BSI Standards Publication

Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies

Part 4-8: Space heating generation systems, air heating and overhead radiant heating systems

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National foreword

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Foreword

This document (EN 15316-4-8:2011) has been prepared by Technical Committee CEN/TC 228 “Heating systems in buildings”, the secretariat of which is held by DIN.

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of an identical text or by endorsement, at the latest by August 2011, and conflicting national standards shall be withdrawn at the latest by August 2011.

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Introduction

This European Standard presents methods for calculation of the additional energy requirements of a heat generation system in order to meet the building demand. The calculation is based on the performance characteristics of the products given in product standards and on other characteristics required to evaluate the performance of the products as included in the system.

This method can be used for the following applications:

- judging compliance with regulations expressed in terms of energy targets;
- optimisation of the energy performance of a planned heat generation system, by applying the method to several possible options;
- assessing the effect of possible energy conservation measures on an existing heat generation system, by calculating the energy use with and without the energy conservation measure.

The user should refer to other European Standards or to national documents for input data and detailed calculation procedures not provided by this standard.

1 Scope

This European Standard is part of a series of standards on the method for calculation of system energy requirements and system efficiencies.

The scope of this specific part is to standardise the:

- required inputs;
- calculation method;
- resulting outputs

for space heating generation by:

a) air heating systems, including control, and

b) overhead radiant heating systems for non-domestic use , including control.

This European Standard does not apply to air heating systems that utilise water as a heat transfer medium.

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.

EN 416-1, *Single burner gas-fired overhead radiant tube heaters for non-domestic use — Part 1: Safety*

EN 419-1, *Non-domestic gas-fired overhead luminous radiant heaters — Part 1:Safety*

EN 621, *Non-domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 300 kW, without a fan to assist transportation of combustion air and/or combustion products*

EN 777-1, *Multi-burner gas-fired overhead radiant tube heater systems for non-domestic use — Part 1: System D - Safety*

EN 777-2, *Multi-burner gas-fired overhead radiant tube heater systems for non-domestic use — Part 2: System E - Safety*

EN 777-3, *Multi-burner gas-fired overhead radiant tube heater systems for non domestic use — Part 3: System F - Safety*

EN 777-4, *Multi-burner gas-fired overhead radiant tube heater systems for non-domestic use — Part 4: System H - Safety*

EN 778, *Domestic gas-fired forced convection air heaters for space heating not exceeding a net heat input of 70 kW, without a fan to assist transportation of combustion air and/or combustion products*

EN 1020, *Non-domestic forced convection gas-fired air heaters for space heating not exceeding a net heat input of 300 kW, incorporating a fan to assist transportation of combustion air or combustion products*

EN 1196, *Domestic and non-domestic gas-fired air heaters — Supplementary requirements for condensing air heaters*

EN 1319, *Domestic gas-fired forced convection air heaters for space heating, with fan-assisted burners not exceeding a net heat input of 70 kW*

EN 13410, *Gas-fired overhead radiant heaters — Ventilation requirements for non-domestic premises*

EN 15316-2-1, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 2-1: Space heating emission systems*

EN 15316-2-3, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 2-3: Space heating distribution systems*

EN 15316-4-1:2008, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-1: Space heating generation systems, combustion systems (boilers)*

EN ISO 7345:1995, *Thermal insulation — Physical quantities and definitions (ISO 7345:1987)*

EN ISO 13790, *Energy performance of buildings — Calculation of energy use for space heating and cooling (ISO 13790:2008)*

3 Terms, definitions, symbols and units

3.1 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 7345:1995 and the following apply.

3.1.1
air heating system
heating system composed of one or more individual forced convection air heating appliances

3.1.2
auxiliary energy
electrical energy used by technical building systems for heating, cooling, ventilation and /or domestic water to support energy transformation to satisfy energy needs

NOTE 1 This includes energy for fans, pumps, electronics, etc.

NOTE 2 Adapted from EN 15316-1:2007.

3.1.3
calculation period
time period over which the calculation is performed

NOTE The calculation period can be divided into a number of calculation steps.

