10	0,5	0,00	0,72	0,86	0,60
11	0,5	0,00	0,62	0,84	0,30
12	0,5	0,00	0,50	0,86	0,42
Annual	0,5	0,00	0,69	0,77	0,63

[a] Add more columns or rows if needed to differentiate between e.g. applications (e.g. building categories, new or existing buildings, etc.), space categories, orientations or climates.

Table B.44c — Movable shutter reduction factor, $f_{sht;with}$, and movable solar shading reduction factor $f_{sh;with}$ (see G.2.2.2.2)

Month	Stockholm (Sweden)				
	$f_{sht;with}$ [a]	$f_{sh;with}$ [a]			
		N	E	S	W
1	0,5	0,00	0,10	0,71	0,00
2	0,5	0,00	0,42	0,76	0,18
3	0,5	0,00	0,56	0,77	0,47
4	0,5	0,00	0,74	0,80	0,59
5	0,5	0,02	0,70	0,71	0,59
6	0,5	0,05	0,69	0,66	0,56
7	0,5	0,03	0,67	0,65	0,53

[a] Add more columns or rows if needed to differentiate between e.g. applications (e.g. building categories, new or existing buildings, etc.), orientations or climates.

Table B.44c *(continued)*

Month	Stockholm (Sweden)				
	$f_{sht;with\ a}$	$f_{sh;with\ a}$			
8	0,5	0,00	0,61	0,70	0,54
9	0,5	0,00	0,58	0,70	0,44
10	0,5	0,00	0,47	0,74	0,24
11	0,5	0,00	0,19	0,62	0,00
12	0,5	0,00	0,00	0,59	0,00
Annual	0,5	0,02	0,62	0,71	0,50

[a] Add more columns or rows if needed to differentiate between e.g. applications (e.g. building categories, new or existing buildings, etc.), orientations or climates.

Table B.45 — Choices between options and methods for calculation of shading by external objects (see F.1)

Application [b]	All applications			Not applicable		
Description	**Choice**			**Choice**		
Calculation of the effect of shading by distant objects included in this document?	Yes			n.a.		
When calculating solar shading on building elements: which types of distant shading objects (not on site) may or shall be taken into account or ignored NOTE For instance landscape (such as hills or dikes), vegetation (such as trees), other constructions (such as buildings)	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	Landscape (such as hills or dikes), other constructions (such as buildings)	Vegetation (such as trees)	-	n.a.	n.a.	n.a.
When calculating solar shading on opaque building elements such as roofs or facades: which types of on site shading objects can or shall be ignored NOTE For instance rebates, overhangs or other shading objects from the own building(s) on site	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	-	-	Rebates, overhangs or other shading objects from the own building(s) on site	n.a.	n.a.	n.a.
When calculating solar shading on transparent building elements: NOTE For instance window rebates, overhangs and side fins	Shall be taken into account:	May be taken into account:	Shall be ignored:	Shall be taken into account:	May be taken into account:	Shall be ignored:
	Window rebates, overhangs and side fins if depth larger than 20% of window height resp. width	Other window rebates, overhangs and side fins	-	n.a.	n.a.	n.a.
Specific subdivision rules for the calculation of solar shading on building elements	None			n.a.		
Choice between the two methods for the solar shading calculation:	Choice [a]			Choice [a]		

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table B.45 *(continued)*

Application [b]	All applications	Not applicable
Description	**Choice**	**Choice**
Method 1, Shading of direct radiation	Yes	n.a.
Method 2, Shading of direct and diffuse radiation	No	n.a.
In case of method 2: give reference to calculation procedure	n.a.	n.a.

[a] Only one Yes per column possible.

[b] Add more columns if needed to differentiate between applications (e.g. building categories, new or existing buildings, etc.).

Table B.46 — Parameters for monthly solar shading due to overhangs (See F.3.5.1.2)

Period:		summer: June - September			
Orientation		A_1	B_1	A_2	B_2
North hemisphere	**South hemisphere**				
S	N	-3,023	0,045	1,285	-0,006
SE-SW	NE-NW	-1,255	0,015	0,905	-0,008
E-W	E-W	-0,684	0,005	0,610	-0,004
NE-NW	SE-SW	-0,654	0,006	0,616	-0,006
N	S	-0,726	0,007	0,616	-0,007

Table B.47 — Parameters for monthly solar shading due to fins (See F.3.5.1.2)

Period:		summer: June - September			
Orientation		A_1	B_1	A_2	B_2
North hemisphere	**South hemisphere**				
S	N	-1,175	0,012	0,860	-0,008
SE-SW	NE-NW	-0,799	0,009	0,684	-0,006
E-W	E-W	0,118	-0,014	0,005	0,010
NE-NW	SE-SW	0,155	-0,041	-0,680	0,009
N	S	0,275	-0,133	0,641	0,039

Table B.48a — Parameters for monthly solar shading by obstacles; more detailed method (See F.3.1.2 and F.3.5.2.2)

Location:	40º north latitude								
Period:	winter: October - May								
Orientation	**Weight, $w_{obst;m;i}$ per sector**				**Solar altitude, $\alpha_{sol;m;i}$ per sector**				**Fraction direct solar irradiation $f_{sol;dir;m}$**
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	
N	0	0	0	0	-	-	-	-	0
NE	0	0	0	1,00	-	-	-	7,6	0,10
E	0	0	0,31	0,69	-	-	9,0	20,8	0,50
SE	0	0,14	0,58	0,28	-	9,2	22,2	24,0	0,70
S	0,06	0,40	0,47	0,07	9,4	22,8	22,6	9,7	0,75

Table B.48a *(continued)*

Location:	40º north latitude								
Period:	winter: October - May								
Orientation	**Weight, $w_{obst;m;i}$ per sector**				**Solar altitude, $\alpha_{sol;m;i}$ per sector**				**Fraction direct solar irradiation $f_{sol;dir;m}$**
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	
SW	0,22	0,63	0,15	0	24,2	22,0	9,6	-	0,70
W	0,70	0,30	0	0	20,6	9,5	-	-	0,50
NW	1,00	0	0	0	8,7	-	-	-	0,10

Table B.48b — Parameters for monthly solar shading by obstacles; more detailed method (See F.3.1.2 and F.3.5.2.2)

Location:	40º north latitude								
Period:	summer: June - September								
Orientation	**Weight, $w_{obst;m;i}$ per sector**				**Solar altitude, $\alpha_{sol;m;i}$ per sector**				**Fraction direct solar irradiation $f_{sol;dir;m}$**
	1	**2**	**3**	**4**	**1**	**2**	**3**	**4**	
N	0	0	0	1,00	-	-	-	17,4	0,10
NE	0	0	0,62	0,38	-	-	20,9	50,2	0,30
E	0	0,48	0,48	0,04	-	21,8	52,5	74,4	0,45
SE	0,33	0,53	0,10	0,03	23,2	54,0	74,4	74,4	0,55
S	0,30	0,20	0,21	0,29	60,5	74,4	74,4	60,7	0,50
SW	0,03	0,11	0,52	0,34	74,4	74,4	54,2	23,1	0,55
W	0,04	0,47	0,49	0	74,4	52,7	21,8	-	0,45
NW	0,37	0,63	0	0	50,3	20,9	-	-	0,30

Annex C
(normative)

Regional references in line with ISO Global Relevance Policy

This document contains specific parallel routes in referencing standards, in order to take into account existing national and/or regional regulations and/or legal environments while maintaining global relevance.

The standards that shall be used as called for in the successive clauses are given in Table C.1.

Table C.1 — Regional references in line with ISO Global Relevance Policy

Subject		Global	Regional: CEN area [a]
1	Thermal transmission — window, door or shutter	ISO 10077-1 ISO 15099	ISO 10077-1
2	Thermal transmission — glazing	ISO 10292	EN 673
Solar transmittance:			
3	— non-scattering glazings	ISO 9050	EN 410
4	— windows with scattering glazing and/or solar shading devices	ISO 15099	ISO 15099
5	— for normal incidence angle	ISO 52022-3 or ISO 15099	ISO 52022-3

[a] CEN area: Countries whose national standards body is a member of CEN. Attention is drawn to the need for observance of EU Directives transposed into national legal requirements.

Annex D
(normative)

Multi-zone calculation with thermal coupling between zones

D.1 General

See 6.4.7. A multi-zone calculation with thermal coupling between zones (calculation with coupled zones) is only to be used with care for special situations. See Table A.7 (Template) and Table B.7 (informative default choice).

A multi-zone calculation with interactions between the zones (a) requires significantly more and often arbitrary input data (on transmission properties and air flow direction and size) and (b) requires compliance with constraints in the building regulations on the zoning rules (freedom of internal partitioning, definitions of zoning in the case of combined use (e.g. a hospital generally also includes an office section, a restaurant section, etc.). A further complication may be the involvement of different heating, cooling and ventilation systems for different zones, which adds to the complexity and arbitrariness of the input and modelling.

D.2 Hourly method

In the case of a multi-zone calculation with thermal coupling between zones (calculation with coupled zones) the formulae are modified as follows, depending on the heat exchanges taken into account.

1) Air flow exchanges

Air flow in one direction only:

In this case the air flow passes from thermal zone 1 to thermal zone 2. For a given hour, the calculation is done first for zone 1 and its air temperature is used to calculate the thermal balance of zone 2.

Air flow in both directions:

In this case, due, for example, to doors opening, zones 1 and 2 are considered as a single zone.

NOTE 1 This is actually already covered by the procedures for thermal zoning in 6.4.2.

2) Heat flow through internal partitions

The aim is to take into account heat flows through walls and floors between adjacent thermal zones. The boundary conditions are modified to calculate an equivalent thermal resistance, area and external temperature, seen from the thermal zone being calculated. The boundary condition of each adjacent thermal zone is the temperature of the surface node calculated at the previous hour.

where

θ_{az} is the internal temperature of the adjacent zone at the previous hour, in °C;

$H_{tr,iw}$ is the heat transfer through internal walls connected to the adjacent zone, determined in accordance with D.4, in W/K;

$H_{tr,if}$ is the heat transfer through floors connected to the adjacent zone, determined in accordance with D.4, in W/K.

The partitioning into thermally coupled zones and the input data shall be described in the report.

NOTE 2 In the case of strong thermal interactions between the zones, the method can lead to oscillations; in that case iteration is needed, using suitable relaxation factors.

D.3 Monthly method

In the case of a multi-zone calculation with thermal coupling between zones (calculation with coupled zones), the procedure, based on monthly calculation intervals, is as follows.

In addition to the data needed for the single-zone or uncoupled-zone calculation, inter-zone data are collected, in accordance with D.4.

