
**Energy performance of buildings —
Energy requirements and efficiencies
of heating, cooling and domestic hot
water (DHW) distribution systems —**

**Part 1:
Calculation procedures**

*Performance énergétique des bâtiments — Besoins énergétiques
et rendements des systèmes de distribution d'eau chaude sanitaire,
chauffage et refroidissement —*

Partie 1: Modes opératoires de calcul



STANDARDSISO.COM : Click to view the full PDF of ISO 52032-1:2022



COPYRIGHT PROTECTED DOCUMENT

© ISO 2022

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Contents

Page

Foreword	iv
Introduction	v
1 Scope	1
2 Normative references	1
3 Terms and definitions	1
4 Symbols, subscripts and abbreviated terms	2
4.1 Symbols	2
4.2 Subscripts	3
4.3 Abbreviated terms	3
5 General description of the method — Output of the method	3
6 Calculation of heat losses and auxiliary energy of distribution systems	4
6.1 Output data	4
6.2 Calculation time intervals	5
6.3 Input data	5
6.3.1 Product technical data (quantitative)	5
6.3.2 Configuration and system design data	5
6.3.3 Operating or boundary conditions	6
6.3.4 Constants and physical data	7
6.3.5 Input data from Annex A (with default choices in Annex B)	7
6.4 Calculation procedure	8
6.4.1 Applicable time interval	8
6.4.2 Operating conditions calculation	8
6.4.3 Heat loss calculation	8
6.4.4 Recoverable energy	11
6.4.5 Auxiliary energy calculation	11
6.4.6 Auxiliary energy for ribbon heater	14
6.4.7 Recoverable and recovered auxiliary energy	14
6.4.8 Lengths of pipes	14
7 Quality control	18
8 Conformance check	18
Annex A (normative) Input and method selection data sheet — Template	19
Annex B (informative) Input and method selection data sheet — Default choices	26
Bibliography	34

Foreword

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

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

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

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

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

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

A list of all parts in the ISO 52032 series can be found on the ISO website.

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

Introduction

This document belongs to the family of International Standards aimed at the international harmonization of the methodology for assessing the energy performance of buildings. Throughout, this group of standards 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. For the correct use of this document a template is given in [Annex A](#) to specify these choices. Default choices are provided in [Annex B](#).

The main target groups of this document are all the users of the set of EPB set of standards (e.g. architects, engineers, regulators).

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 ISO/TR 52032-2 ^[12]¹⁾ and in CEN/TR 15316-6-3^[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 1 In ISO/TR 52000-2 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 2 The modules represent EPB standards, although one EPB standard can cover more than one module and one module can be covered by more than one EPB standard, e.g. a simplified and a detailed method respectively. See also [Clause 2](#) and [Tables A.1](#) and [B.1](#).

1) Under preparation. Stage at the time of publication: ISO/AWI TR 52032-2.

Table 1 — Position of this document within the modular structure of the set of EPB standards

Overarching		Building (as such)		Technical building systems												
	Descriptions	M1	sub1	Descriptions	M2	sub1	Descriptions	Heating	Cooling	Ventila- tion	Humidifica- tion	Dehumidifica- tion	Domes- tic hot water (DHW)	Light- ing	Building automa- tion and control	Electric- ity pro- duction
1	General		1	General	1	General	General	M3	M4	M5	M6	M7	M8	M9	M10	M11
2	Common terms and definitions; symbols, units and subscripts		2	Building energy needs	2	Needs										
3	Applica- tions		3	(Free) Indoor conditions without systems	3	Maximum load and power										
4	Ways to express energy performance		4	Ways to express energy performance	4	Ways to express energy performance										
5	Building functions and building boundaries		5	Heat transfer by transmission	5	Emission and control										
6	Building occupancy and operating conditions		6	Heat transfer by infiltration and ventilation	6	Distribu- tion and control	ISO 52032-1 (this document)	ISO 52032-1 (this document)					ISO 52032-1 (this document)			
7	Aggre- gation of energy services and energy carriers		7	Internal heat gains	7	Storage and control										

Table 1 (continued)

Overarching		Building (as such)		Technical building systems											
	Descriptions	M1	sub1	M2	sub1	Descriptions	M3	M4	M5	M6	M7	M8	M9	M10	Electricity production
8	Building partitioning		8	Solar heat gains	8	Generation									
					8-1	Combustion boilers									
					8-2	Heat pumps									
					8-3	Thermal solar photovoltaics									
					8-4	On-site co-generation									
					8-5	District heating and cooling									
					8-6	Direct electrical heater									
					8-7	Wind turbines									
					8-8	Radiant heating, stoves									
9	Calculated energy performance		9	Building dynamics (thermal mass)	9	Load dispatching and operating conditions									
10	Measured energy performance		10	Measured energy performance	10	Measured energy performance									
11	Inspection		11	Inspection	11	Inspection									

Table 1 (continued)

Overarching		Building (as such)		Technical building systems											
	Descriptions		Descriptions		Descriptions	Heating	Cooling	Ventilation	Humidification	Dehumidification	Domestic hot water (DHW)	Lighting	Building automation and control	Electricity production	
sub1		M1	sub1	M2	sub1	M3	M4	M5	M6	M7	M8	M9	M10	M11	
12	Ways to express indoor comfort		12	-	12	BMS									
13	External environment conditions														
14	Economic calculation	15459-1													
NOTE The shaded modules are not applicable															

Energy performance of buildings — Energy requirements and efficiencies of heating, cooling and domestic hot water (DHW) distribution systems —

Part 1: Calculation procedures

1 Scope

This document specifies the energy performance calculation of water-based distribution systems for space heating, space cooling and domestic hot water (DHW).

This document is applicable to the heat flux from the distributed water to the space and the auxiliary energy of the related pumps.

The heat flux and the auxiliary energy for pumps can be calculated for any time interval (hour, month and year). The input and output data are mean values of the time interval.

Instead of calculating the energy performance of water-based distribution systems, it is also possible to use measurements as long as they follow the time intervals of the whole performance calculation or can be divided into those time intervals.

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 performance of buildings and building components — Physical quantities and definitions*

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

ISO 52031, *Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Space emission systems (heating and cooling)*

3 Terms and definitions

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

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

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

3.1

tapping profile

domestic hot water (DHW) drawn off over time

3.2

setback mode

operation mode for pumps at the end of scheduled usage time

3.3

boost mode

operation mode for pumps before the beginning of scheduled usage time

3.4

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/EC 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.]

4 Symbols, subscripts and abbreviated terms

4.1 Symbols

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

Symbol	Description	Unit
<i>b</i>	factor for pump design selection	-
<i>B</i>	width	m
<i>c</i>	specific heat	Wh/(kg·K)
<i>C</i>	constant	-
<i>d</i>	diameter	m
<i>f</i>	resistance ratio	-
<i>F</i>	force	N
<i>h</i>	total surface coefficient of heat transfer	W/(m·K)
<i>H</i>	height	m
<i>L</i>	length	m
<i>m</i>	mass	kg
<i>n</i>	number	-
<i>p</i>	differential pressure	kPa
<i>P</i>	power	N
<i>q</i>	heat flowrate	W/K
<i>Q</i>	heat flow	kWh
<i>R</i>	pressure loss per m	kPa/m
<i>t</i>	time	h
<i>v</i>	flowrate	m ³ /h
<i>V</i>	volume	m ³
<i>W</i>	energy demand	kWh
<i>z</i>	depth	m
<i>β</i>	mean part load in a time interval	-
<i>ε</i>	expenditure energy factor	-
<i>θ</i>	temperature	°C