[EN 15316-1:2007]

3.1.4
combustion power
product of the fuel flow rate and the net caloric value of the fuel

3.1.5
condensing air heater
air heater designed to make use of the latent heat released by condensation of water vapour in the combustion flue products

NOTE The heater will allow the condensate to leave the heat exchanger in liquid form by way of a condensate drain.

3.1.6
energy need for heating or cooling
energy to be delivered to or extracted from a conditioned space to maintain the intended temperature conditions during a given period of time

3.1.7
energy use for space heating
energy input to the heating system to satisfy the energy need for heating

3.1.8
forced convection air heater
appliance designed to provide space heating from a central source by distributing heated air, by means of an air moving device, either through ducting or directly into the heated space

3.1.9
flued heater
heating appliance of type B or C, connected to a flue or a device for evacuating the products of combustion to the outside of the room in which the appliance is installed

3.1.10
gross calorific value
quantity of heat released by a unit quantity of fuel, when it is burned completely with oxygen at a constant pressure equal to 101 320 Pa, and when the products of combustion are returned to ambient temperature

NOTE 1 This quantity includes the latent heat of condensation of any water vapour contained in the fuel and of the water vapour formed by the combustion of any hydrogen contained in the fuel.

NOTE 2 Adapted from EN 15316-4-7:2008.

3.1.11
high-low appliance
appliance capable of operating either at its nominal fuel heat input or at a fixed reduced heat input

3.1.12
heated space
room or enclosure which, for the purposes of the calculation, is assumed to be heated to a given set-point temperature or set point temperatures, and whose total volume can be split up into several heating zones

3.1.13
heating system thermal loss
thermal loss from a technical building system for heating that does not contribute to the useful output of the system

NOTE Thermal energy recovered directly in the subsystem is not considered as a system thermal loss but as heat recovery and directly treated in the related system standard.

3.1.14
load factor
ratio between the time the burner is on and the total time the generation system is available to supply heat as demanded by system controls

3.1.15
modes of operation
various modes in which the heating system can operate (set-point mode, cut-off mode, reduced mode, set-back mode, boost mode)

[EN 15316-4-7:2008]

3.1.16
modulating appliance
appliance capable of varying its heat input in a continuous manner between the nominal fuel heat input and a minimum value, whilst maintaining continuous burner firing

3.1.17
multi-burner overhead radiant tube system
radiant tube heater system which employs two or more burner units with each unit incorporating independent flame monitoring

NOTE The units may be located in one or more sections of tubing. One or more fans may be used to assist in the evacuation of products of combustion or the supply of combustion air.

3.1.18
net calorific value
gross calorific value minus condensation latent heat of the water vapour in the products of combustion at ambient temperature

3.1.19
on/off appliance
appliance without the capability to vary the fuel burning rate whilst maintaining continuous burner firing

NOTE This includes appliances with alternative burning rates set once only at the time of installation, referred to as range rating.

3.1.20
overhead radiant heating system
heating system composed of one or more individual overhead radiant heating appliances

3.1.21
overhead radiant luminous heater
appliance intended for installation at a height above head level which is designed to heat the space beneath by radiation and in which the heat is produced by means of burning the fuel at or near the outer surface of a material such as a ceramic plaque or gauze, or by means of an atmospheric burner heating a gauze or similar material

3.1.22
overhead radiant tube heater
appliance intended for installation above head level which is designed to heat the space beneath by radiation by means of a tube or tubes, heated by the internal passage of combustion products

3.1.23
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 Adapted from EN 15316-4-1:2008.

3.1.24
recovered system thermal loss
part of the 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 Adapted from EN 15316-4-1:2008.

3.1.25
space heating
process of heat supply for thermal comfort

3.1.26
thermal zone
part of the heated space with a given set-point temperature, throughout which the internal temperature is assumed to have negligible spatial variation

3.1.27
total heating system thermal loss
total of the heating system thermal losses, including recoverable thermal losses

3.1.28
type A appliance
appliance not intended for connection to a flue or to a device for evacuation the products of combustion directly to the outside of the room in which the appliance is installed

3.1.29
unflued heater
heating appliance of type A, not connected to a flue

3.1.30
ventilation
process of supplying or removing air by natural or mechanical means to or from a space

