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Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 3-1 Domestic hot water systems, characterisation of needs (tapping requirements)

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Contents

Foreword

This document (prEN 15316-3-1:2005) has been prepared by Technical Committee CEN/TC 228 “Heating systems in buildings”, the secretariat of which is held by DS.

The subjects covered by CEN/TC 228 are the following:

- design of heating systems (water based, electrical etc.);
- installation of heating systems;
- commissioning of heating systems;
- instructions for operation, maintenance and use of heating systems;
- methods for calculation of the design heat loss and heat loads;
- methods for calculation of the energy performance of heating systems.

Heating systems also include the effect of attached systems such as hot water production systems.

All these standards are systems standards, i.e. they are based on requirements addressed to the system as a whole and not dealing with requirements to the products within the system.

Where possible, reference is made to other European or International Standards, a.o. product standards. However, use of products complying with relevant product standards is no guarantee of compliance with the system requirements.

The requirements are mainly expressed as functional requirements, i.e. requirements dealing with the function of the system and not specifying shape, material, dimensions or the like.

The guidelines describe ways to meet the requirements, but other ways to fulfil the functional requirements might be used if fulfilment can be proved.

Heating systems differ among the member countries due to climate, traditions and national regulations. In some cases requirements are given as classes so national or individual needs may be accommodated.

In cases where the standards contradict with national regulations, the latter should be followed.

Introduction

This document is one of three documents that together describe methods for calculation of system energy requirements and system efficiencies related to domestic hot water systems. In particular this document describes methods for calculating the domestic hot water requirements. The user shall refer to other European standards or to National documents for input data and detailed calculation procedures not provided by this standard.

Only the calculation method is normative. Values necessary to complete the calculations should be given in a National Annex. Default values are given in informative annex A.

1 Scope

This standard is part of a set of standards covering methods for the calculation of system energy requirements and system efficiencies of heating systems in buildings. In particular this standard is one of a number of standards dealing with domestic hot water systems.

The scope of this specific part is to standardise the methods for determining the domestic hot water requirements. This standard covers the domestic hot water requirements in all buildings.

The calculation of domestic hot water requirements applies to a dwelling, a building or a zone of a building (Q_W).

In order to be coherent with calculation methods for space heating systems, emission losses representing taps and control should be taken into account.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

prEN wi *x, Heating systems in buildings - Method for calculation of system energy requirements and system efficiencies – Part 1: General*

3 Terms and definitions

THIS SECTION HAS STILL TO BE PROVIDED BY SEPARATE GROUP WORKING ON COMMON DEFINITIONS.

The following definition to be added as unlikely to be included in common definitions.

Power shower A shower having an associated pump to increase the water flow rate and pressure.

4 Symbols and Units

THE SYMBOLS AND UNITS ARE BEING CO-ORDINATED BY A SEPARATE GROUP. THESE SYMBOLS AND UNITS TO BE BROUGHT IN LINE WITH THE AGREED LIST WHEN IT IS AVAILABLE. SYMBOLS IN THE EQUATIONS THROUGHOUT THE DOCUMENT TO BE BROUGHT IN LINE.

For the purposes of this standard, the following symbols and units (Table 1) and indices (Table 2) apply:

Table 1: Symbols and units

Symbol	Name of quantity	Unit
A	area	m^2
C	specific heat capacity	J/(kg K)
d	diameter	mm
f	conversion factor	-
L	length	m
M	mass	kg
N	number of operating times	-
t	time, period of time	s
T	thermodynamic temperature	K
Q	quantity of heat, energy	J
ϕ	thermal power	W
P	electrical power	W
U	heat loss coefficient	W/mK
V	volume	m^3
W	electrical auxiliary energy	J
x,y	constants	-
z	running time	h/d
η	efficiency	-
θ	celsius temperature	°C
λ	heat conductivity	W/mK
ρ	density of water	kg/m^3