Symbol	Description	Unit
λ	thermal conductivity	W/(m·K)
ρ	density	kg/m ³
ψ	linear thermal transmittance	W/(m·K)
V_{Tap}	tapping profile	24 [1/h] – per day

4.2 Subscripts

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

a	outer	add	additional	ah	ambient heating
amb	ambient	an	regular mode	aux	auxiliary
avg	average	atap	after tapping	boost	boost heating
		C	cooling	ci	calculation interval
comp	components	corr	correction	cs	conditioned space
D	insulation	des	design	dis	distribution
e	efficiency	el	existing	em	embedded
equi	equivalent	fl	floor	H	heating
HB	hydraulic balance	HC	heating/cooling	HCW	heating/cooling/domestic hot water (DHW)
hydr	hydraulic			i	variable
		in	input	ir	inner
j	zone index	ls	loss	mean	mean
nom	nominal heat loss	non	non-insulated	op	operation
out	output	p	pipe	pmp	pump
P1	pump control system #1	P2	pump control system #2	rbl	recoverable
ref	reference	rib	ribbon	rvd	recovered
setb	setback mode	stub	open circuited stubs	w	water
				W	DHW

4.3 Abbreviated terms

DHW	domestic hot water (system)
-----	-----------------------------

5 General description of the method — Output of the method

This method covers the calculation of:

- thermal loss of the distribution system for space heating, space cooling and domestic hot water (DHW) in the zone;
- recoverable thermal loss for space heating, space cooling and DHW in the zone;
- auxiliary energy demand of distribution systems;
- recoverable auxiliary energy in the zone for space heating, space cooling and DHW in the zone;
- recovered auxiliary energy in the fluid in the zone for space heating, space cooling and DHW in the zone.

The time interval of the output can be according to the time interval of the input values:

- hourly;
- monthly;
- yearly.

All input and output values are mean values in the corresponding time interval. Because of summarized time intervals with the same boundary conditions and no dynamic effect being taken into account, the bin-method is also valid.

6 Calculation of heat losses and auxiliary energy of distribution systems

6.1 Output data

The output data of this method are listed in [Table 2](#).

Table 2 — Output data of this method

Description	Symbol	Unit	Validity interval ^a	Intended destination module	Varying ^b
Thermal loss of the distribution system for heating in the zone	$Q_{H,dis,ls}$	kWh	0 to ∞	M3-1	Yes
Thermal loss of the distribution system for cooling in the zone	$Q_{C,dis,ls}$	kWh	0 to ∞	M4-1	Yes
Thermal loss of the distribution system for DHW in the zone	$Q_{W,dis,ls}$	kWh	0 to ∞	M3-1	Yes
Recoverable thermal loss of the distribution system for heating in the zone	$Q_{H,dis,rbl}$	kWh	0 to ∞	M3-1	Yes
Recoverable thermal loss of the distribution system for cooling in the zone	$Q_{C,dis,rbl}$	kWh	0 to ∞	M4-1	Yes
Recoverable thermal loss of the distribution system for DHW in the zone	$Q_{W,dis,rbl}$	kWh	0 to ∞	M3-1	Yes
Auxiliary energy for distribution system heating in the zone	$W_{H,dis}$	kWh	0 to ∞	M3-1	Yes
Auxiliary energy for distribution system cooling in the zone	$W_{C,dis}$	kWh	0 to ∞	M4-1	Yes
Auxiliary energy for distribution system DHW in the zone	$W_{W,dis}$	kWh	0 to ∞	M3-1	Yes
Recoverable auxiliary energy for distribution system heating in the zone	$Q_{H,dis,rbl}$	kWh	0 to ∞	M3-1	Yes
Recoverable auxiliary energy for distribution system cooling in the zone	$Q_{C,dis,rbl}$	kWh	0 to ∞	M4-1	Yes
Recoverable auxiliary energy for distribution system DHW in the zone	$Q_{W,dis,rbl}$	kWh	0 to ∞	M3-1	Yes
Recovered auxiliary energy for distribution system heating in the zone	$Q_{H,dis,rvd}$	kWh	0 to ∞	M3-1	Yes
Recovered auxiliary energy for distribution system cooling in the zone	$Q_{C,dis,rvd}$	kWh	0 to ∞	M4-1	Yes

^a Practical range, informative.

^b "Varying": value can vary over time; different values per time interval, e.g. hourly values or monthly values (not constant values over the year).

Table 2 (continued)

Description	Symbol	Unit	Validity interval ^a	Intended destination module	Varying ^b
Recovered auxiliary energy for distribution system DHW in the zone	$Q_{W,dis,rvd}$	kWh	0 to ∞	M3-1	Yes
^a Practical range, informative.					
^b "Varying": value can vary over time; different values per time interval, e.g. hourly values or monthly values (not constant values over the year).					

6.2 Calculation time intervals

The methods described in [Clause 6](#) are suitable for the following calculation time intervals:

- hourly;
- monthly;
- yearly.

For this method, the output time interval is the same as the input time-interval. This method does not take into account any dynamic effect.

6.3 Input data

6.3.1 Product technical data (quantitative)

Table 3 — Product technical input data list

Characteristics	Symbol	Catalogue unit	Computed unit	Validity interval ^a	Ref.	Varying ^b
Energy efficiency index	EEI		-	0 to 1		YES
^a Practical range, informative.						
^b "Varying": value can vary over time; different values per time interval, e.g. hourly values or monthly values (not constant values over the year).						

6.3.2 Configuration and system design data

6.3.2.1 Process design

The input data of the process design are listed in [Table 4](#).

Table 4 — Process design input data list

Process design		
tapping profile	V_{tap}	24 · [l/h]
temperature difference between hot water tapping temperature to the return temperature in a circulation loop system (design value)	$\Delta\theta W$	°C
number of operations of circulation pump	n_{nom}	1/d
average hot water temperature in circulation system without operation	$\vartheta_{W,avg}$	°C
resistance ratio of components in the piping system	f_{comp}	—
pressure loss per length	$R_{HCW,max}$	kPa/m
pressure losses of additional resistances	$\Delta R_{HCW,add}$	kPa
length of pipes	L	m

Table 4 (continued)

Process design		
equivalent length of pipes (e.g. valves, hangers)	L_{equi}	m

6.3.2.2 Controls

This identifier (see [Table 5](#)) indicates how the pump is controlled.

Table 5 — Identifiers for pump control

Identifier	Code	Meaning
HEAT_DISTR_CTRL_PMP	0	Uncontrolled
HEAT_DISTR_CTRL_PMP	1	On-off mode
HEAT_DISTR_CTRL_PMP	2	Multi-stage-control
HEAT_DISTR_CTRL_PMP	3	Variable speed control based on Δp -constant
HEAT_DISTR_CTRL_PMP	4	Variable speed control based on Δp -variable

In this document a distinction is only made between codes 0, 3 and 4 because codes 1 and 2 relate to the energy demand and not to the type of operation.

This identifier (see [Table 6](#)) indicates how the pump is operating in intermittent control of emission and/or distribution.

Table 6 — Identifiers for pump control (intermittent)

Identifier	Code	Meaning
HEAT_DISTR_CTRL	0	No automatic control
HEAT_DISTR_CTRL	1	Fixed time program
HEAT_DISTR_CTRL	2	control with optimum start/stop
HEAT_DISTR_CTRL	3	Control with demand evaluation

In this document a distinction is only made between codes 0, 2 and 3. Code 1 relates to the energy demand.

The values correspond to those in ISO 52031.

The identifier for pump selection in the design process (see [Table 7](#)) takes into account whether the pump is selected with its working point at the design point or not. Different from design point is also used for existing pumps.