3.2 Symbols and units

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

Table 1 — Symbols and units

Symbol	Name of quantity	Unit
α	heat loss factor	–
β	load factor, power factor	–
Φ	heat flow rate, thermal power	kW
θ	Celsius temperature	°C
η	efficiency factor	–
cp	specific heat capacity	kWh/m^{3}K
c	specific mass, specific factor	kg/kW or - %
E	energy in general, including primary energy, except heat, work and auxiliary electric energy	kWh
f	conversion factor, correction factor	–
H	parameter height of building	m
k	factor, Part of recoverable auxiliary energy, Part of envelope losses	–
K	burner multistage or modulation ratio	–
n	exponent	–
P	power in general, including electrical (auxiliary) power	kW
Q	quantity of heat	kWh
t	time, period of time	h
T	thermodynamic temperature	K
W	electrical (auxiliary) energy	kWh
y	electrical (auxiliary) energy rate as percentage of nominal heat input	–

Table 2 — Indices

air	air	fin	final	plt	pilot flame
amb	ambient	fg	flue gas	P0	power at zero load
avg	average	gen	generation	Pn	power at nominal load
aux	auxiliary	gn	gains	Px	power at x load
blw	blower	H	heating	r	return
br	burner	in	input to system	rad	radiant
ctr	control	int	internal	ref	reference
ch	chimney	j	indices	rvd	recovered
cmb	combustion	ls	loss	rbl	recoverable
cond	condensation				
corr	corrected	mass	mass, specific weight	sto	storage
		max	maximum		
dis	distribution	min	minimal	t	total
DHW	domestic hot water	mod	modulating	test	test conditions
		nom	nominal	th	thermal
e	external	nrbl	non recoverable	w	heating system water
el	electrical	nrvd	non recovered		
env	envelope	off	off	x	indices
em	emission	on	on	z	indices
exh	exiting the building	out	output from system		

4 Principle of the method

4.1 Heat balance of the generation sub-system, including control of heat generation

4.1.1 Physical factors taken into account

The calculation method of the heat generation sub-system takes into account:

- heat demand of the heat distribution sub-system or heat emission sub-system;

NOTE Heating systems with radiant luminous and radiant tube heaters as well as warm air heaters located inside the heated space include sub-system heat generation and heat emission in one appliance; in this case, a separate heat distribution sub-system does not exist, distribution losses are zero.

and the heat losses and/or recovery due to the following physical factors:

- heat losses to the chimney (or flue gas exhaust) during total time of generator operation (running and stand-by);
- heat losses through the generator(s) envelope during total time of generator operation (running and stand-by);

- heat losses due to air exchange required for flue gas evacuation (in case of type A appliances) during total time of generator operation (running and stand-by);
- auxiliary energy.

The relevance of these effects on the energy requirements depends on:

- type of heat generator(s);
- location of heat generator(s);
- part load ratio;
- operation conditions (temperature, control, etc.);
- control strategy (on/off, high-low, modulating, etc.).

4.1.2 Calculation structure (input and output data)

The calculation method of this standard requires input data from other parts of the EN 15316 standards series:

- heat demand of the heat distribution sub-system(s) $\Sigma Q_{\mathrm{H,dis,in}}$, calculated according to EN 15316-2-3

or alternatively:

- heat demand of the heat emission and control sub-system(s) $\Sigma Q_{\mathrm{H,em,in}}$, calculated according to EN 15316-2-1.