Add to the heat transfer, by transmission and ventilation of zone z, the following terms:

$$Q_{\text{tr},zy;m} = H_{\text{tr},zy} \cdot \left(\theta_{z,\text{H/C};m} - \theta_{y,\text{mn};m}\right) \cdot \Delta t_{\text{m}}$$
$$Q_{\text{ve},z\rightarrow y;m} = H_{\text{ve},z\rightarrow y} \cdot \left(\theta_{z,\text{H/C};m} - \theta_{y,\text{mn};m}\right) \cdot \Delta t_{\text{m}} \quad \text{(D.1)}$$

where $\theta_{y,\text{mn};m}$ represents the actual mean temperature in an adjacent zone y, including any overheating (heating mode) or undercooling (cooling mode), as determined in 6.6.11.6.

It is important to note that, for zone y, the actual mean temperature shall be used. In zone z itself the temperature set-point $\theta_{z,\text{H}}$ for heating and $\theta_{z,\text{C}}$ for cooling shall be used. Taking the temperature set-point for zone y instead of the actual mean temperature would result in significant errors if there are strong interactions between the zones. In zone z itself, the actual mean temperature is not an input parameter in the calculation of the energy balance, but an implicit result of the utilization of heat gains or heat losses.

NOTE 1 These contributions to Q_{tr} and Q_{ve} also change the heat-balance ratio for heating and/or cooling mode.

The calculation of the energy needs for heating and cooling shall be made in an iterative way (usually two or three steps suffice):

NOTE 2 The next rules are reconsidered in case there are also other reasons for iteration (see 6.4 and 6.6)

1) assume initially that the actual mean temperature in each zone is equal to the temperature set-points for heating or cooling for that zone, determined in accordance with 6.6.11;

2) calculate the energy needs for heating and cooling for each zone, taking into account the contribution of the heat transfer by transmission and/or ventilation between the zones, as described above;

3) on the basis of these results, calculate for each zone the actual mean temperature, as described above;

4) if the actual mean temperature of any of the zones differs by more than an acceptable minimum criterion (e.g. 0,3 °C), repeat from step 2); otherwise the iteration is completed successfully.

NOTE 3 This method is described (including computerized model and validation results), for the heating mode, in [26] of ISO/TR 52016-2[1].

The partitioning into thermally coupled zones and the input data shall be described in the report.

D.4 All methods: input data

The heat transfer coefficients between zones z and y are:

$H_{\text{tr},zy}$ is the transmission heat transfer coefficient between zones z and y, in W/K;

$H_{\text{ve},z\text{->}y}$ is the ventilation heat transfer coefficient from zone z to zone y, in W/K;

$H_{\text{ve},y\text{->}z}$ is the ventilation heat transfer coefficient from zone y to zone z, in W/K.

where

$$H_{ve,z \to y} = \rho_a \cdot c_a \cdot q_{V,z \to y} \tag{D.2}$$

$$H_{ve,y \to z} = \rho_a \cdot c_a \cdot q_{V,y \to z} \tag{D.3}$$

$q_{V,z \to y}$ is the net air flow rate from zone *z* to zone *y*, in m^3/s;

$q_{V,y \to z}$ is the net air flow rate from zone *y* to zone *z*, in m^3/s.

NOTE The ventilation heat transfer coefficient $H_{Vve,z\text{-}\to y}$ differs from $H_{ve,y\text{-}\to z}$ if the air flow rate is not the same in two directions.

Table A.8 provides a normative template and Table B.8 informative default values for the amount of heat transfer.

Annex E
(normative)

Heat transfer and solar heat gains of windows and special elements

E.1 General

This annex provides the procedures to make the available thermal transmission and total solar transmission properties of transparent building elements, such as windows, doors and curtain walls, suitable for the calculation of the thermal balance and loads and needs of the building or part of the building.

This annex also provides the procedures to calculate the heat transfer and solar heat gains of special elements, such as opaque elements with transparent insulation, ventilated solar walls and ventilated envelope elements.

E.2 Windows

E.2.1 Frame area fraction of windows

The glazed area can be obtained directly from the geometric data or window properties (Method A), or the glazed area can be derived from a fixed frame area fraction (Method B).

Method A

The frame area fraction of window element *wi*, $F_{\text{fr};wi}$, shall be calculated according the following formula:

$$F_{\text{fr};wi} = 1 - \frac{A_{\text{gl};wi}}{A_{wi}} \quad \text{(E.1)}$$

where, for window element *wi;*

$F_{\text{fr;w}i}$ is the frame area fraction.

$A_{\text{gl;w}i}$ is the glazed area of window element *wi*, obtained from ISO 13789, in m^2.

$A_{\text{w}i}$ is the area of window element *wi*, obtained from ISO 13789, in m^2; in case of protruded components the projected area shall be used.

Method B

The glazed area $A_{\text{gl};wi}$ of window element *wi*, shall be calculated according to the following formula:

$$A_{\text{gl};wi} = \left(1 - F_{\text{fr};wi}\right) \cdot A_{wi} \quad \text{(E.2)}$$

where, for window element *wi;*

$F_{fr;wi}$ is the frame area fraction, obtained according to Table A.8 (normative template) with informative default value in Table B.8.

A_{wi} is the area of window element *wi*, obtained from ISO 13789, in m^2; in case of protruded components the projected area shall be used.

The normative template for the choice between method A or method B is given in Table A.21 (hourly method) and Table A.42 (monthly method). For the case of method B, the same table also gives the template for the value for the fixed frame area fraction. The informative default choice and value are given in respectively Table B.21 and Table B.42. The same choice shall be made for all window elements in the building.

E.2.2 Total solar energy transmittance of transparent elements

E.2.2.1 General

A transparent building element, like a window, (glazed) door, curtain wall, is hereafter called window.

The transparent part of a window is hereafter called glazing or glazed part of the window.

The total solar energy transmittance of the glazing of window *wi*, $g_{gl;wi}$, is the ratio of energy passing through the window to that incident upon it.

NOTE 1 The effect of transmission through, absorption in and (multiple) reflection at the window itself and other layers is included in the total solar energy transmittance.

For windows with non-scattering glazing, the solar energy transmittance for radiation perpendicular to the glazing, $g_{gl;n;wi}$, shall be calculated in accordance with ISO 9050 (or see Subject 3 in Table C.1).

The total solar energy transmittance depends on the angle of incidence (altitude and azimuth) of the incident solar radiation. The (weighted time average) value needed for the calculations is somewhat lower than $g_{gl;n}$. Therefore, a correction factor, F_w, is used as given by the following formula:

$$g_{gl;wi} = F_w \cdot g_{gl;n;wi} \tag{E.3}$$

where

$g_{gl;wi}$ is the total solar energy transmittance (corrected for angle of incidence);

F_w is a correction factor for non-scattering glazing, obtained from Table A.22 (normative template; hourly method) and Table A.43 (normative template; monthly method). The informative default values are given in respectively Table B.22 and Table B.43.;

$g_{gl;n;wi}$ is the solar energy transmittance for radiation perpendicular to the glazing; obtained from Table A.43 (normative template), with informative default values given in Table B.43.

Default values of the total solar energy transmittance at normal incidence, g_n, for typical types of glazing are obtained from Table A.22 (normative template; hourly method) and Table A.43 (normative template; monthly method), with informative default values given in respectively Table B.22 and Table B.43.

For windows with scattering glazing or solar shading provisions, the solar energy transmittance for radiation perpendicular to the glazing (normal incidence), $g_{gl;n}$, can significantly underestimate the solar transmittance. The total solar energy transmittance, corrected for angle of incidence, is calculated according to the weighted sum as given by the following formula:

$$g_{gl;wi} = a_{gl} \cdot g_{gl,alt;wi} + \left(1 - a_{gl}\right) \cdot g_{gl,dif;wi} \tag{E.4}$$

where

$g_{\mathrm{gl};wi}$ is the total solar energy transmittance of the glazing of window *wi*;

a_{gl} is a weighting factor, representative of the position (orientation, tilt) of the window, climate and season, obtained from Table A.22 (hourly method) and Table A.43 (monthly method). The informative default values are given in respectively Table B.22 and Table B.43;

$g_{\mathrm{gl},alt;wi}$ is the solar energy transmittance of the glazing for solar radiation from an altitude angle, alt_{gl}, representative of the position (orientation, tilt) of the window, climate and season, obtained in accordance with ISO 15099 (or see Subject 4 in Table C.1). The altitude angle, alt_{gl}, is obtained from Table A.22 (hourly method) and Table A.43 (monthly method). The informative default values are given in respectively Table B.22 and Table B.43;

$g_{\mathrm{gl,dif}}$ is the solar energy transmittance of the glazing for isotropic diffuse solar radiation, obtained in accordance with ISO 15099 (or see Subject 4 in Table C.1).

NOTE 2 The second right-hand term in Formula (E.4) is a simplification, taking together the diffuse radiation from the direction of the sky plus the ground-reflected radiation.

If solar protection devices are present, the total solar energy transmittance of the glazing including the solar protection device, $g_{\mathrm{gl;sh}}$, shall be calculated according to ISO 52022-3.

Default values of the reduction factor for the total solar energy transmittance, for typical types of blinds, are obtained from Table A.22 (normative template; hourly method) and Table A.43 (normative template; monthly method), with informative default values given in respectively Table B.22 and Table B.43. These reduction factors shall be multiplied by the total solar energy transmittance of the glazing to obtain the *g*-value of the glazing with blind.

E.2.2.2 Hourly method

For the hourly calculation method the following situations can occur:

a) solar protection device completely closed;

b) solar protection device not completely closed.

In case a) the glazing component and the solar protection device are treated as a single envelope component.

In case b) two different components shall be considered:

— the portion of glazing area not covered by the solar protection device, comprising the glazing component only;

— the portion of glazing area covered by the solar protection device, treated as in case a).

The appropriate schedules for the operation of solar protection devices are obtained on an hourly basis in accordance with G.2.2.1 in Annex G.

If the window comprises blinds with movable slats, the solar transmittance shall be calculated with the blinds at such a position that direct solar radiation from the angle, alt_{gl}, is blocked, but with maximum possible light transmittance and view through.

NOTE 3 In the case of horizontal venetian blinds with the slats in such a position (e.g. slightly inclined) that direct solar radiation is fully blocked, the solar energy transmission by diffuse radiation and by ground-reflected radiation can be significantly more than $g_{\mathrm{gl;n}}$.

This implies that the value of the total solar energy transmittance of the glazed part of any window *wi* can vary as function of the time interval *t*: $g_{\mathrm{gl};wi;t}$.

E.2.2.3 Monthly method

For the monthly calculation method the monthly mean effective total solar energy transmittance of the glazed part of window *wi*, $g_{gl;m}$, for month *m*, is obtained on a monthly basis in accordance with G.2.2.2 in Annex G.