Table 7 — Identifiers for pump selection

Identifier	Code	Meaning
PUMP_DISTR_SEL	1	When selection is at design point
PUMP_DISTR_SEL	2	When selection is different from design point

6.3.3 Operating or boundary conditions

Required operating condition data for this calculation procedure are listed in [Table 8](#).

Table 8 — Operating condition data list

Name	Symbol	Unit	Range ^a	Origin module	Varying ^b
Operating conditions					
Input temperature of the heating circuit	$\vartheta_{H,in}$	°C	0 to 110	M3-5	Yes
Output temperature of the heating circuit	$\vartheta_{H,out}$	°C	0 to 110	M3-5	Yes
Flowrate in the heating circuit	v_H	m ³ /h	0 to ∞		Yes
Mean part load of heating circuit	$\beta_{H,dis}$	—	0 to 1		Yes
Input temperature of the cooling circuit	$\vartheta_{C,in}$	°C	0 to 110	M4-5	Yes
Output temperature of the cooling circuit	$\vartheta_{C,out}$	°C	0 to 110	M4-5	Yes
Flowrate in the cooling circuit	v_C	m ³ /h	0 to ∞		Yes
Mean part load of cooling circuit	$\beta_{C,dis}$	—	0 to 1		Yes
Temperature of DHW	ϑ_W	°C	30 to 70	M8-1	Yes
Temperature difference between hot water tapping temperature to the return temperature in a circulation loop system	$\Delta\vartheta_W$	°C	1 to 20		Yes
Flowrate in the DHW circulation system	v_W	m ³ /h	0 to ∞		Yes
Calculation interval	t_{ci}	h	1 to 8 760	M1-9	Yes
Total time operation	t_{op}	h	0 to 8 760	M1-6	Yes
Surrounding zone temperature in the calculation interval at heating period	$\vartheta_{ah,H}$	°C	−40 to +40	M2-2	Yes
Surrounding zone temperature in the calculation interval at cooling period	$\vartheta_{ah,C}$	°C	−40 to +40	M2-2	Yes
Surrounding zone temperature in the calculation interval at DHW period	$\vartheta_{amb,W}$	°C	−40 to +40	M2-2	Yes
Operation time of the distribution system	$t_{HCW,op}$	h	0 to 8 760	M2-2	Yes
^a Practical range, informative.					
^b "Varying": value can vary over time; different values per time interval, e.g. hourly values or monthly values (not constant values over the year).					

6.3.4 Constants and physical data

Table 9 indicates constants and physical data.

Table 9 — Constants and physical data

Name	Symbol	Unit	Value
(specific heat · density) of water	$c_w \cdot \rho_w$	kWh/(m ³ ·K)	1,15
Specific heat of water	c_w	kWh/(kg·K)	1,163·10 ^{−3}
Density of water	ρ_w	kg/m ³	990

6.3.5 Input data from Annex A (with default choices in Annex B)

The user shall follow the templates for choices in references, methods and input given in Annex A.

NOTE Informative default choices are given in Annex B, respecting the template of Annex A.

6.4 Calculation procedure

6.4.1 Applicable time interval

The procedure can be used with the following time intervals:

- hourly;
- monthly;
- yearly.

The bin-method can also be used because in this method only identical time intervals are summarized.

No dynamic effects are taken into account because there are no significant time constants.

This procedure is not suitable for dynamic simulations.

6.4.2 Operating conditions calculation

6.4.3 Heat loss calculation

6.4.3.1 General

The heat loss calculation of a distribution system is based on the mean water supply temperature, the surrounding temperature in a space, the thermal transmittance of the pipes, the length of the pipes and the operation time.

6.4.3.2 Mean water temperature for space heating and space cooling with circulation

The mean water temperature in the distribution systems $\vartheta_{HC;mean}$ for space heating and space cooling is given by:

$$\vartheta_{HC;mean} = \frac{\vartheta_{HC;in} + \vartheta_{HC;out}}{2} \text{ [}^{\circ}\text{C]} \quad (1)$$

where

$\vartheta_{HC;mean}$ is the mean water temperature in the distribution system at the time interval, in $^{\circ}\text{C}$;

$\vartheta_{HC;in}$ is the input water temperature in the emission system, at the time interval, as determined in the relevant standard under EPB module M3-5, in $^{\circ}\text{C}$;

$\vartheta_{HC;out}$ is the output water temperature in the emission system at the time interval, as determined in the relevant standard under EPB module M3-5, in $^{\circ}\text{C}$.

6.4.3.3 Mean water temperature for DHW with circulation

The mean water temperature in the distribution system $\vartheta_{W;mean}$ for DHW with circulation is given by:

$$\vartheta_{W;mean} = \vartheta_W - \frac{\Delta\vartheta_W}{2} \quad (2)$$

where

ϑ_W is the hot water temperature at the time interval, as determined in the relevant standard under EPB module M8-2, in $^{\circ}\text{C}$;

$\Delta\vartheta_W$ is the temperature difference between hot water tapping temperature to the return temperature in a circulation loop system. It is a design value declared as an input in the process design input data list in $^{\circ}\text{C}$.

The mean water temperature during operation (tapping) is in case of stubs: $\vartheta_{W;\text{mean}} = \vartheta_W$

6.4.3.4 Linear thermal transmittance

The linear thermal transmittance Ψ for insulated pipes in air with a total heat transfer coefficient including convection and radiation at the outside is given by:

$$\Psi = \frac{\pi}{\left(\frac{1}{2 \cdot \lambda_D} \cdot \ln \frac{d_a}{d_{ir}} + \frac{1}{h_a \cdot d_a} \right)} \quad (3)$$

where

d_{ir} is the inner diameter (without insulation) of the pipe, in m;

d_a is the outer diameter (with insulation) of the pipe, in m

h_a is the outer total surface coefficient of heat transfer (convection and radiation), as obtained from [Table A.8](#) (normative template, with informative choice in [Table B.8](#)), in $\text{W}/(\text{m}^2\text{K})$;

λ_D is the thermal conductivity of insulation, in W/mK .

For embedded pipes the linear thermal transmittance Ψ_{em} is given by:

$$\Psi_{em} = \frac{\pi}{\frac{1}{2} \left[\frac{1}{\lambda_D} \cdot \ln \frac{d_a}{d_{ir}} + \frac{1}{\lambda_{em}} \cdot \ln \frac{4 \cdot z}{d_a} \right]} \quad (4)$$

where

z is the depth of pipe from surface, in m;

λ_{em} is the thermal conductivity of embedded material, in W/mK .

For non-insulated pipes the linear thermal transmittance Ψ_{non} is given by:

$$\Psi_{non} = \frac{\pi}{\frac{1}{2 \cdot \lambda_p} \cdot \ln \frac{d_{p,a}}{d_{p,ir}} + \frac{1}{h_a \cdot d_{p,a}}} \quad (5)$$

where

$d_{p,ir}$ is the inner diameter of the pipe, in m;

$d_{p,a}$ is the outer diameter of the pipe, in m;

λ_p is the thermal conductivity of the pipe material, in W/mK .

As an approximation the linear thermal transmittance Ψ_{non} is given by:

$$\Psi_{non} = h_a \cdot \pi \cdot d_{p,a} \quad (6)$$

In absence of detailed information, typical values for the linear thermal transmittance Ψ can be obtained from [Table A.7](#) (template, with informative default values in [Table B.7](#)).

6.4.3.5 Thermal loss

The thermal losses are divided into two types of operation:

- during operation;
- without operation.