Table 2: Indices

amb	ambiant	hydr	hydraulic	p	pipe
ave	average	h	heating energy	P	primary
corr	corrected	int	internal	r	recovered
col	collectif	in	input to system	s	storage
d	distribution	ind	independent	sb	standby
e	external	l	loss	t	total
em	emission	nom	nominal	out	output from system
g	generation, losses	nhs	non heated space	W	domestic hot water
gs	gains	PM	pipe material	x	indices

5 Method for calculation of domestic hot water requirement for different installations

This clause describes four methods for calculation of the energy requirements of the delivered domestic hot water. The methods differ as to the level of detail assumed for the domestic hot water demand. For example whether the conditions relating to the different uses of the hot water are taken into account.

A National Annex may specify which method should be used for different building types. A national Annex may also specify which method is acceptable for the purpose of energy labelling or any other specific use.

The calculations are based on a daily domestic hot water requirement.

5.1 Energy of delivered domestic hot water based on tapping programs

This method is characterised by the use of one or more 24-hour cycles that define a number of domestic hot water draw-off requirements.

Tapping programs may be given in a National Annex. These must identify the building type(s) for which they can be used. The tapping programs must include the energy content of each draw-off, the corresponding delivery temperature and the appropriate flow rate.

For single-family dwellings the tapping programs detailed in EN 13203-2 should be used. These are given in Annex A. Reference should be made to EN 13203-2 for a full explanation of these tapping programs.

Weekly, monthly or annual domestic hot water requirements can be obtained by multiplying the daily data by the appropriate number of days. A National Annex may indicate that a combination of tapping programs may be used in these calculations.

5.2 Energy of delivered domestic hot water based on volume required

This method is characterised by calculating the daily domestic hot water volume required.

The energy content of the domestic hot water delivered to the user (Q_W) depends on the volume delivered and the water temperature. The energy content is calculated by:

$$Q_W = 4.182 * V_W * (\theta_{W,t} - \theta_{W,o}) \quad \text{(MJ/day)} \quad (1)$$

where:

V_W volume of domestic hot water delivered at specified temperature, m^3/day

$\theta_{W,t}$ specified temperature of domestic hot water at tapping point, °C

$\theta_{W,o}$ temperature of the inlet water, °C

5.2.1 Domestic hot water delivery temperature

The required domestic hot water delivery temperature depends on the use. In order to achieve a consistent basis for calculations, values can be provided in a National Annex. In the absence of a National Annex a default delivery temperature as given in Annex B may be applied.

5.2.2 Cold water supply temperature

In some countries, variations in cold water supply temperature are sufficient to have a significant affect on the energy requirement for domestic hot water. National values can be applied to take account of local variations and more than one set of temperature values can be applied to reflect differences in cold water supply temperature in different geographical areas.

National values should be provided in a National Annex.

In the absence of a National Annex a default cold water supply temperature as given in Annex B may be applied.

5.2.3 Domestic hot water volume requirement

The required volume of domestic hot water, V_W , is determined by the type of building and its use and is calculated by:

$$V_W = \frac{a * N_U}{1000} \quad \text{m}^3\text{/day} \qquad (2)$$

where:

a unit requirement based on litres of water at 60°C /day

N_U number of units to be taken into account

The values of a and N_U depend on:

— the type of building;

— the type of activity carried out within the building;

— the use of a zone within a building where more than one activity is carried out;

— standards or class of activity, such as the category of a hotel (number of stars) or the class of catering establishment.

Alternatively, the floor area may be used for N_U in equation 2 with corresponding values of a .

National values for a and N_U should be provided in a National Annex. If a National Annex is not provided or does not include these values, default values given in Annex B may be applied.

5.2.3.1 Single family dwellings

The values of a for single family dwellings may be given in a National Annex. The corresponding value of N_U is the floor area of the dwelling.