E.3 Thermally unconditioned zone with internal or solar gains (including sunspace or atrium)

E.3.1 General

These calculation procedures apply to a thermally unconditioned zone with internal and/or solar gains, adjacent to one or more thermally conditioned zones, such as a conservatory or attached greenhouse or atrium, separated by partition wall(s) from the thermally conditioned zone(s).

NOTE See zoning rules in 6.4 for the definition of this category of spaces.

The calculation method quantifies the positive effect during the heating (cold) season. However, the same procedure shall also be used to calculate the gains in the cooling (warm) season, taking into account any extra (seasonal) solar protection and ventilation provisions, if present.

Alternatively, default values for the adjustment factor, $b_{ztu;m}$, may be used, for instance as function of the type and/or size of the adjacent unconditioned space, that implicitly include the effect of the gains, if available in Table A.4 (normative template), already presented in 6.4.5.5, with informative default choice in Table B.4. In that case the gains into or through the thermally unconditioned zone shall be set to zero.

E.3.2 Procedures

E.3.2.1 Hourly calculation procedures

The internal heat gains in the thermally unconditioned zone *ztu*, $\Phi_{int;dir;ztu;t}$, in W, at time interval *t*, are determined in 6.5.12.2.

For the solar heat gains, it is assumed, in a first approximation, that the absorbing surfaces are all shaded in the same proportion by external obstacles and by the outer envelope of the thermally unconditioned zone.

The reduction factor for the solar radiation through the external partition of a thermally unconditioned zone *ztu*, $F_{sol;ue,ztu;t}$, is calculated with the following formula:

$$F_{sol;ue;ztu;t} = g_{gl;ue;ztu;t} \cdot \left(1 - F_{fr;ue;ztu}\right) \tag{E.5}$$

where

$g_{gl;ue;ztu;t}$ is the effective total solar energy transmittance of the glazing of the external partition of the thermally unconditioned zone *ztu*, at time interval *t*, as determined in E.2.2;

$F_{fr;ue,ztu}$ is the frame area fraction for the external partition, calculated as the ratio of total opaque and total opaque plus transparent areas of the external partition of the thermally unconditioned zone *ztu*. In case of protruded components the projected area shall be used.

NOTE The total solar energy transmittance can be a function of time, for instance in case of movable or switchable shading provision.

The solar heat gain inside the thermally unconditioned zone *ztu*, $\Phi_{\mathrm{sol};ztu;t}$, in W, at time interval *t*, is calculated by summing the solar heat gain of each opaque surface, *j*, in the thermally unconditioned zone:

$$\Phi_{\mathrm{sol};ztu;t} = F_{\mathrm{sol;ue};ztu;t} \cdot \sum_{j(\mathrm{opaque})} \left(a_{\mathrm{sol},j} A_j \cdot \left(I_{\mathrm{sol;dif};j;t} + I_{\mathrm{sol;dir};j;t} \cdot F_{\mathrm{sh;obst};j;t} \right) \right) \tag{E.6}$$

where, at time interval *t*

$F_{\mathrm{sol;ue},ztu;t}$ is the reduction factor for the solar radiation through the external partition of the thermally unconditioned zone *ztu*, as determined above;

A_j is the area of each opaque surface *j* inside the thermally unconditioned zone *ztu* as determined according to 6.5.8 for the thermal transmission properties, in m^2; in case of protruded components the projected area shall be used;

$\alpha_{\mathrm{sol};j}$ is the average solar absorption coefficient of the opaque surface *j* inside the thermally unconditioned zone *ztu*, obtained from Table A.15, with informative default values given in Table B.15;

$F_{\mathrm{sh;obst};j;t}$ is the shading reduction factor for external obstacles for the opaque surfaces, *j*, in the thermally unconditioned zone, *ztu*, as calculated in accordance with Annex F;

$I_{\mathrm{sol;dir};wi;t}$ is the direct incident solar radiation on the opaque surfaces, *j*, obtained from the relevant standard under EPB module M1-13, in W/m^2;

$I_{\mathrm{sol;dif};wi;t}$ is the diffuse incident solar radiation on the opaque surfaces, *j*, obtained from the relevant standard under EPB module M1-13, in W/m^2.

E.3.2.2 Monthly calculation procedures

The internal heat gains in the thermally unconditioned zone *ztu*, $Q_{\mathrm{int;dir};ztu;m}$, in kWh, at month *m*, are determined in 6.6.7.2.

For the solar heat gains, it is assumed, in a first approximation, that the absorbing surfaces are all shaded in the same proportion by external obstacles and by the outer envelope of the thermally unconditioned zone.

The reduction factor for the solar radiation through the external partition of a thermally unconditioned zone *ztu*, for heating/cooling, $F_{\mathrm{sol;ue},ztu;\mathrm{H/C};t}$, is calculated with the following formula:

$$F_{\mathrm{sol;ue};ztu;\mathrm{H/C};m} = g_{\mathrm{gl;ue};ztu;\mathrm{H/C};m} \cdot \left(1 - F_{\mathrm{fr;ue};ztu}\right) \tag{E.7}$$

where

$g_{\mathrm{gl;ue};ztu;\mathrm{H/C};m}$ is the effective total solar energy transmittance of the glazing of the external partition of the thermally unconditioned zone *ztu*, for heating/cooling, in month *m*, obtained in accordance with E.2.2;

$F_{\mathrm{fr;ue},ztu}$ is the frame area fraction for the external partition, calculated as the ratio of total opaque and total opaque plus transparent areas of the external partition of the thermally unconditioned zone *ztu*. In case of protruded components the projected area shall be used.

NOTE The total solar energy transmittance is a monthly mean value, including correction, for instance in case of movable or switchable shading provision. See E.2.2.

The solar heat gain inside the thermally unconditioned zone *ztu*, for heating/cooling, $Q_{H/C;sol;ztu;m}$, in kWh, in month *m*, is calculated by summing the solar heat gain of each opaque surface, *j*, in the thermally unconditioned zone:

$$Q_{H/C;sol;ztu;m} = F_{sol;ue;ztu;H/C;m} \cdot F_{sh;obst;ztu;m} \cdot \sum_{j(opaque)} \left(a_{sol;j} \cdot A_j H_{sol;j;m} \right) \tag{E.8}$$

where, for month *m*:

$F_{sol;ue,ztu;H/C;m}$ is the reduction factor for the solar radiation through the external partition of the thermally unconditioned zone *ztu*, for heating/cooling, as determined above;

A_j is the area of each opaque surface *j* inside the thermally unconditioned zone *ztu* as determined according to 6.5.8 for the thermal transmission properties, in m^2; in case of protruded components the projected area shall be used;

$\alpha_{sol;j}$ is the average solar absorption coefficient of the opaque surface *j* inside the thermally unconditioned zone *ztu*, obtained from Table A.29, with informative default values given in Table B.29;

$F_{sh;obst;ztu;m}$ is the shading reduction factor for external obstacles for the external partition of the thermally unconditioned zone, *ztu*, as calculated in accordance with Annex F;

$H_{sol;j;m}$ is the total monthly solar irradiation at the transparent element *j*, with a given orientation and tilt angle, obtained from the relevant standard under EPB module M1-13, in kWh/m^2.

E.3.3 Reduction factor to avoid overestimation of the gains, monthly method

For the monthly calculation method, in case of an external thermally unconditioned zone (see 6.4.5), a reduction factor is applied to avoid overestimation of the gains in the heating mode, based on the ratio of the heat transfer and the gains:

In case of a single adjacent thermally conditioned zone:

$$f_{gn;max;H;ztu;m} = \frac{b_{ztu;m} \cdot H_{ztc;ztu;m} \cdot \left(\theta_{int;set;H;ztc;m} - \theta_{e;a;m} \right) \times 0,001 \times t_m}{\left(Q_{H;int;ztu;m} + Q_{H;sol;ztu;m} \right)} \tag{E.9}$$

In case of a multiple adjacent thermally conditioned zones:

$$f_{gn;max;H;ztu;m} = \frac{b_{tuz,k;m} \cdot \sum_{ztc} \left(H_{ztc;ztu;m} \cdot \left(\theta_{int;set;H;ztc;m} - \theta_{e;a;m} \right) \right) \times 0,001 \times t_m}{\left(Q_{H;int;ztu;m} + Q_{H;sol;ztu;m} \right)} \tag{E.10}$$

where, for month *m*

$f_{gn;max;H;ztu;m}$ is the reduction factor to avoid overestimation of the gains from the thermally unconditioned zone *ztc*, for the heating mode, in W/K;

$b_{ztu;m}$ is the adjustment factor for the thermally unconditioned adjacent zone *ztu*, as determined in 6.4.5.4;

$H_{ztc;ztu;m}$ is the heat transfer coefficient between the thermally unconditioned zone *ztu* and the adjacent thermally conditioned zone *ztc*, as determined in 6.4.5.4, in W/K;

$\theta_{int;set;H;ztc;m}$ is the set-point temperature of the adjacent thermally conditioned zone *ztc* for heating, determined in accordance with 6.6.11, in °C; in case of multiple adjacent thermally conditioned zones, the temperatures are weighted according to the distribution factor $F_{ztc;ztu;m}$ for the heat transfer between the thermally conditioned zone *ztc* and the thermally unconditioned zone *ztu*, as determined in 6.4.5.4;

$\theta_{e;a;m}$ is the mean external air temperature, obtained from the relevant standard under EPB module M1-13, in °C;

$Q_{H;int;ztu,k;m}$ are the internal heat gains for the heating mode in the external thermally unconditioned zone *ztu* (see 6.4.5), as determined in 6.6.7.2, in kWh;

$Q_{H;sol;ztu;m}$ are the solar gains for the heating mode in the external thermally unconditioned zone *ztu* (see 6.4.5), as determined in 6.6.8.2, in kWh;

t_m is the duration of the month *m*, obtained from the relevant standard under EPB module M1-13, in h.

NOTE 1 This formula has as effect that for the calculation in the heating mode the incoming gains in the thermally unconditioned zone are not larger than the heat transfer through the thermally unconditioned zone.

For the monthly calculation method, in case of an internal thermally unconditioned zone (see 6.4.5), the reduction factor to avoid overestimation of the gains in the heating mode is set to 1:

$$f_{gn;max;H;ztu;m} = 1 \tag{E.11}$$

NOTE 2 Because the internal type of thermally unconditioned zone is only applicable in case of insignificant gains.

E.3.4 Conservative approximation, monthly method

For the monthly calculation method, the following procedure may be used as a conservative approximation of the procedure in E.3.2.

For the heating mode, ignore the additional (indirect) gains via the sunspace into the calculation zone: $\Phi_{sol;ztu;m} = 0$.