The tapping profile (see [Table 4](#)) includes the DHW-flow by each hour. If the DHW-flow per hour > 0 all pipes in the sections S, V, and A (equal to stubs) are in operation. The DHW-flow is distributed to all stubs. This simplified assumption is made because generally the tapping profile do not allow the DHW-flow to be divided per stub. When within the tapping profile there is no tapping but the circulation loop is in operation, then pipes in sections S and V are in operation and the stubs (pipe sections A) are not in operation. During no tapping and no operation of the circulation loop, all pipe sections (S, V, A) are not in operation.

Depending on the mode combination the following formulae are used. The calculations apply for the circulation loops and the open stubs. Note that the length of the pipes in each zone shall be used divided and added for each pipe section (S, V, A as determined in [6.4.8](#)).

6.4.3.6 Thermal loss during operation (space heating, space cooling, DHW)

The thermal loss for a distribution system $Q_{\text{HCW};\text{dis};\text{ls}}$ for space heating, space cooling and DHW (including the circulation loop and the open stubs – during tapping per pipes S, V and A as determined in [6.4.8](#) are in operation) in a zone during operation time is given by:

$$Q_{\text{HCW};\text{dis};\text{ls}} = \frac{1}{1000} \sum_0^{t_{\text{HCW};\text{op}}} \sum_j \Psi_j \cdot (\vartheta_{\text{HCW};\text{mean}} - \vartheta_{\text{HCW};\text{amb};j}) \cdot (L + L_{\text{equi}})_j \cdot t_{\text{ci}} \quad (7)$$

where

- j is the index for zone (unconditioned or conditioned);
- $\vartheta_{\text{HCW};\text{amb};j}$ is the surrounding temperature in the zone at the time interval, in °C;
- L is the length of the pipe in the zone (unconditioned or conditioned), according to section S, V or A as determined in [6.4.8](#), in m;
- L_{equi} is the equivalent length of pipe in the zone (unconditioned or conditioned) for, e.g. valves, hangers, in m;
- t_{ci} is the length of the calculation time interval, in h;
- $t_{\text{HCW};\text{op}}$ is the total operation time for space heating, space cooling and circulation loop of DHW, in h.

6.4.3.7 Thermal loss without operation

The thermal loss in circulation systems without operation $Q_{\text{w};\text{dis};\text{non}}$ is calculated according to [Formula \(8\)](#), where the mean water temperature at operation time is substituted by the average hot water temperature $\vartheta_{\text{W};\text{avg}}$ in the circulation system without operation and stubs during no tapping at the time interval:

$$Q_{\text{w};\text{dis};\text{non}} = \frac{1}{1000} \sum_0^{t_{\text{W};\text{op}}} \sum_j \Psi_j \cdot (\vartheta_{\text{W};\text{avg}} - \vartheta_{\text{W};\text{amb};j}) \cdot (L + L_{\text{equi}})_j \cdot t_{\text{ci}} \quad [\text{kWh}] \quad (8)$$

where $\vartheta_{\text{W};\text{avg}}$ is the average hot water temperature in circulation system without operation at the time interval, in °C.

The average hot water temperature after a tapping during a time without operation $\vartheta_{W,avg;j,t}$ is given by:

$$\vartheta_{W,avg;j,t} = \vartheta_{W,amb,j} + (\vartheta_{W,avg;j,t-1} - \vartheta_{W,amb,j}) \cdot e^{-\frac{\Psi_j \cdot L_j (\vartheta_{W,avg;j,t-1} - \vartheta_{W,amb,j})}{c_w \cdot \rho_w \cdot V_{w;j}} \cdot t-1} \quad [^{\circ}\text{C}] \quad (9)$$

where

- $V_{w;j}$ is the volume of water in pipes in zone j in section S, V or A as determined in 6.4.8, in m^3 ;
- c_w is the specific heat of water, as specified in Table 9, in $\text{kWh}/(\text{kg} \cdot \text{K})$;
- Ψ_j is the linear thermal transmittance zone j in section S, V or A as determined in 6.4.8, in $\text{W}/(\text{m} \cdot \text{K})$;
- ρ_w is the specific density of water, as specified in Table 9, in kg/m^3 ;
- t is the calculation interval after a tapping before the next tapping (see tapping profile as determined in the relevant standard under EPB module M3-5), $t=0$ starts at the end of last tapping before a non-operation period and ends as the next tapping starts. t starts again with $t=0$;
- L_j is the length of pipes in zone j according to section S, V or A as determined in 6.4.8, in m.

A simplified method to calculate the mean temperature $\vartheta_{W,avg;j}$ without detailed information about the tapping profile for use in Formula (8) is given by:

$$\vartheta_{W,avg;j} = 25 \cdot \Psi_j^{-0,2} \quad (10)$$

6.4.3.8 Total distribution system thermal loss with operation and without operation

The total thermal loss in a DHW distribution system is given by:

$$Q_{\text{HCW};\text{dis};\text{ls};\text{total}} = Q_{\text{HCW};\text{dis};\text{ls}} + Q_{\text{HCW};\text{dis};\text{non}} \quad (11)$$

6.4.4 Recoverable energy

The recoverable thermal loss of distribution systems for space heating, space cooling and DHW $Q_{\text{HCW};\text{dis};\text{rbl}}$ in the zone is given by Formulae (7 and 8) under the boundary condition that the pipes with length L_j are located in conditioned spaces. Therefore the recoverable thermal loss as a part $f_{\text{HCW};\text{dis};\text{rbl}}$ of the total losses is given as:

$$f_{\text{HCW};\text{dis};\text{rbl}} = \frac{Q_{\text{HCW};\text{dis};\text{ls};\text{cs}}}{Q_{\text{HCW};\text{dis};\text{ls};\text{total}}} \quad (12)$$

$$Q_{\text{HW};\text{dis};\text{rbl}} = f_{\text{HCW};\text{dis};\text{rbl}} \cdot Q_{\text{HW};\text{dis};\text{ls};\text{total}} \quad (13)$$

$$Q_{\text{C};\text{dis};\text{rbl}} = -f_{\text{HCW};\text{dis};\text{rbl}} \cdot Q_{\text{C};\text{dis};\text{ls};\text{total}} \quad (14)$$

6.4.5 Auxiliary energy calculation

The auxiliary energy demand of distribution systems is based on the hydraulic design power of the circulation pump, the differential pressure of the pipe system in a zone at design point, the flow at design point, the expenditure energy factor of the circulation pump at operation point and the operation time.

The hydraulic design power of a circulation pump $P_{\text{HCW;hydr;des}}$ is given by:

$$P_{\text{HCW;hydr;des}} = \frac{\Delta p_{\text{HCW;des}} \cdot \dot{V}_{\text{HCW;des}}}{3600} \quad (15)$$

where

$\Delta p_{\text{HCW;des}}$ is the differential pressure (delivery height) in a circuit (piping system) at design point, in kPa;

$\dot{V}_{\text{HCW;des}}$ is the flow at design point, in m³/h.

The differential pressure of a pipe system $\Delta p_{\text{HCW;des}}$ in a circuit (piping system) is given by:

$$\Delta p_{\text{HCW;des}} = (1 + f_{\text{comp}}) \cdot R_{\text{HCW;max}} \cdot L_{\text{max}} + \Delta R_{\text{HCW;add}} \quad (16)$$

where

f_{comp} is the resistance ratio of components in the piping system, as obtained from [Table A.13](#) (template, with informative value in [Table B.13](#));

$R_{\text{HCW;max}}$ is the pressure loss per length, as obtained from [Table A.12](#) (template, with informative values in [Table B.12](#)), in kPa/m;

L_{max} is the maximum length of the circuit, as obtained from [6.4.8](#), in m;

$\Delta R_{\text{HCW;add}}$ is the pressure losses of additional resistances, as obtained from [Table A.14](#) (template, with informative values in [Table B.14](#)), in kPa.