Alternatively, the value of a can be calculated. Calculation of a takes into account the requirements of smaller dwellings, where the domestic hot water requirement is larger on a floor area basis than it is for larger dwellings. The value of a is calculated by:

$$a = \frac{X * Ln(N_U) - Y}{N_U} \qquad \text{if } N_U > \text{threshold level} \qquad (3)$$

$a = Z$ if N_U ≤ threshold level but above a minimum level (4)

where X , Y and Z are constants.

Values for X , Y and Z as well as for the threshold and minimum levels of N_U may be given in a National Annex. If a National Annex is not provided or does not include these values, default values given in Annex B may be applied. These values are based on a domestic hot water requirement in litres per day at 60°C.

National regulations may require the domestic hot water requirements for single-family dwellings to be calculated separately for the kitchen and the bathroom.

5.2.4 Time periods

Weekly, monthly or annual domestic hot water requirements can be obtained by multiplying the daily data by the appropriate number of days. If different cold water temperatures are used in the calculations then the weekly, monthly or annual domestic hot water demand should be based on the number of days associated with each cold water temperature used. A National Annex will give the number of days.

5.3 Energy of delivered domestic hot water based directly on floor area

This method is characterised by the assumption that there is a linear relationship between the domestic hot water demand and the floor area of the building.

If the domestic hot water requirement is directly related to floor area, the energy content of the domestic hot water delivered to the user (Q_W) may be calculated by:

$Q_W = C_{tap} * A$ (MJ/day) (5)

where:

C_{tap} is a specific domestic hot water demand per day based on a water delivery temperature of 60°C and cold water supply temperature of 10°C

A specified floor area, m^2

This approach may only be used if values for C_{tap} are given in a National Annex. The National Annex must also indicate if the specified floor area is the net or gross area of the building.

Weekly, monthly or annual domestic hot water requirements can be obtained by multiplying the daily data by the appropriate number of days.

5.4 Tabulated energy requirements of delivered domestic hot water

This method is characterised by the assumption that the domestic hot water is related to the building type and use.

It is acceptable to provide a table of the energy requirements for domestic hot water. This method may be used for any building type. The energy requirements shall be tabulated against a single parameter or multiple parameters depending on:

— the type of building;

— the type of activity carried out within the building;

— the use of a zone within a building where more than one activity is carried out;

— standards or class of activity, such as the category of a hotel (number of stars) or the class of catering establishment.

As an example, the energy requirement for a single-family dwelling would be tabulated against the floor area.

The table should be based on similar temperature conditions as the calculation method and should be provided in a National Annex.

Weekly, monthly or annual domestic hot water requirements can be obtained by multiplying the daily data by the appropriate number of days.

Annex A
(informative)
Tapping Programs for Single Family Dwellings

Domestic hot water tapping programs are given that are appropriate for single-family dwellings. The cover a very low useage appropriate to a single person use to a very large use appropriate to a large family.

Tapping program No. 2 is representative of an average European use.

These are reproduced from EN 13203-2

Table A.1: Tapping program No. 1

	Start (h.min)	Energy (kWh)	Type of delivery	ΔT desired (K), to be achieved during tapping	Min. ΔT (K), = start of counting useful energy
1	07.00	0,105	Small		15
2	07.30	0,105	Small		15
3	08.30	0,105	Small		15
4	09.30	0,105	Small		15
5	11.30	0,105	Small		15
6	11.45	0,105	Small		15
7	12.45	0,315	Dish washing	45	0
8	18.00	0,105	Small		15
9	18.15	0,105	Household cleaning		30
10	20.30	0,420	Dish washing	45	0
11	21.30	0,525	Large		30
Total		2,1			