For the cooling mode the same as for the heating mode: $\Phi_{sol;ztu,m} = 0$, but, in addition to that, ignore the sunspace for the calculation of the solar heat gains into the calculation zone. This implies that reduction of the solar energy transmittance by the sunspace envelope is ignored, except for solar shading provisions that are permanently applied during the whole cooling season.

NOTE For the hourly calculation method a distinction between heating and cooling mode is not possible.

E.3.5 Special elements

This document does not provide normative calculation procedures for the heat transfer and solar heat gains in case of special elements such as opaque elements with transparent insulation, ventilated solar walls (Trombe walls) and ventilated envelope elements.

NOTE Informative calculation procedures are provided in ISO/TR 52016-2:2017, E.3.5 [1].

Annex F
(normative)

Calculation of solar shading reduction factors

F.1 Selection of methods

The amount of solar radiation impinging on the external surface of the building envelope element is calculated according to the relevant standard under EPB module M1-13. The shading reduction factors in this document here may concern distant obstacles (if not already taken into account in the relevant standard under EPB module M1-13) and obstacles on (or close by) the building itself and overhangs, side fins and rebates (especially for windows).

The choice which obstacles are taken into account for which building elements is indicated for the hourly calculation procedures in Table A.25 (normative template), with informative default choice provided in Table B.25, and for the monthly calculation procedures in Table A.45 (normative template), with informative default choice provided in Table B.45.

Because different shading objects in the same direction may overlap, serious errors may be introduced due to double counting if the effect of shading objects is calculated separately, by first calculating the irradiance for one set of (e.g. distant) shading objects and then use the output as input to calculate the effect of another set of (e.g. nearby or on site) shading objects.

This could occur if the shading by distant objects is done already in the relevant standard under EPB module M1-13. Therefore, it is recommended that the shading calculation is done in the underlying standard, the application standard where the position, location and all surroundings of the irradiated surface is known.

This leads to the following options:

Option 1:

The shading reduction factor by distant objects is already calculated in the relevant standard under EPB module M1-13.

Option 2:

To avoid double counting, the shading reduction factor by distant objects is included in this document.

The choice between Option 1 or Option 2 is indicated, for the hourly calculation procedures in Table A.25 (normative template), with informative default choice provided in Table B.25 and for the monthly calculation procedures in Table A.45 (normative template), with informative default choice provided in Table B.45.

NOTE 2 In ISO 52010-1:2017, Table B.6, Option 2 is the default option, so in the equivalent Table B.25 and Table B.45 of this document a consistent choice is made.

Objects in the environment may block part of the solar irradiance on a surface (e.g. hills, trees, other buildings, other parts of the same building).

The same or other objects may also reflect solar radiation and consequently lead to a higher irradiance.

NOTE 3 For example, on the northern (southern) hemisphere, a highly reflecting surface (e.g. glazed adjacent building) in front of the North (South) facing façade of the assessed building.

In order to avoid that for those objects specific solar reflectivity data have to be gathered, it is an option, as a simplification, to assume that:

a) The direct radiation (including circumsolar irradiance) is partially blocked, if the object is in the path between sun and surface;

b) the diffuse irradiance (including irradiance from ground reflectance) remains unaffected.

NOTE 4 This is physically equal to the situation where the radiation reflected (and/or transmitted) by the objects in the environment is equal to the diffuse radiation blocked by these objects.

For the calculation of the solar shading two methods are provided.

— Method 1, Shading of direct radiation, see F.3.

— Method 2, Shading of direct and diffuse radiation, see F.4.

The choice between Method 1 and Method 2 is indicated for the hourly calculation procedures in Table A.25 (normative template), with informative default choice provided in Table B.25, and for the monthly calculation procedures in Table A.45 (normative template), with informative default choice provided in Table B.45.

The same tables also contain an option to add specific rules for the subdivision of the shaded object or objects.

NOTE 5 For instance: subdivision of (large) windows or façades.

F.2 Application on system components, such as thermal solar collectors and photovoltaic panels

The procedures in this Annex to calculate the shading reduction factor on building elements is also applicable to calculate the effect of shading on solar irradiated system components, such as thermal solar collectors and photovoltaic panels.

NOTE In case of photovoltaic panels, depending on the type and the arrangement of the photovoltaic elements, the effect of solar shading on the electric output can be much larger than proportional to the shaded surface, due to increased electric resistance in the shaded elements.

F.3 Method 1, Shading of direct radiation

F.3.1 Shading reduction factor

F.3.1.1 Hourly calculation procedures

The shading reduction factor of the surface k for external obstacles, $F_{sh;obst;k;t}$, at time interval t is equal to:

$$F_{sh;obst;k;t} = \frac{F_{sh;dir;k;t} \cdot I_{dir;tot;k;t} + I_{dif;tot;k;t}}{I_{dir;tot;k;t} + I_{dif;tot;k;t}} \quad \text{(F.1)}$$

where, for each shaded surface k and each time interval t:

$F_{sh;obst;k;t}$ is the dimensionless shading reduction factor for external obstacles;

$F_{sh;dir;k;t}$ is the shading reduction factor for direct irradiance, determined according to F.3.6.1;

$I_{dir;tot;k;t}$ is the total direct solar irradiance, as determined in the relevant standard under EPB module M1-13, in W/m^2;

$I_{dif;tot;k;t}$ is the total diffuse solar irradiance, as determined in the relevant standard under EPB module M1-13, in W/m^2.

F.3.1.2 Monthly calculation procedures

The shading reduction factor of the surface k for external obstacles, $F_{sh;obst;k;m}$, in month m is equal to:

The total solar irradiation on the surface k, $H_{tot;sh;k;m}$, including the effect of shading, is the sum of the calculated total solar irradiation, corrected for shading by objects by means of the shading reduction factor for direct solar radiation and the fraction of direct solar radiation in the total radiation:

$$F_{sh;obst;k;m} = F_{sh;dir;k;m} \cdot f_{sol;dir;m} \quad \text{(F.2)}$$

where, for each shaded surface k and each month m:

$F_{sh;obst;k;m}$ is the dimensionless shading reduction factor for external obstacles;

$F_{sh;dir;k;m}$ is the shading reduction factor for direct irradiance, determined according to F.3.6.2;

$f_{sol;dir;m}$ is the fraction of direct solar radiation in the total radiation, obtained as a function of climatic data and orientation from Table A.48 (normative template) with informative default values in Table B.48.

The direct shading reduction factor, $F_{sh;dir;k;t}$, is determined by the monthly mean solar altitude angle or by simplified correlation factors(for simple shading objects) and by the geometry of the shaded surface, k, and the shading objects.

F.3.2 Simple and more detailed shading objects

Two types of shading objects are distinguished with respect to the calculation method:

— Simple shaped obstacles for façade elements, such as (window) rebates, overhangs with infinite length and side fins with infinite height, or other geometrically similar shading objects, such as other building parts (e.g. walls) or balconies.

— Other obstacles, either shading from ground (bottom up; called [normal] “obstacle”) or shading from sky (top down, hanging; called “overhang”).

F.3.3 Identification and geometry of shading objects

F.3.3.1 Simple rebates, overhangs and side fins

This method applies to (window) rebates, overhangs with infinite length and side fins with infinite height or to other geometrically similar shading objects (such as balconies or walls).

See Figure F.1.

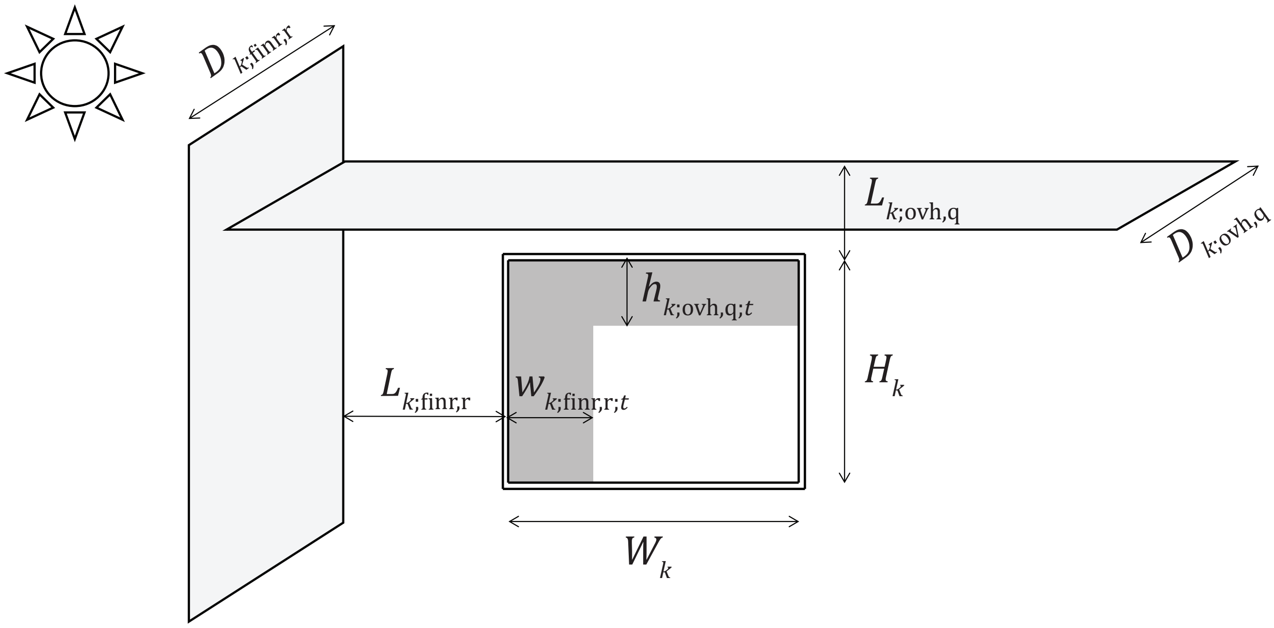


Figure F.1 — Geometry of simple overhangs or side fins

The shaded object (façade element):

The following data are needed for the façade element:

H_k the height of the façade element *k*, obtained from the geometry data of the element, in m; if tilted: the vertical projection of the height;

W_k the width of the façade element *k*, obtained from the geometry data of the element, in m.

Overhang:

The term overhangs includes window or façade fixed elements and other building parts (such as balconies), if applicable.

The following data are needed for each shading object, *q*, that can be regarded as overhang:

$D_{k;\text{ovh},q}$ the depth of the overhang *q*, measured from the plane of the façade element *k*, in horizontal direction, obtained according to the local situation, in m;

$L_{k;\text{ovh},q}$ the vertical distance between the edge of the façade element *k* and the overhang *q*, obtained according to the local situation, in m.

Side fins:

This method applies to side fins with infinite height or to other geometrically similar shading objects (such as walls).