The hydraulic energy demand $W_{\text{HCW;dis;hydr;an}}$ is given by:

$$W_{\text{HCW;dis;hydr;an}} = P_{\text{HCW;hydr;des}} \cdot \beta_{\text{HCW;dis}} \cdot t_{\text{HCW;op;an}} \cdot f_{\text{HCW;corr}} \quad (17)$$

where

$\beta_{\text{HCW;dis}}$ is the part load of the distribution system;

$t_{\text{HCW;op;an}}$ is the operation time of the distribution system, in h;

$f_{\text{HCW;corr}}$ is the correction factor for special design conditions of the distribution system, as obtained from [Table A.15](#) (template, with informative values in [Table B.15](#)).

The auxiliary energy demand $W_{\text{HCW;dis;an}}$ is given by:

$$W_{\text{HCW;dis;an}} = W_{\text{HCW;dis;hydr;an}} \cdot \varepsilon_{\text{HCW;dis}} \quad (18)$$

where $\varepsilon_{\text{HCW;dis}}$ is the expenditure energy factor of the distribution pump.

The expenditure energy factor of distribution pumps $\varepsilon_{\text{HCW;dis}}$ is given by:

$$\varepsilon_{\text{HCW;dis}} = f_{\text{HCW;e}} \cdot (C_{P1} + C_{P2} \cdot \beta_{\text{HCW;dis}}^{-1}) \cdot \frac{EEI}{0,25} \quad (19)$$

where

$f_{\text{HCW;e}}$ is the factor for efficiency, determined as described below;

C_{p1} is the constant depending on control system of the pump, as obtained from [Tables A.9 to A.11](#) (templates, with informative values in [Tables B.9 to B.11](#));

C_{p2} is the constant depending on control system of the pump, as obtained from [Tables A.9 to A.11](#) (templates, with informative values in [Tables B.9 to B.11](#));

EEI is the energy efficiency index, determined as described below.

The factor for efficiency $f_{HCW,e}$ in general is given by:

$$f_{HCW,e} = \frac{P_{HCW;ref}}{P_{HCW;hydr;des}} \quad (20)$$

where $P_{HCW;ref}$ is the reference power of the pump.

For circulation pumps (wet rotor pump) with hydraulic power $0,001 < P_{HC;hydr;des} < 2,5$ kW, the reference power is given by:

$$P_{HC;ref} = \left(1,7 \cdot P_{HC;hydr;des} + 17 \cdot \left(1 - e^{-0,3 \cdot P_{HC;hydr;des}} \right) \right) \quad (21)$$

The EEI-value for circulation pumps (wet rotor pump) is determined by a measurement procedure as described in [Table A.17](#) (template, with informative choice in [Table B.17](#)). If the EEI of a real pump is known it can be taken into account.

For all other pumps, EEI in [Formula \(24\)](#) shall be set to $EEI = 0,25$ and the factor for efficiency $f_{HCW,e}$ is then given by:

$$f_{HCW,e} = \left(1,25 + \left(\frac{0,2}{P_{HCW;hydr;des}} \right)^{0,5} \right) \cdot b \quad (22)$$

where b is the factor for pump design selection (see identifier PUMP_DISTR_SEL in [Table 9](#)).

For existing installations, it is approximately correct to use the power rating given on the label at the pump for $P_{el;pmp}$; in case of non-controlled pumps with more than one speed level, $P_{el;pmp}$ shall be taken from the speed level at which the pump is operated. Then the factor for efficiency is given by:

$$f_{HCW,e} = \frac{P_{el;pmp}}{P_{HCW;hydr;des}} \quad (23)$$

where $P_{el;pmp}$ is the power rating on the label at existing pump (at speed level of pump operation), in kW.

For intermittent operation of circulation pumps in space heating or space cooling systems there are three different phases and the total is the sum of these parts:

- regular mode $W_{HCW;dis;hydr;an}$
- setback mode $W_{HCW;dis;setb}$
- boost mode $W_{HCW;dis;boost}$

For the setback operation, the pump is operated at minimum speed. When the real efficiency in the setback operation is not known, the power is assumed to be constant 30 % of the electrical power at

design point and then the auxiliary energy demand $W_{\text{HCW;dis;setb}}$ taking into account a mean pump efficiency of 30 %, is given by:

$$W_{\text{HCW;dis;setb}} = P_{\text{HCW;hydr;des}} \cdot t_{\text{ci}} \quad (24)$$

For boost mode operation the power of the pump is the electrical power at design point. The auxiliary energy demand $W_{\text{HCW;dis;boost}}$ also taking a mean pump efficiency into account, is given by:

$$W_{\text{HCW;dis;boost}} = 3,3 \cdot P_{\text{HCW;hydr;des}} \cdot t_{\text{ci}} \quad (25)$$

When the real power of the circulation pump in the different modes is available the calculation should use this data.

6.4.6 Auxiliary energy for ribbon heater

The auxiliary energy demand for a ribbon heater in DHW distribution systems $W_{\text{W;dis;rib}}$ is given by:

$$W_{\text{W;dis;rib}} = Q_{\text{W;dis;ls}} \quad (26)$$

where $Q_{\text{W;dis;ls}}$ is calculated according to [Formula \(7\)](#), in kWh, taking into account only the length of the hot water pipes.

6.4.7 Recoverable and recovered auxiliary energy

The recoverable auxiliary energy for distribution systems for space heating and DHW $Q_{\text{HCW;dis;rbl}}$ as heat flux to the zone which is the heat flux from the pump to the surrounding zone is given by:

$$Q_{\text{HW;dis;rbl}} = f_{\text{rbl;dis}} \cdot W_{\text{HW;dis}} \quad (27)$$

where $f_{\text{rbl;dis}}$ is the factor for recoverable auxiliary energy in distribution systems, $f_{\text{aux;rbl}}$, as obtained from [Table A.16](#) (template, with informative values in [Table B.16](#)).

In case of distribution systems for space cooling, the heat flux to the zone is given by using the same factor for recoverable energy but becomes negative, so that the energy demand in the conditioned space is increased:

$$Q_{\text{C;dis;rbl}} = -f_{\text{rbl;dis}} \cdot W_{\text{C;dis}} \quad (28)$$

The recovered auxiliary energy for distribution systems for space heating and DHW $Q_{\text{HW;dis;rvd}}$ in the zone as heat flux direct to the fluid (in case of wet rotor pump) is given by:

$$Q_{\text{HW;dis;rvd}} = (1 - f_{\text{rbl;dis}}) \cdot W_{\text{HW;dis;aux}} \quad (29)$$

In case of distribution systems for space cooling, the heat flux to fluid in the zone is given by using the same factor for recoverable energy but becomes negative, so that the energy demand for cooling the fluid increased:

$$Q_{\text{C;dis;rvd}} = -(1 - f_{\text{rbl;dis}}) \cdot W_{\text{C;dis}} \quad (30)$$

6.4.8 Lengths of pipes

6.4.8.1 General

In all basic formulae for thermal distribution losses, the lengths of pipes in the individual sections l are required.

If these lengths are not known during the design process or from measurement in existing buildings, approximations may be applied:

- for space heating and space cooling distribution networks see [6.4.8.2](#);
- for DHW distribution networks see [6.4.8.3](#).

Losses of distribution subsystems are calculated by summing the losses of each homogeneous section according to the specific formulae.