Equivalent hot water litres at 60 °C | 36 |

Table A.2: Tapping program No. 2

	Start (h.min)	Energy (kWh)	Type of delivery	ΔT desired (K), to be achieved during tapping	Min. ΔT (K), = start of counting useful energy
1	07.00	0,105	Small		15
2	07.15	1,400	Shower		30
3	07.30	0,105	Small		15
4	08.01	0,105	Small		15
5	08.15	0,105	Small		15
6	08.30	0,105	Small		15
7	08.45	0,105	Small		15
8	09.00	0,105	Small		15
9	09.30	0,105	Small		15
10	10.30	0,105	Floor cleaning	30	0
11	11.30	0,105	Small		15
12	11.45	0,105	Small		15
13	12.45	0,315	Dish washing	45	0
14	14.30	0,105	Small		15
15	15.30	0,105	Small		15
16	16.30	0,105	Small		15
17	18.00	0,105	Small		15
18	18.15	0,105	Household cleaning		30
19	18.30	0,105	Household cleaning		30
20	19.00	0,105	Small		15
21	20.30	0,735	Dish washing	45	0
22	21.15	0,105	Small		15
23	21.30	1,400	Shower		30
Total		5,845			

Equivalent hot water litres at 60 °C | 100,2 |

Table A.3: Tapping program No. 3

	Start (h.min)	Energy (kWh)	Type of delivery	ΔT desired (K), to be achieved during tapping	Min. ΔT (K), = start of counting useful energy
1	07.00	0,105	Small		15
2	07.05	1,400	Shower		30
3	07.30	0,105	Small		15
4	07.45	0,105	Small		15
5	08.05	3,605	Bath	30	0
6	08.25	0,105	Small		15
7	08.30	0,105	Small		15
8	08.45	0,105	Small		15
9	09.00	0,105	Small		15
10	09.30	0,105	Small		15
11	10.30	0,105	Floor cleaning	30	0
12	11.30	0,105	Small		15
13	11.45	0,105	Small		15
14	12.45	0,315	Dish washing	45	0
15	14.30	0,105	Small		15
16	15.30	0,105	Small		15
17	16.30	0,105	Small		15
18	18.00	0,105	Small		15
19	18.15	0,105	Household cleaning		30
20	18.30	0,105	Household cleaning		30
21	19.00	0,105	Small		15
22	20.30	0,735	Dish washing	45	0
23	21.00	3,605	Bath	30	0
24	21.30	0,105	Small		15
Total		11,655			

Equivalent hot water litres at 60 °C | 199,8 |

Table A.4: Tapping program No. 4

	Start (h.min)	Energy (kWh)	Type of delivery	ΔT desired (K), to be achieved during tapping	Min. ΔT (K), = start of counting useful energy
1	07.00	0,105	Small		15
2	07.15	1,82	Shower		30
3	07.26	0,105	Small		15
4	07.45	4,42	Bath	30	0
5	08.01	0,105	Small		15
6	08.15	0,105	Small		15
7	08.30	0,105	Small		15
8	08.45	0,105	Small		15
9	09.00	0,105	Small		15
10	09.30	0,105	Small		15
11	10.00	0,105	Small		15
12	10.30	0,105	Floor cleaning	30	0
13	11.00	0,105	Small		15
14	11.30	0,105	Small		15
15	11.45	0,105	Small		15
16	12.45	0,735	Dish washing	45	0
17	14.30	0,105	Small		15
18	15.00	0,105	Small		15
19	15.30	0,105	Small		15
20	16.00	0,105	Small		15
21	16.30	0,105	Small		15
22	17.00	0,105	Small		15
23	18.00	0,105	Small		15
24	18.15	0,105	Household cleaning		30
25	18.30	0,105	Household cleaning		30
26	19.00	0,105	Small		15
27	20.30	0,735	Dish washing	45	0
28	20.46	4,42	Bath	30	0
29	21.15	0,105	Small		15
30	21.30	4,42	Bath	30	0
Total		19,07			