The following data are needed for each shading object, *r*, that can be regarded as side fin:

$D_{k;\text{finr},r}$ the depth of the right hand side fin *r*, measured from the plane of the façade element *k*, in perpendicular direction, obtained according to the local situation, in m;

$L_{k;\text{finr},r}$ the horizontal distance between the edge of the façade element *k* and the right hand (outwards facing) side fin *r*, obtained according to the local situation, in m;

$D_{k;\text{finl},l}$ the depth of the left hand side fin *l*, measured from the plane of the façade element *k*, in perpendicular direction, obtained according to the local situation, in m;

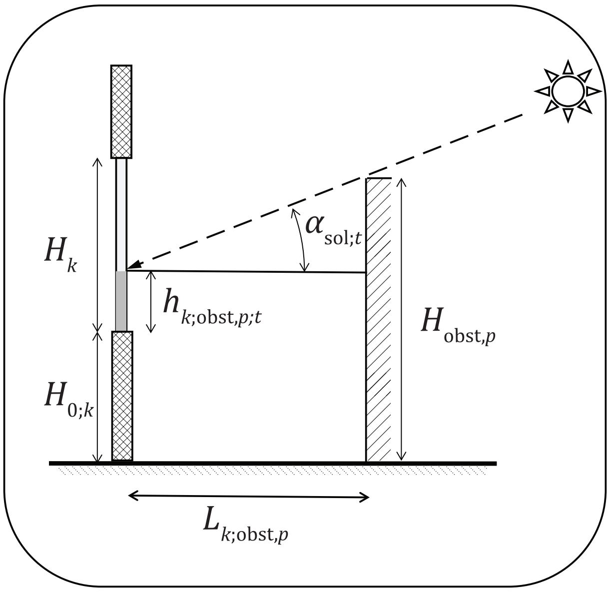
$L_{k;\text{finl},l}$ the horizontal distance between the edge of the façade element *k* and the left hand (outwards facing) side fin *l*, obtained according to the local situation, in m.

Rebate:

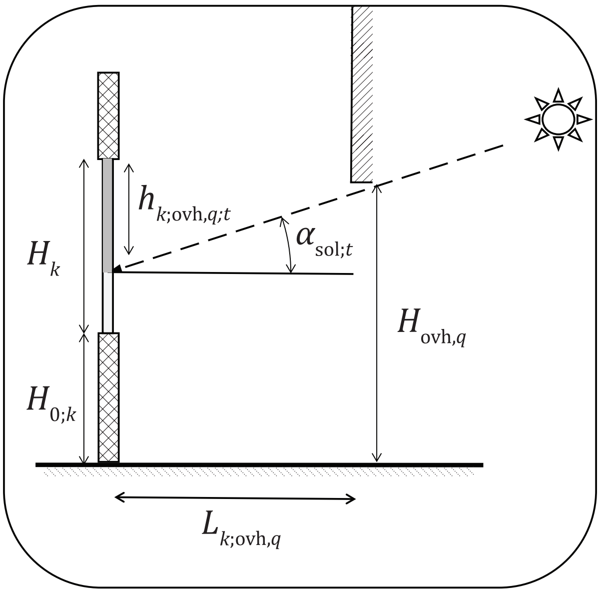
A rebate can be modelled as a combination of overhang and side fins, but separate correlation factors have been deployed for a more precise result.

F.3.3.2 Other shading objects; more detailed method

The shaded object and the shading object (obstacle or overhang) are characterized by the following data. See Figure F.2.



a. Vertical cross-section - obstacles



b. Vertical cross-section - overhangs

Figure F.2 — Shading of the direct solar beam due to shading objects

NOTE 1 For the monthly calculation procedures the subscript *t* is replaced by the subscript *m*.

The following data are needed for the shaded object *k*:

H_k the height of the shaded object *k*, obtained from the geometry data of the element, in m; if tilted: the vertical projection of the height;

W_k the width of the shaded object *k*, obtained from the geometry data of the element, in m; for the calculation method and types of shading objects under F.3.3.2 (in contrast to F.3.3.1) the real width is not needed and, if not available, may be set to 1 m;

β_k is the tilt angle of the shaded surface (from horizontal, measured upwards facing), obtained from the geometric data of the construction element, in degrees;

γ_k is the orientation angle of the shaded surface, obtained from the geometric data of the construction element, in degrees (expressed as the geographical azimuth angle of the horizontal projection of the inclined surface normal; convention: angle from South, eastwards positive, westwards negative).

If the vertical cross-section of the shaded object is not constant, the vertical cross-section shall be assessed in the middle of the object.

For the specification of the shading objects, the skyline is divided into a number of segments, i = 1 to $n_{\text{sh;segm}}$, each characterized by the upper boundary of the azimuth angle, $\gamma_{\text{sh;obst;max;}i}$, using the convention in this document: angle from South, eastwards positive, westwards negative.

NOTE 2 North->East->South->West->North = +180 -> +90 -> 0 -> -90 -> -180 degrees.

Hourly calculation procedures:

The choice in the number of segments, $n_{\text{sh;segm}}$, and whether the size of the segments (indicated by the boundaries of the azimuth angle, $\gamma_{\text{sh;obst;max;}i}$) are fixed or flexible, is given in Table A.26 (template), with informative default choice provided in Table B.26.

In case of a relatively small number of segments, such as 8, it is recommended to choose a fixed width (360/8 = 45º) and to use the same discretization of the orientation of the shaded object.

Monthly calculation procedures:

The choice is fixed to $n_{\text{sh;segm}}$ = 8 with fixed angles of 45º.

NOTE In case of a monthly time interval a finer discretization does not add to the overall accuracy.

Hourly and monthly calculation procedures:

For each segment separately an equal height and distance of the obstacle over the segment is to be assumed.

The following properties are collected, per shading obstacle (if any), *p*, in each segment *i*:

$H_{\text{obst},p;i}$ the height of the shading obstacle *r*, from ground level, obtained according to the local situation, in m;

$L_{k;\text{obst},p;i}$ the horizontal distance between the shaded object *k* and the shading obstacle *r*, obtained according to the local situation, in m.

If there are overhangs, the following properties are collected, per overhang (if any), *q*, in each segment *i*, using the same segmentation as for obstacles:

$H_{\text{ovh},q;i}$ the lowest height of the shading overhang *q*, from ground level, obtained according to the local situation, in m;

$L_{k;\text{ovh},q;i}$ the horizontal distance between the shaded object *k* and the shading overhang *q*, obtained according to the local situation, in m.

The horizontal distance can be the distance to the building (for distant obstacles), or the distance to the (centre of) the shaded surface, for remote obstacles or window related obstacles (window sills, side fins, overhangs).

The difference between obstacles and overhangs is that an obstacles ends at a certain height above the ground level, while an overhang starts at a certain height above the ground level.

F.3.4 Check if the shaded surface is in the view field of the solar beam

F.3.4.1 Hourly calculation procedures

If the shaded surface k is outside the field of view of the solar beam, the shading is complete (the total direct solar irradiance $I_{dir;tot;k;t} = 0$):

if -90 > ($\gamma_{k;t}$ - $\varphi_{sol;t}$) > +90 or if -90 > ($\beta_{k;t}$ - $\alpha_{sol;t}$) > +90

$$F_{sh;dir k;t} = 0 \tag{F.3}$$

where, for each shaded surface k and each time interval t:

$F_{sh;dir;k;t}$ is the dimensionless direct shading reduction factor of the shaded surface;

$\alpha_{sol;t}$ is the solar altitude angle, as determined in the relevant standard under EPB module M1-13, in degrees;

$\varphi_{sol;t}$ is the solar azimuth angle, per hour, as determined in the relevant standard under EPB module M1-13, in degrees (Convention in this document: angle from South, eastwards positive, westwards negative);

β_k is the tilt angle of the shaded surface (from horizontal, measured upwards facing), obtained from the geometric data of the construction element in degrees;

γ_k is the orientation angle of the shaded surface, obtained from the geometric data of the construction element, in degrees (expressed as the geographical azimuth angle of the horizontal projection of the inclined surface normal; convention: angle from South, eastwards positive, westwards negative).

In that case, for this time interval, the shading calculation is done.

Otherwise proceed with F.3.5 and F.3.6.

F.3.4.2 Monthly calculation procedures

For the monthly calculation procedures the orientation of the shaded object is rounded to 45 degrees, so that the outwards view of the object covers four segments, as illustrated in Figure F.3.

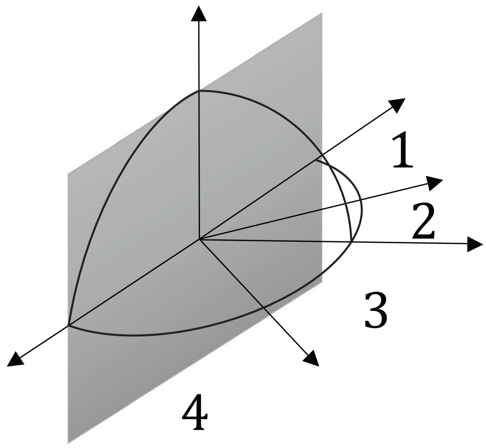


Figure F.3 — Monthly calculation procedures: division of skyline into 8 segments, with 4 segments in view of the shaded object

F.3.5 Calculate the individual shading paths

F.3.5.1 Simple rebates, overhangs and side fins

F.3.5.1.1 Hourly calculation procedures

See Figure F.1 in F.3.3.1.

Overhangs:

This method applies to (window) overhangs with infinite length or to other geometrically similar shading objects (such as balconies).

The height of the shade cast by each overhang q on the façade element k at time interval t is given by:

$$h_{k;ovh;q;t} = \frac{D_{k;ovh;q} \cdot \tan\left(\alpha_{sol;t}\right)}{\cos\left(\varphi_{\mathrm{sol;t}} - \gamma_{\mathrm{k}}\right)} - L_{k;ovh;q} \qquad \text{(F.4)}$$

where

$h_{k;\mathrm{ovh},q;t}$	is the height of the shadow of overhang q on the façade element k at time interval t, in m;
$D_{k;\mathrm{ovh},q}$	the depth of the overhang q, as determined in F.3.3.1, in m;
$L_{k;\mathrm{ovh},q}$	the vertical distance between the edge of the façade element k and the overhang q, as determined in F.3.3.1, in m;
$\alpha_{\mathrm{sol};t}$, $\varphi_{\mathrm{sol};t}$, γ_k	are the same angles as for the previous formulae, see F.3.4.1.

Side fins:

The term side fins include window rebates, window or façade fixed elements and other building parts (such as walls), if applicable.

This method applies to (window) side fins with infinite height or to other geometrically similar shading objects.