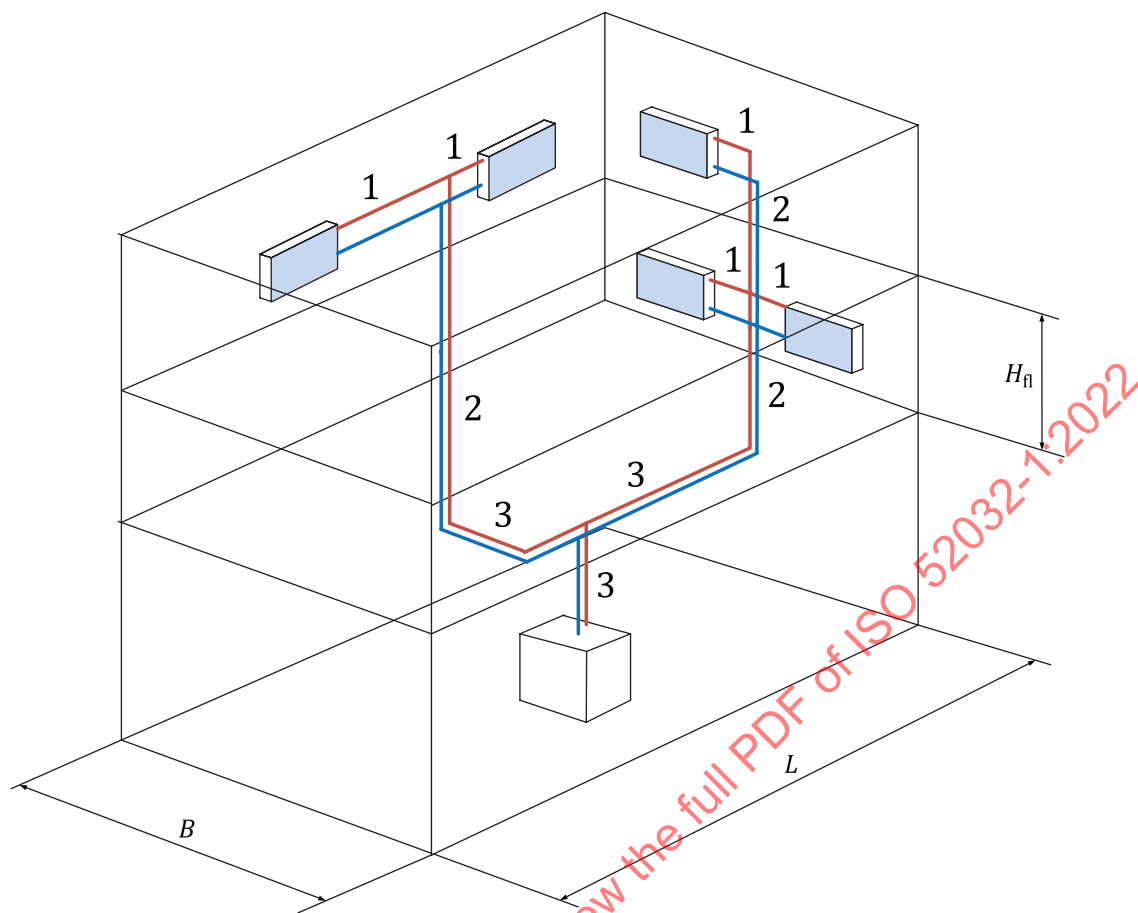
6.4.8.2 Space heating and space cooling systems

The correlations to get the input data of the length of pipes are given in [A.3.1](#) (template, with informative default values in [B.3.1](#)), per section of the distribution network.

Losses of distribution subsystems are calculated summing the losses of each homogeneous section according to the specific formulae.

Typically, a network for space heating and cooling systems is divided in the following sections, as shown in [Figure 1](#):

- **A**: connection of radiators to vertical shafts;
- **S**: vertical shafts;
- **V**: base distributor/collector.

**Key**

- 1 section A
- 2 section S
- 3 section V

Figure 1 — Typical network of space heating and space cooling systems

For the correlations in [A.3.1](#) and [B.3.1](#), the following input data apply (see [Figure 1](#)):

- L length of the building, in m;
- B width of the building, in m;
- H_{fl} floor height, in m;
- n_{fl} number of floors (levels).

The maximum length of pipes, L_{max} , (see [6.4.5](#)) is obtained from [Table A.4](#) (template, with informative choice in [Table B.4](#)).

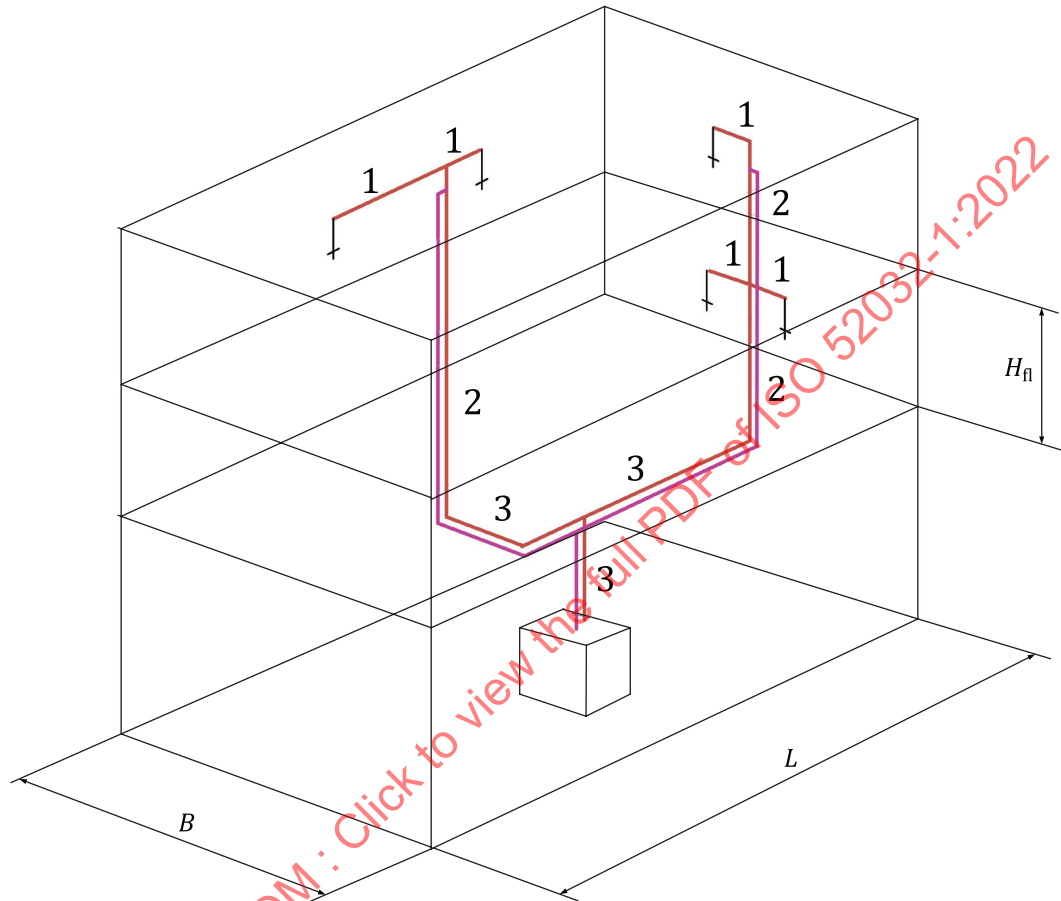
6.4.8.3 Domestic hot water (DHW) systems

The correlations to get the input data of the length of pipes are given in [A.3.2](#) (template, with informative default values in [B.3.2](#)), per section of the distribution network.