Equivalent hot water litres at 60 °C | 325 |

Table A.5: Tapping program No.5

	Start (h.min)	Energy (kWh)	Type of delivery	ΔT desired (K), to be achieved during tapping	Min. ΔT (K), = start of counting useful energy
1	07.00	0,105	Small		15
2	07.15	1,82	Shower		30
3	07.26	0,105	Small		15
4	07.45	6,24	Shower + bath	30	0
5	08.01	0,105	Small		15
6	08.15	0,105	Small		15
7	08.30	0,105	Small		15
8	08.45	0,105	Small		15
9	09.00	0,105	Small		15
10	09.30	0,105	Small		15
11	10.00	0,105	Small		15
12	10.30	0,105	Floor cleaning	30	0
13	11.00	0,105	Small		15
14	11.30	0,105	Small		15
15	11.45	0,105	Small		15
16	12.45	0,735	Dish washing	45	0
17	14.30	0,105	Small		15
18	15.00	0,105	Small		15
19	15.30	0,105	Small		15
20	16.00	0,105	Small		15
21	16.30	0,105	Small		15
22	17.00	0,105	Small		15
23	18.00	0,105	Small		15
24	18.15	0,105	Household cleaning		30
25	18.30	0,105	Household cleaning		30
26	19.00	0,105	Small		15
27	20.30	0,735	Dish washing	45	0
28	20.46	6,24	Shower + bath	30	0
29	21.15	0,105	Small		15
30	21.30	6,24	Shower + bath	30	0
Total		24,53			

Equivalent hot water litres at 60 °C | 420 |

Table A.6: Tapping flow rates

Type of tapping	Energy (kWh)	Hot water flow rates corresponding to a temperature rise of 45 K (l/min)
Household cleaning	0,105	3 ± 0,5
Small	0,105	3 ± 0,5
Floor cleaning	0,105	3 ± 0,5
Dish washing	0,315	4 ± 0,5
Dish washing	0,420	4 ± 0,5
Dish washing	0,735	4 ± 0,5
Large (cycle n°1)	0,525	4 ± 0,5
Shower	1,400	6 ± 0,5
Shower (cycles n°4 et n°5)	1,800	6 ± 0,5
Bath	3,605	10 ± 0,5
Bath (cycle n°4)	4,420	10 ± 0,5
Shower + Bath (cycle n°5)	6,240	16 ± 0,5

Annex B
(informative)

Default values for calculation of domestic hot water requirements for buildings

A default value of 60°C should be used for the domestic hot water delivery temperature.

A default value of 10°C should be used for the cold water supply temperature.

Default values of a and N_U are given in Table B.1.

Table B.1: Default values for calculation of domestic hot water requirements for buildings

Type of activity	a	N_U
Dwelling	See below	Floor area (m²)
Accommodation	30	Number of beds
Health establishment without accommodation	10	Number of beds
Health establishment with accommodation – without laundry	57	Number of beds
Health establishment with accommodation – with laundry	90	Number of beds
Education	Hot water requirements not taken into account	
Offices		
Theatres and lecture theatres		
Shops		
Catering, 2 meals per day. Traditional cuisine	22	Number of guests per meal
Catering, 2 meals per day. Self service	8	Number of guests per meal
Catering, 1 meal per day. Traditional cuisine	11	Number of guests per meal

Type of activity	a	N_U
Hotel, 1-star, without laundry	57	Number of beds
Hotel, 1-star, with laundry	71	Number of beds
Hotel, 2-star, without laundry	78	Number of beds
Hotel, 2-star, with laundry	92	Number of beds
Hotel, 3-star, without laundry	100	Number of beds
Hotel, 3-star, with laundry	114	Number of beds
Hotel, 4-star and GC, without laundry	120	Number of beds
Hotel, 4-star and GC, with laundry	135	Number of beds
Sports establishment	103	Number of showers installed
Storage	Hot water requirements not taken into account	
Industry		
Transport		
Other		

For single family dwellings, the value of a is calculated by:

$$a = \frac{X * Ln(N_U) - Y}{N_U} \qquad \text{if } N_U > 30 \text{ m}^2 \qquad \text{(A2)}$$

$$a = Z \qquad \text{if } 15 \leq N_U \leq 30 \text{ m}^2 \qquad \text{(A3)}$$

The default values for X , Y and Z are:

X = 62

Y = 160

Z = 2