The width of the shade cast by each right hand side fin r on the façade element k at time interval t is given by:

When the sun is in the opposite direction:

if $(\varphi_{sol;t} - \gamma_k) > 0$, then $w_{k;finr,r;t} = 0$.

Otherwise:

$$w_{k;finr,r;t} = D_{k;finr,r} \cdot \tan\left(\varphi_{sol;t} - \gamma_k\right) - L_{k;finr,r} \tag{F.5}$$

The width of the shade cast by each left hand side fin l on the façade element k at time interval t is given by:

When the sun is in the opposite direction:

if $(\varphi_{sol;t} - \gamma_k) < 0$, then $w_{k;finl,l;t} = 0$.

Otherwise:

$$w_{k;finl,l;t} = D_{k;finl,l} \cdot \tan\left(\varphi_{sol;t} - \gamma_k\right) - L_{k;finl,l} \tag{F.6}$$

where

$w_{k;finr,r;t}$	is the width of the shadow of the right hand side fin r on the façade element k at time interval t, in m;
$w_{k;finl,l;t}$	is the width of the shadow of the left hand side fin l on the façade element k at time interval t, in m;
$D_{k;finr,r}$, $D_{k;finl,l}$	are the depths of the side fins, as determined in F.3.3.1, in m;
$L_{k;finr,r}$, $L_{k;finl,l}$	are the distances to the side fins, as determined in F.3.3.1, in m;
$\alpha_{sol;t}$, γ_k	are the same angles as for the previous formulae, see F.3.4.1.

Rebate:

A rebate can be modelled as a combination of overhang and side fins.

F.3.5.1.2 Monthly calculation procedures

See Figure F.1 in F.3.3.1.

Overhangs:

This method applies to (window) overhangs with infinite length or to other geometrically similar shading objects (such as balconies).

The height of the shade cast by each overhang q on the façade element k in month m is given by:

$$h_{k;ovh;q;m} = 1 - H_k \cdot \left\{1 + \left[\begin{array}{l}\left(A_1 + B_1 \cdot c_{South} \cdot \left(\phi_w - \delta_m\right)\right) \cdot P_{1;k;ovh;q} \\ +\left(A_2 + B_2 \cdot c_{South} \cdot \left(\phi_w - \delta_m\right)\right) \cdot P_{1;k;ovh;q} \cdot P_{2;k;ovh;q}\end{array}\right]\right\} \tag{F.7a}$$

If $h_{k;ovh,q;m} < 0$: $h_{k;ovh,q;m} = 0$.

If $h_{k;\text{ovh},q;m} > H_k$: $h_{k;\text{ovh},q;m} = H_k$.

NOTE 1 The formula is based on empirical correlations using a detailed solar shading calculation method, see ISO/TR 52016-2.

with

$$P_1;k;\text{ovh};q = \frac{D_{k;\text{ovh};q}}{H_k} \text{ and } P_2k;\text{ovh};q = \frac{L_{k;\text{ovh};q}}{H_k} \quad \text{(F.7b)}$$

where

$h_{k;\text{ovh},q;m}$ is the height of the shadow of overhang q on the façade element k in month m, in m;

H_k is the height of the façade element k, as determined in F.3.3.1, in m;

$D_{k;\text{ovh},q}$ is the depth of the overhang q on the façade element k, as determined in F.3.3.1, in m;

$L_{k;\text{ovh},q}$ is the vertical distance between the edge of the façade element k and the overhang q, as determined in F.3.3.1, in m;

c_{South} is a correction factor for the Southern hemisphere:

Northern hemisphere: $c_{\text{South}} = 1$;

Southern hemisphere: $c_{\text{South}} = -1$;

δ_m is the solar declination for month m, obtained from Table 20 in 6.3.6, in degrees;

φ_{W} is the latitude of the weather station, as determined in the relevant standard under EPB module M1-13, in degrees.

Values for the correlation coefficients, A1, B1, A2 and B2, for different orientations, are given in Table A.46 (template), with informative default choice provided in Table B.46.

Side fins:

The term side fins include window rebates, window or façade fixed elements and other building parts (such as walls), if applicable.

This method applies to (window) side fins with infinite height or to other geometrically similar shading objects (such as walls).

The width of the shade cast by both side fins on the façade element k in month m is given by:

$$w_{k;fin;m} = 1 - W_k \cdot \Big\{1 + \Big[\big(A_1 + B_1 \cdot c_{South} \cdot (\phi_w - \delta_m)\big) \cdot P_{1;k;fins;s} + \big(A_2 + B_2 \cdot c_{South} \cdot (\phi_w - \delta_m)\big) \cdot P_{1;k;fins;s} \cdot P_{2;k;fins;s}\Big]\Big\} \quad \text{(F.8)}$$

If < $w_{k;\text{fin};m} < 0$: $w_{k;\text{fin};m} = 0$.

If $w_{k;\text{fin};m} > W_k$: $w_{k;\text{fin};m} = W_k$.

with

$$P_{1;k;fins;s} = \frac{D_{k;fins;s}}{W_k} \text{ and } P_{2;k;fins;s} = \frac{L_{k;fins;s}}{W_k} \quad \text{(F.9)}$$

By approximation, Table F.1 provides the width of the shade cast by each side fin separately.

Table F.1 — Width of the shade cast by each side fin

Orientation		$w_{k;\text{finr},r;m}$	$w_{k;\text{finl},l;m}$
North hemisphere	South hemisphere		
S, N	N, S	$w_{k;\text{finr},r;m} = 0{,}5\ w_{k;\text{fin};m}$	$w_{k;\text{finl},l;m} = 0{,}5\ w_{k;\text{fin};m}$
E, NE	W, SW	$w_{k;\text{finr},r;m} = w_{k;\text{fin};m}$	$wk;\text{finl},l;m = 0$
W, NW	E, SE	$wk;\text{finr},r;m = 0$	$w_{k;\text{finl},l;m} = w_{k;\text{fin};m}$
SE	NW	$w_{k;\text{finr},r;m} = 0{,}75\ w_{k;\text{fin};m}$	$w_{k;\text{finl},l;m} = 0{,}25\ w_{k;\text{fin};m}$
SW	NE	$w_{k;\text{finr},r;m} = 0{,}25\ w_{k;\text{fin};m}$	$w_{k;\text{finl},l;m} = 0{,}75\ w_{k;\text{fin};m}$

NOTE 2 These separate values are needed to enable the calculation of the effect for the combination of different shading objects (see F.3.6.2).

where

$w_{k;\text{finr},r;m}$ is the width of the shadow of the right hand side fin r on the façade element k in month m, in m;

$w_{k;\text{finl},l;m}$ is the width of the shadow of the left hand side fin l on the façade element k in month m, in m;

W_k is the width of the façade element k, as determined in F.3.3.1, in m;

$D_{k;\text{finr},r}$, $D_{k;\text{finl},l}$ are the depths of the side fins, as determined in F.3.3.1, in m;

$L_{k;\text{finr},r}$, $L_{k;\text{finl},\text{l}}$ are the distances to the side fins, as determined in F.3.3.1, in m;

c_{South}, δ_m, φ_W are the same factor and angles as for the previous formulae (overhang).

Values for the correlation coefficients, A1, B1, A2 and B2, for different orientations, are given in Table A.47 (template), with informative default choice provided in Table B.47.

Rebate:

A rebate can be modelled as a combination of overhang and side fins.

NOTE 3 Separate correlation factors have been developed for a more precise result. However, these do not provide the difference between height and width of the cast shade, which is needed to enable the calculation of the effect for the combination of different shading objects (see F.3.6.2).

F.3.5.2 Other shading objects; more detailed method

F.3.5.2.1 Hourly calculation procedures

See Figure F.2 in F.3.3.2.

Obstacles:

For each obstacle p in the segment i that matches the azimuth of the sun, $\varphi_{\text{sol};t}$, the height of the shading on the shaded object k is determined with the following formula:

$$h_{k;\text{obst},p;t} = \max\left[0; H_{\text{obst},p;i} - H_{0;k} - L_{k;\text{obst},p;i} \times \tan\left(\alpha_{\text{sol};t}\right)\right] \quad \text{(F.10)}$$

where, for each shaded surface k and each time interval t

$h_{k;obst;p;t}$	is the height of the shade from the obstacle *p* in segment *i* on the shaded surface *k*; if tilted: vertical projection, in m;
$H_{0;k}$	is the base height of the shaded surface *k*, as determined in F.3.3.2, in m;
$H_{obst,p;i}$	is the height of the shading obstacle *p* in segment *i*, as determined in F.3.3.2, in m;
$L_{k;obst,p;i}$	is the horizontal distance between the shaded surface *k* and the shading obstacle *p* in segment *i*, as determined in F.3.3.2, in m;
$\alpha_{sol;t}$	is the solar altitude angle, as determined in the relevant standard under EPB module M1-13, in degrees.

If the vertical cross section of the shaded object is not constant, the vertical cross section shall be assessed in the middle of the object.

Overhangs:

For each overhang *q* in the segment that matches the azimuth of the sun, $\varphi_{sol;t}$, the height of the shading on the shaded object *k* is determined with the following formula:

$$h_{k;ovh;q;t} = \max\left[0; H_k + H_{0;k} - H_{ovh;q;i} + L_{k;ovh;q;i} \times \tan\left(\alpha_{sol;t}\right)\right] \quad \text{(F.11)}$$

where, for each shaded surface *k* and each time interval *t*

$h_{k;ovh,q;t}$	is the height of the shade from the overhang *q* on the shaded surface *k*; if tilted: vertical projection, in m;
$H_{ovh,q;i}$	is the lowest height of the overhang *q* in segment *i*, as determined in F.3.3.2, in m;
$L_{k;ovh,q;i}$	is the horizontal distance between the shaded surface *k* and the shading overhang *q* in segment *i*, as determined in F.3.3.2, in m;

and where the other variables are the same as for the previous formula.

F.3.5.2.2 Monthly calculation procedures

See Figure F.2 in F.3.3.2.

The calculation procedure is similar as for the hourly method, but with fixed segments, with a monthly mean solar altitude and a weighting factor for each sector that depend on the latitude, orientation and period (month or season).