Losses of distribution subsystems are calculated by summing the losses of each homogeneous section according to the specific formulae.

Typically, a network for DHW systems is divided into the following sections, as shown in [Figure 2](#):

- **A**: connection of outlets to vertical shafts;
- **S**: vertical shafts;
- **V**: base distributor/collector.



Key

- 1 section A
- 2 section S
- 3 section V

Figure 2 — Typical network for domestic hot water (DHW) systems

For the correlations in [A.3.2](#) and [B.3.2](#), the following input data apply to the correlation (see [Figure 2](#)):

- L length of the building, in m;
- B width of the building, in m;
- H_{fl} floor height, in m;
- n_{fl} number of floors (levels).

The maximum length of pipes, L_{max} , (see [6.4.5](#)) is obtained from [Table A.6](#) (template, with informative choice in [Table B.6](#)).

7 Quality control

The calculation report shall include the values of the following data:

Length of pipes in each section for heating, cooling and DHW	L_S, L_V, L_A
Thermal loss for heating, cooling and DHW	$Q_{HCW;dis;ls}$
Auxiliary energy for heating cooling and DHW	$W_{HCW;dis}$
Thermal expenditure energy factor for heating, cooling and DHW	$\varepsilon_{HCW;dis}$
Mean part load of mass flow for heating and cooling	$\beta_{HCW;dis}$
Hydraulic balancing of the circuit	

8 Conformance check

To check if the calculation procedure is applicable or if it has been applied correctly to the installed system, check the following items:

- insulation of distribution pipes;
- approximately length of installed pipes;
- control settings of the pumps compatible with calculation assumptions;
- annual auxiliary energy consumption of distribution pumps;
- supply and return temperatures in the circuits.

Annex A (normative)

Input and method selection data sheet — Template

A.1 General

The template in this annex shall be used to specify the choices between methods, the required input data and references to other standards.

NOTE 1 Following this template does not guarantee consistency of data.

NOTE 2 The template in this annex 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 can 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, e.g. Table NA.3a, Table NA.3b.

The shaded fields in the tables are part of the template and consequently the information cannot be altered.

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
M1-6		
M1-9		
M2-2		
M3-1		
M3-5		
M4-1		
M4-5		
M8-1		
M8-2		
^a If a reference comprises more than one document, the references can be differentiated.		
^b Informative.		

A.3 Input correlations to the length of pipes in zones (buildings)

A.3.1 Space heating and space cooling distribution systems

A.3.1.1 Correlations

For a block building, the length of the pipes for each section is given by [Table A.2](#) for a two-pipe-system and [Table A.3](#) for a one-pipe system. If the building has more than one zone, the length, width, floor height and number of floors should be taken into account. In these tables the correlations for surrounding temperatures in each section are also included.

These correlations are valid for the boundary conditions given in [A.3.1.2](#).

Table A.2 — Two-pipe-system (see [6.4.8.2](#))

Values	Result	Unit	Section V (from the generator to the shafts)	Section S (vertical shafts)	Section A (connection pipes)
Mean surrounding temperature	$\theta_{ah;H}, \theta_{ah;C}$	°C			
Pipe length in case of shafts in outside walls	L_i	m			
Pipe length in case of shafts inside the building	L_i	m			

Table A.3 — One-pipe-system (see [6.4.8.2](#))

Values	Result	Unit	Section V (from the generator to the shafts)	Section S (vertical shafts)	Section A (connection pipes)
Pipe length in case of shafts inside of the building	L	m			

The maximum length L_{max} from the generator to the most distant emission system is given by [Table A.4](#):

Table A.4 — Maximum length L_{max} (see [6.4.8.2](#))

Parameter	Symbol	Unit	Formula
Maximum length from the generator to the most distant emission system	L_{max}	m	(B.1)

A.3.1.2 Boundary conditions

NOTE This subclause is open for free text.

A.3.2 Domestic hot water (DHW) distribution systems

A.3.2.1 Correlations

For a block building, the length of the pipes for each section is given by [Table A.5](#). In this table the correlations for surrounding temperatures in each section are also included.

These correlations are valid for the boundary conditions given in [A.3.2.2](#).

Table A.5 — Default values for calculation of thermal losses from DHW circulation loop and DHW distribution pipes (see 6.4.8.3)

Parameters	Symbol	Unit	Section L_V	Section L_S	Section L_A
Ambient temperature outside the heating period	$\theta_{ah;W}$	°C			
Ambient temperature	$\theta_{ah;W}$	°C			
Length of circulation loop	L	m			—
Length of main distribution pipe	L	m			—
Length of individual branching pipe, only for transfer into adjacent rooms with a common installation wall	L	m	—	—	
Length of individual branching pipe, for all other cases	L	m	—	—	

The maximum length L_{max} from the boiler or storage tank to the most distant tap is given by Table A.6:

Table A.6 — Maximum length L_{max} (see 6.4.8.3)

Parameter	Symbol	Unit	Formula
Maximum length from the boiler or storage tank to the most distant tap	L_{max}	m	(B.2)

A.3.2.2 Boundary conditions

NOTE This subclause is open for free text.

A.4 Input correlations to linear thermal transmittance of pipes in zones (buildings)

A.4.1 General

Thermal losses of distribution subsystems are calculated by summing the losses of each homogeneous section according to the specific formulae (see 6.4.3). This clause identifies:

- Typical values of linear thermal transmittance of pipes in each section.

A.4.2 Network for space heating, space cooling and domestic hot water (DHW) systems

A.4.2.1 Sections

The type of network, shown in 6.4.8, Figure 1 and Figure 2, is divided into the following sections:

- **A**: connection of radiators to vertical shafts;
- **S**: vertical shafts;
- **V**: base distributor/collector.

A.4.2.2 Input data to the correlation

There are no special input data required.

A.4.2.3 Correlations

For each section of the network default, values for the linear thermal transmittance of pipes are given in [Table A.7](#) depending on the age or the class of the building.

Table A.7 — Typical values of linear thermal transmittance of pipes for new and existing buildings

Age/class of building	ψ [W/mK]		
	Section L_V	Section L_S	Section L_A
From 1995 – assumed that insulation thickness is approximately equal to the pipe external diameter			
1980 to 1995 – assumed that insulation thickness is approximately equal to half of the pipe external diameter			
Up to 1980			
Non-insulated pipes exposed			
$A \leq 200 \text{ m}^2$			
$200 \text{ m}^2 < A \leq 500 \text{ m}^2$			
$A > 500 \text{ m}^2$			
Non-insulated pipes installed in external walls		total/usable ^a	
External wall non-insulated			
External wall with external insulation			
External wall without insulation but characterized by a low thermal transmittance ($U = 0,4 \text{ W/m}^2\text{K}$)			

^a Total = total thermal losses of the pipe, usable = recoverable thermal losses.

The outer total surface coefficient of heat transfer (convection and radiation) h_a , is given by [Table A.8](#).

Table A.8 — Outer total surface coefficient of heat transfer h_a (see [6.4.3](#))

Parameter	Symbol	Unit	Value
Outer total surface coefficient of heat transfer (convection and radiation)	h_a	W/(m ² K)	

A.5 Input correlations to constants for distribution pumps

A.5.1 General

The calculation of the auxiliary energy of distribution pumps depends on the expenditure energy factor of distribution pumps $\varepsilon_{X,dis}$. The influence of the control system is characterized by constants based on a unique efficiency curve of pumps.

A.5.2 Constants for the calculation of the expenditure energy factor of distribution pumps

The constants are given in [Tables A.9](#) to [A.11](#) corresponding to the identifier HEAT_DISTR_CTRL_PMP.