Obstacles:

For each obstacle *p* in the segment *i* (*i* = 1, 2, 3, 4) the height of the shading on the shaded object *k* is determined with the following formula:

$$h_{k;obst;p;m} = \sum_{i=1}^{4}\left(w_{obst;m;i} \cdot h_{k;obst;p;m;i}\right) \quad \text{(F.12)}$$

with

$$h_{k;obst,p;m;i} = \max\left[0; H_{obst,p;i} - H_{0;k} - L_{k;obst,p;i} \cdot \tan\left(\alpha_{sol;m;i}\right)\right] \quad \text{(F.13)}$$

where, for each shaded surface *k* and each month *m*

$h_{\mathrm{k;obst;}p;m}$ is the height of the shade from the obstacle p on the shaded surface k; if tilted: vertical projection, in m;

$w_{\mathrm{obst;}m;i}$ is the weighting factor for segment i, for month m, as a function of the latitude of the location and the orientation of the shaded object, obtained from Table A.48 (normative template) with informative default values in Table B.48; the sum of the weighting factors over the 4 segments shall be 1 or 0;

$h_{\mathrm{k;obst;}p;m;i}$ is the height of the shade from the obstacle p in segment i on the shaded surface k; if tilted: vertical projection, in m;

$H_{0;k}$ is the base height of the shaded surface k, as determined in F.3.3.2, in m;

$H_{\mathrm{obst,}p;i}$ is the height of the shading obstacle p in segment i, as determined in F.3.3.2, in m;

$L_{k;\mathrm{obst,}p;i}$ is the horizontal distance between the shaded surface k and the shading obstacle p in segment i, as determined in F.3.3.2, in m;

$\alpha_{\mathrm{sol;}m;i}$ is the monthly mean solar altitude angle for month m, as a function of the latitude of the location and the orientation of the shaded object and segment number i, obtained from Table A.48 (normative template) with informative default values in Table B.48, in degrees.

NOTE Typically, the monthly values will be chosen equal for a number of months in a season.

Overhangs:

For each overhang q in the segment i (i = 1, 2, 3, 4) the height of the shading on the shaded object k is determined with the following formula:

$$h_{k;ovh;p;m} = \sum_{i=1}^{4}\left(w_{\mathrm{obst};m;i} \cdot h_{k;ovh;p;m;i}\right) \quad \text{(F.14)}$$

with

$$h_{k;\mathrm{ovh};q;m;i} = \max\left[0; H_k + H_{0;k} - H_{\mathrm{ovh};q;i} + L_{k;\mathrm{ovh};q;i} \cdot \tan\left(\alpha_{\mathrm{sol};m;i}\right)\right] \quad \text{(F.15)}$$

where, for each shaded surface k and each time interval t

$h_{\mathrm{k;ovh;}p;m}$ is the height of the shade from the overhang q on the shaded surface k; if tilted: vertical projection, in m;

$h_{\mathrm{k;ovh;}p;m;i}$ is the height of the shade from the overhang q in segment i on the shaded surface k; if tilted: vertical projection, in m;

$H_{\mathrm{ovh,}q;i}$ is the height of the overhang p in segment i, as determined in F.3.3.2, in m;

$L_{k;\mathrm{ovh,}q;i}$ is the horizontal distance between the shaded surface k and the overhang q in segment i, as determined in F.3.3.2, in m;

and where the other variables are the same as for the previous formula.

F.3.6 Calculation of the shading reduction factor for direct solar irradiation

F.3.6.1 Hourly calculation procedures

The height of the shade on the shaded surface k from all obstacles p, $h_{k;obst;t}$ is the largest of all, with as maximum value the height of the shaded object:

$$h_{k;obst;t} = \min\left(H_k ; \max_p\left(h_{k;obst,p;t}\right)\right) \quad (F.16)$$

The height of the shade on the shaded surface k from all overhangs q, $h_{k;ovh;t}$ is the largest of all, with as maximum value the height of the shaded object:

$$h_{k;ovh;t} = \min\left(H_k ; \max_q\left(h_{k;ovh,q;t}\right)\right) \quad (F.17)$$

The height of the remaining sunlit area on the shaded surface k from all obstacles p and all overhangs q is equal to:

$$h_{k;sun;t} = \max\left(0; H_k - \left(h_{k;obst;t} + h_{k;ovh;t}\right)\right) \quad (F.18)$$

The width of the shade on the shaded surface k from all right side fins r, $w_{k;finr;t}$ is the largest of all, with as maximum value the width of the shaded object:

$$w_{k;finr;t} = \min\left(W_k ; \max_r\left(w_{k;finr,r;t}\right)\right) \quad (F.19)$$

The width of the shade on the shaded surface k from all left side fins l, $h_{k;finl;t}$ is the largest of all, with as maximum value the width of the shaded object:

$$w_{k;finl;t} = \min(W_k ; \max_l(w_{k;finl,l;t})) \quad (F.20)$$

The width of the remaining sunlit area on the shaded surface k from all right hand side fins r and all left hand side fins l is equal to:

$$w_{k;sun;t} = \max\left(0; W_k - \left(h_{k;finr;t} + h_{k;finl;t}\right)\right) \quad (F.21)$$

Finally, the direct shading reduction factor of the shaded surface for obstacles, overhangs and side fins on the shaded surface k at time interval t is given by the following formula:

$$F_{sh;dir;k;t} = \frac{h_{k;sun;t} \cdot w_{k;sun;t}}{H_k \cdot W_k} \quad (F.22)$$

where

$F_{sh;dir;k;t}$ is the dimensionless direct shading reduction factor of the shaded surface k for all shading objects, at time interval t.

H_k is the (vertically projected) height of the shaded surface, as determined in F.3.3.1 or in F.3.3.2, in m;

W_k is the width of the shaded surface, as determined in F.3.3.1 or in F.3.3.2, in m.

NOTE In case of a titled shaded surface ($H_k W_k$) cannot be substituted by the area of the object.

F.3.6.2 Monthly calculation procedures

The same formulae as for the hourly calculation procedures, with subscript t (for each hourly time interval) replaced by m (for each month).

F.4 Method 2: Shading of direct and diffuse radiation

In this method shading by diffuse solar radiation is also taken into account.

The diffuse shading factor, $F_{sh;dif}$, is determined in addition to the direct shading reduction factor, $F_{sh;dir}$.

For this method sky view factors have to be calculated. This can be simplified by dividing the skyline in a number of segments, $n_{sh;segm}$, as in step 1 of F.2.2.2, and calculate the sky view factors for each segment separately assuming an equal skyline height over the segment.

First of all the total direct (direct + circumsolar-diffuse), sky-diffuse, horizon-diffuse and with all of them the reflected-diffuse radiation will be calculated according to the relevant standard under EPB module M1-13.

From this information the following is calculated:

a) Sky-diffuse irradiance given by the view factor between the building element and the sky, taking into account the obstacles. This view factor will be multiplied by the sky-diffuse solar irradiance;.

b) Horizon-diffuse irradiance given by the view factor between the building element and the horizon elevation given by the method for non-isotropic diffuse irradiance according to the relevant standard under EPB module M1-13. This view factor will be multiplied by the horizon-diffuse solar irradiance.

c) The rest of the view factor to 1 will be considered to increment to the reflected irradiance.

NOTE The full set of formulae of this method are provided in ISO/TR 52016-2[1] . As discussed in the Technical Report, the detailed method is only more accurate if the total solar irradiation at the surface of the obstacles and the value of the solar reflectivity at these surfaces (which can even be specular, in case of glazed facades) are taken into consideration.

Annex G
(normative)

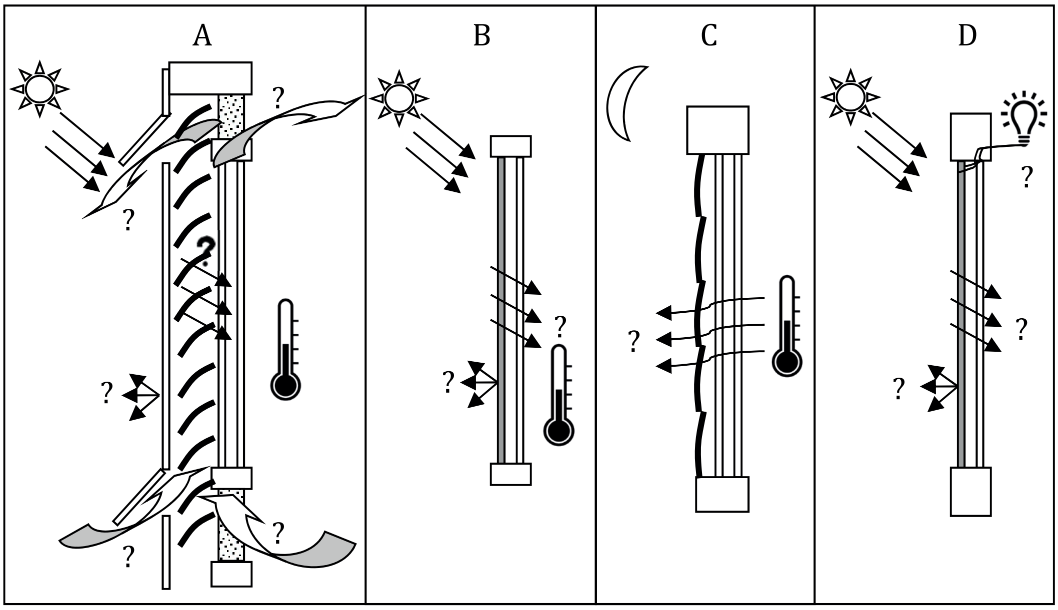
Dynamic transparent building elements

G.1 General

This annex provides the procedures for the energy, load and internal temperature calculations in case of dynamic transparent building elements.

Dynamic transparent building elements are elements with thermal and/or solar and/or visual properties that vary with boundary conditions, either passively or due to an active control.

NOTE Examples are given in Figure G.1.



Key

A example of façade element with movable blinds and vents

B example of switchable glazing

C example of thermally insulating shutters

D example of PV integrated glazing

Figure G.1 — Examples of dynamic transparent elements

Where daylight transmission is involved, the visual transmittance is an input for the relevant standards dealing with lighting and lighting systems under EPB module M9.

Where ventilation through the dynamic building element is involved, the associated supply or exhaust air flow is linked to the relevant standards dealing with ventilation and ventilation systems under EPB module M5; the associated additional heat supply or heat removal by air circulation or ventilation through the dynamic building element is taken into account in the effective *U*-value and *g*-value.

G.2 Procedures

G.2.1 Dynamic properties

The main properties of the dynamic building element k that are relevant for the calculation, with different values for each state i, are:

— $U_{\text{dyn};k;I}$, the thermal transmittance, in W/(m^2·K);

— $g_{\text{dyn};k;I}$, the total solar energy transmittance;

— $\tau_{\text{sol; dyn};k;I}$, the solar transmittance;

— $\tau_{\text{vis; dyn};k;I}$, the visual transmittance.

These properties can vary passively or be controlled actively, as a function of specific boundary conditions.

NOTE 1 Examples of passive variations: naturally vented cavity; thermochrome glazing. Example of active control: openable vents; mechanical air circulation; tilt angle of Venetian blinds; movable blinds or shutters (up/down).

The motivation(s) for the control can be one of the following or a combination of:

— thermal insulation to decrease transmission heat losses;

— glare prevention and/or increased visual comfort;

— utilization of daylight for better visual comfort and/or decreased artificial light;

— solar protection to avoid overheating or to diminish the need for space cooling.

The properties at each state i and the associated boundary conditions shall be provided in a tabulated form.

In case of gradually varying properties a number of representative discrete states shall be chosen.

NOTE 2 The chosen number of discrete states depends on the balance between the overall accuracy of the calculations on the one hand and the uncertainty in the physical process and uncertainty in the use in practice on the other. The extreme is to use only one discrete state for the whole year, which is for instance common practice for the total solar energy transmittance in case of a window with Venetian blinds down, where the natural air circulation along the blinds is actually a function of the temperatures of the blinds and adjacent glazing (in turn: function of solar irradiation), environment temperature and e.g. wind.

These properties at each state i shall be obtained from ISO 10077-1, ISO 15099, ISO 10292, ISO 9050 or ISO 52022-3 (or see Subjects 1–5 in Table C.1).

The type of boundary conditions depend on the type of product and the type of control. Typical boundary conditions are:

— season;

— time of sunrise and sunset;

— occupancy period;

— indoor operating temperature;

— external air temperatures;

— wind speed and/or direction;

— intensity of solar irradiation at the transparent element;

— intensity of daylight illuminance at the transparent element;

— solar angle (altitude and azimuth).

These functions can be simple lower or upper limits or include for instance a hysteresis, time delay or minimum duration.

NOTE 3 E.g. in case of active control to avoid oscillation (e.g. control of blinds up/down), or in case of passive product: as intrinsic property (e.g. thermochrome glazing).

In many cases the functions are a combination of two or more boundary conditions.

The type of control can be manual, motorized operation with manual control, or motorized operation with automatic control.

More complex functions, combinations of different boundary conditions are also an option, with e.g. predictive algorithms and/or combined with control of HVAC and lighting.

NOTE 4 See e.g. 5.2 and informative Annex D, *The impact of innovative integrated BACS functions (examples)* of EN 15232-1 (see M10-1) N3).

For integrated photovoltaic modules there may be an interaction between the electric output and the thermal or optical properties.

G.2.2 Effect on energy, load or temperature calculation

G.2.2.1 Hourly calculation method

G.2.2.1.1 General procedure

For the hourly calculation method of the energy need for heating and cooling, heating or cooling load or internal temperature, the modes of operation are derived directly from the boundary conditions for each hour.

For glare prevention the hourly time interval is too large, the assumed control strategy should avoid a too optimistic scenario.

G.2.2.1.2 Window with movable shutter or solar shading device

In line with the principles on building automation and control described in the relevant standard under EPB module M10-1, the following motivations for the control of movable shutters and solar shading devices (blinds) are distinguished:

— Motivation for control of shutters: thermal insulation and/or burglary protection.

— Motivations for blind control: solar protection to avoid overheating and to avoid glaring.

Four levels of control are distinguished:

0. Manual operation: energy saving and comfort depends only on the user behaviour.

1. Motorized operation with manual control: Mostly used only for easiest manual (motor supported) operation, energy saving and comfort depends only on the user behaviour.

2. Motorized operation with automatic control: Automatic controlled operation to reduce energy

3. Combined light/blind/HVAC control: To optimize energy use for HVAC, blind and lighting for occupied and non-occupied spaces.

N3) National footnote: The correct title of Annex D of DIN EN 15232-1:2017 is: “Examples of how to use the BAC function list of EN ISO 16484-3 to describe functions from this European Standard.”

Depending on the level of control (levels 0 to 3 above), the operation assumed in the calculations depends on the climatic conditions, conditions of use and assumed (standard) occupancy behaviour. The conditions of use are specified for each space category in the relevant standard under EPB module M1-6.

The shutters are primarily operated during night time, when there is no need for daylight and view through. For shutters the typical conditions for the application in this document are:

— time of sunrise and sunset;

— occupancy period;

— external air temperatures.

The solar shading devices are primarily operated during hours of high intensity of solar irradiance. For solar blinds the typical conditions for the application in this document are:

— season;

— occupancy period;

— indoor operating temperature;

— intensity of solar irradiation at the transparent element.

In case of level 3 control the conditions for operation are more complex.

For movable shutters default choices are given in Table A.23 (normative template), with informative values in Table B.23.

For movable solar shading devices default choices are given in Table A.24 (normative template), with informative values in Table B.24.

G.2.2.2 Monthly calculation method

G.2.2.2.1 General procedure

For the monthly calculation method the modes of operation cannot be derived directly from the boundary conditions, except when the variation in properties is on a monthly or seasonal basis.

Method A:

Step 1:

If the relevant assumed boundary conditions that determine the states of the transparent element are a priori known, for instance occupancy, external temperature or intensity of solar irradiation and daylight illuminance, as described in G.2.2.1 for the hourly calculation method, a first order approximation is given by pre-calculating the weighted average property, obtained by taking the sum over all time intervals (hours) Δt_{h} of the month:

$$U_{\mathrm{dyn};k;m} = \frac{\sum_t \left(U_{\mathrm{dyn};k;i} \cdot \Delta\theta_{\mathrm{int\text{-}e};t}\right)}{\sum_t \left(\Delta\theta_{\mathrm{int\text{-}e};t}\right)} \tag{G.1}$$

$$g_{\mathrm{dyn};k;m} = \frac{\sum_t \left(g_{\mathrm{dyn};k;m;\mathrm{mn}} \cdot I_{\mathrm{sol};t}\right)}{\sum_t I_{\mathrm{sol};t}} \tag{G.2}$$

$$\tau_{\mathrm{sol;dyn};k;m} = \frac{\sum_t \left(\tau_{\mathrm{sol;dyn};k;m;\mathrm{mn}} \cdot I_{\mathrm{sol};t}\right)}{\sum_t I_{\mathrm{sol};t}} \tag{G.3}$$

$$\tau_{\text{vis;dyn};k;m} = \frac{\sum_t \left(\tau_{\text{vis;dyn};k;m;\text{mn}} \cdot E_{\text{v};t}\right)}{\sum_t E_{\text{v};t}} \tag{G.4}$$

where

$U_{\text{m;mn}}$ is the monthly mean U-value with different values U_i at different states i, in W/(m^2·K);

$g_{\text{m;mn}}$ is the monthly mean g-value with different values g_i at different states i;

$\tau_{\text{sol m;mn}}$ is the monthly mean value of the property τ_{sol}, with different values $\tau_{\text{sol;i}}$ at different states i;

$\tau_{\text{vis m;mn}}$ is the monthly mean value of τ_{vis}, with different values $\tau_{\text{vis};i}$ at different states i;

$\Delta\theta_{\text{int-e}}$ is the approximation for the indoor-outdoor temperature difference, in K; in this temperature difference the indoor temperature is the temperature set-point, where feasible and possible corrected for intermittency, either as one monthly time average value or with a different value for the intermittency period (see 6.5.9);

NOTE 1 The decreased set-point during intermittency is usually not a good approximation, because that lower limit can almost never be reached.

$I_{\text{sol;tot};t}$ is the total (direct + diffuse) solar irradiance on the transparent element, in W/m^2;

$E_{\text{v};t}$ is the global daylight illuminance on the transparent element, in Lx;

Δt_{h} is the time interval, in h;

i is an index for the different states that can be different per hour, depending on one or more boundary conditions, as specified in G.2.1.

Both the total solar irradiance and the global daylight illuminance depend on the orientation and tilt angle of the transparent element and on external obstacles (shading).

Step 2:

As a next step, correction factors may be added, taking into account dynamic effects due to inertia of the building and/or due to dynamic interactions with other physical processes. These correction factors can be derived by comparing results of hourly calculations according to G.2.1, from a series of representative cases.

NOTE 2 Due to differences in climate, operation and building use, these cases and thus the correction factors are typically determined at national level.

For movable shutters and movable solar shading devices default choices are given in Table A.44 (normative template), with informative values in Table B.44.

Method B:

If the relevant assumed boundary conditions that determine the states of the transparent element are not a priori known, for instance because they depend on the energy need for heating or cooling, the monthly method is not suited.

In principle, an approximation can be obtained by:

Step 1:

Choosing one of the states for the value for the property.

Step 2:

Similar to step 2 of Method A.

G.2.2.2.2 Window with movable shutter or solar shading device

If the window is combined with a shutter, the monthly mean effective *U*-value of window *wi*, $U_{w;m}$, for month *m*, is given by

$$U_{w;m} = \left(1 - f_{sht;with}\right) \cdot U_w + f_{sht;with} \cdot U_{w;sht} \qquad (G.5)$$

where

$U_{w;m}$ is the monthly mean effective total solar energy transmittance of the glazing;

U_w is the thermal transmittance of the window, when the shutter is not in use, obtained from ISO 13789, in W/(m²·K);

$U_{w;sht}$ is the thermal transmittance of the combination of window and shutter, when the shutter is in use, obtained from ISO 13789, in W/(m²·K);

$f_{sht;with}$ is the weighted (climate- and season-dependent) fraction of the time with the shutter in use, e.g. as a function of hour of the day and night time duration, taking into account the average indoor-outdoor temperature difference (including effect of night time temperature set back), obtained from Table A.44 (normative template), with informative default values given in Table B.44.

If the glazing is combined with a movable shading device, the monthly mean effective total solar energy transmittance of the glazed part of window *wi*, $g_{gl;m}$, for month *m*, is given by

$$g_{gl;wi;m} = \left(1 - f_{sh;with}\right) \cdot g_{gl;wi} + f_{sh;with} \cdot g_{gl;sh;wi} \qquad (G.6)$$

where

$g_{gl;wi;m}$ is the monthly mean effective total solar energy transmittance of the glazing;

$g_{gl;wi}$ is the total solar energy transmittance of the glazing, when the solar shading is not in use, obtained in accordance with ISO 9050 (or see Subject 3 in Table C.1);

$g_{gl;sh;wi}$ is the total solar energy transmittance of the combination of glazing and shading, when the solar shading is in use, obtained in accordance with ISO 52022-3;

$f_{sh;with}$ is the weighted fraction of the time with the solar shading in use, e.g. as a function of the intensity of incident solar radiation (thus climate-, season- and orientation-dependent), obtained from Table A.44 (normative template), with informative default values given in Table B.44.

NOTE This can also be valid for awnings.

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[5] CEN/TS 16628, *Energy Performance of Buildings – Basic principles for the set of EPB standards*

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[10] ISO/TR 52019-2, *Energy performance of buildings — Hygrothermal performance of building components and building elements — Part 2: Explanation and justification*

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[17] ISO 9488, *Solar energy — Vocabulary*

N4) National footnote: Obtainable from: Beuth Verlag GmbH, 10772 Berlin (www.beuth.de/regelwerke/international).