Table A.9 — Constants C_{p1} and C_{p2} for space heating distribution pumps (see 6.4.5)

Pump control <i>HEAT_DISTR_CTRL_PMP</i>	C_{p1}	C_{p2}
0 = uncontrolled		
3 = Δp_{const}		
4 = $\Delta p_{\text{variable}}$		

Table A.10 — Constants C_{p1} and C_{p2} for space cooling distribution pumps (see 6.4.5)

Pump control <i>HEAT_DISTR_CTRL_PMP</i>	C_{p1}	C_{p2}
0 = uncontrolled		
3 = controlled		

Table A.11 — Constants C_{p1} and C_{p2} for DHW distribution circulation pumps (see 6.4.5)

Pump control <i>HEAT_DISTR_CTRL_PMP</i>	C_{p1}	C_{p2}
0 = uncontrolled		
3 = controlled		

A.6 Input correlations to additional resistances and resistance ratio

A.6.1 General

The calculation of the auxiliary energy of distribution pumps depends on the differential pressure of a pipe system $\Delta p_{\text{HCW,des}}$. The additional resistances can be calculated by a simplified method taking into account a resistance ratio or by adding additional typical resistances.

A.6.2 Network for space heating, space cooling and domestic hot water (DHW) systems

A.6.2.1 Correlations for pressure loss per length

Table A.12 — Pressure loss per length (see 6.4.5)

Pressure loss per length ^a	R [kPa/m]
Standard networks in buildings	
Networks in buildings with swaged sockets	
District heating/cooling networks between buildings	
^a Rows may be changed and additional rows may be added for alternative network descriptions.	

A.6.2.2 Correlations for resistance ratio

To take into account all the resistances of components within the network (i.e. valves, flanges, fittings) the factor f_{comp} can be set depending on network design. A common assumption is given in [Table A.13](#).

Table A.13 — Resistance ratio (see 6.4.5)

Resistance ratio	f_{comp} [-]
for common networks	
for networks with many changes of direction	

A.6.2.3 Correlations of additional resistances

To take into account the resistances of components at the start and end of the network (i.e. emitter, generator) the Δp_{add} can be taken from the [Table A.14](#).

Table A.14 — Additional resistances (see 6.4.5)

Type of resistance ^a	Δp_{add} [kPa]
Type of emitter	
Radiator	
Floor heating system	
Heat meter	
Type of heat generator	
Generator with water content > 0,15 l/kW	
Generator with water content ≤ 0,15 l/kW	$\Phi_{\text{H,out,max}} < 35 \text{ kW}$
	$\Phi_{\text{H,out,max}} \geq 35 \text{ kW}$
^a Rows may be changed and additional rows may be added for other types.	

A.6.2.4 Correlations correction factor of the distribution system

The largest correction factor for special design conditions of the distribution system, $f_{\text{HCW;corr}}$ is the hydraulic balance. But in special cases the factor for the hydraulic balance can be multiplied with a special factor. See [Table A.15](#).

Table A.15 — Factors for hydraulic balance of the network (see 6.4.5)

Factors	
Correction factor for special design conditions of the distribution system, $f_{\text{HCW;corr}}$	$f_{\text{HCW;corr}} = f_{\text{HB}} \cdot f_{\text{special}}$
Factor for hydraulic balance of the network, f_{HB}	
Balanced	
Not balanced	
Special factor, f_{special}	

A.7 Correlations factor for recoverable auxiliary energy**Table A.16 — Factor for recoverable auxiliary energy (see 6.4.7)**

Factor for recoverable auxiliary energy	$f_{\text{aux;rbl}}$
Pump with insulation	
Pump without insulation	

Table A.16 (continued)

Factor for recoverable auxiliary energy	$f_{\text{aux,rbl}}$
Pump (dry running meter)	

A.8 Input data — Energy efficiency index of real water-pumps

The procedure for assessing the energy efficiency index, *EEl*, for real pumps is given in [Table A.17](#).

Table A.17 — Energy efficiency index *EEl* for real pumps (see 6.4.5)

Energy efficiency index	<i>EEl</i>
Measurement procedures	
Standard value(s)	
- for distribution pumps in heating circuits	
^a Rows may be changed and additional rows may be added for other types	

Annex B (informative)

Input and method selection data sheet — Default choices

B.1 General

The template in this annex shall be used to specify the choices between methods, the required input data and references to other standards.

NOTE 1 Following this template does not guarantee consistency of data.

NOTE 2 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 can 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, e.g. Table NA.3a, Table NA.3b.

The shaded fields in the tables are part of the template and consequently the information cannot be altered.

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
M1-6	ISO 17772-1	<i>Energy performance of buildings — Indoor environmental quality — Part 1: Indoor environmental input parameters for the design and assessment of energy performance of buildings</i>
	EN 16798-1	<i>Energy performance of buildings — Ventilation of 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)</i>
M1-9	ISO 52000-1	<i>Energy performance of buildings — Overarching EPB assessment — Part 1: General framework and procedures</i>
M2-2	ISO 52016-1	<i>Energy performance of buildings — Energy needs for heating and cooling, internal temperatures and sensible and latent heat loads — Part 1: Calculation procedures</i>
M3-1	EN 15316-1	<i>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</i>
M3-5	ISO 52031	<i>Energy performance of buildings — Method for calculation of system energy requirements and system efficiencies — Space emission systems (heating and cooling)</i>
^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
	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	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
M4-5	EN 15316-2	See M3-5
M8-1	EN 15316-1	See M3-1
M8-2	EN 12831-3	Energy performance of buildings — Method for calculation of the design heat load — Domestic hot water systems heat load and characterization of needs, Module M8-2, M8-3
^a If a reference comprises more than one document, the references can be differentiated.		
^b Informative.		

B.3 Input correlations to the length of pipes in zones (buildings)

B.3.1 Space heating and space cooling systems

B.3.1.1 Correlations

For a block building, the length of the pipes for each section is given by [Table B.2](#) for a two-pipe-system and [Table B.3](#) for a one-pipe system. If the building has more than one zone, the length, width, floor height and number of floors should be taken into account. In these tables the correlations for surrounding temperatures in each section are also included.

These correlations are valid for the boundary conditions given in [B.3.1.2](#).

Table B.2 — Two-pipe-system (see [6.4.8.2](#))

Values	Result	Unit	Section V (from the generator to the shafts)	Section S (vertical shafts)	Section A (connection pipes)
Mean surrounding temperature	$\theta_{ah;H}, \theta_{ah;C}$	°C	13 respectively 20	20	20
Pipe length in case of shafts in outside walls	L_i	m	$2 \times L + 0,016\,25 \times L \times B^2$	$0,025 \times L \times B \times H_{fl} \times n_{fl}$	$0,55 \times L \times B \times n_{fl}$
Pipe length in case of shafts inside the building	L_i	m	$2 \times L + 0,032\,5 \times L \times B + 6$	$0,025 \times L \times B \times H_{fl} \times n_{fl}$	$0,55 \times L \times B \times n_{fl}$

Table B.3 — One-pipe-system (see [6.4.8.2](#))

Values	Result	Unit	Section V (from the generator to the shafts)	Section S (vertical shafts)	Section A (connection pipes)
Pipe length in case of shafts inside of the building	L	m	$2 \times L + 0,032\,5 \times L \times B + 6$	$0,025 \times L \times B \times H_{fl} \times n_{fl} + 2 \times (L + B) \times n_{fl}$	$0,1 \times L \times B \times n_{fl}$

The maximum length L_{max} from the generator to the most distant emission system is given by [Table B.4](#).