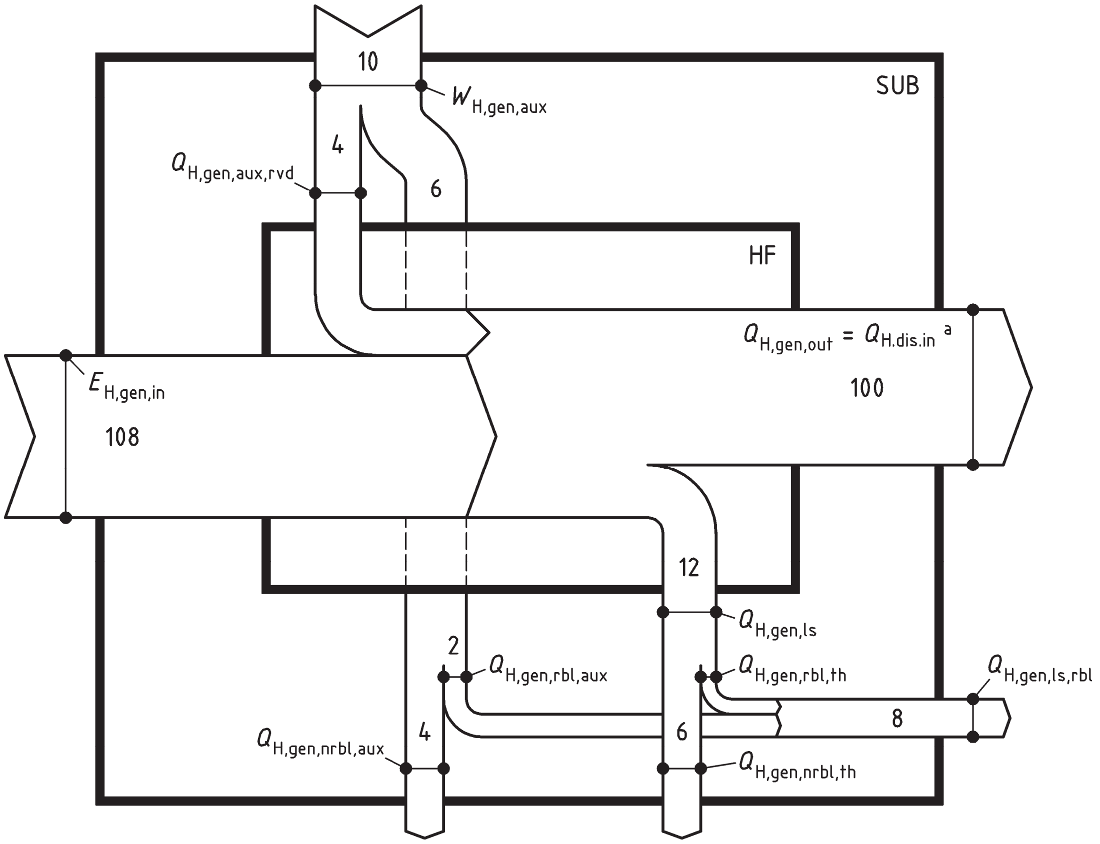
The performance of the generation sub-system may be characterised by additional input data to take into account:

- type and characteristics of the generation sub-system;
- generator settings;
- type of the generation control system;
- location of the generator;
- operating conditions;
- heat requirement.

Based on these data, the following output data are calculated by this standard:

- fuel heat requirement, $E_{\mathrm{H,gen,in}}$;
- total generation heat losses, $Q_{\mathrm{H,gen,ls}}$;
- recoverable generation heat losses, $Q_{\mathrm{H,gen,ls,rbl}}$;
- generation auxiliary energy consumption, $W_{\mathrm{H,gen,aux}}$.

Figure 1 shows the calculation inputs and outputs of the generation sub-system.



Key

SUB	Generation subsystem balance boundary
HF	Heating fluid balance boundary (see Equation (1))
$Q_{H,gen,out}$	Generation subsystem heat output (input to distribution subsystem(s))
$E_{H,gen,in}$	Generation subsystem fuel input (energyware)
$W_{H,gen,aux}$	Generation subsystem total auxiliary energy
$Q_{H,gen,aux,rvd}$	Generation subsystem recovered auxiliary energy
$Q_{H,gen,ls}$	Generation subsystem total thermal heat losses
$Q_{H,gen,ls,rbl}$	Generation subsystem recoverable heat
$Q_{H,gen,rbl,th}$	Generation subsystem recoverable thermal losses
$Q_{H,gen,rbl,aux}$	Generation subsystem recoverable auxiliary energy
$Q_{H,gen,nrbl,th}$	Generation subsystem non recoverable thermal losses
$Q_{H,gen,nrbl,aux}$	Generation subsystem non recoverable auxiliary energy

NOTE Figures shown are sample percentages.

Figure 1 — Generation sub-system inputs, outputs and energy balance

4.2 Thermal energy required for heat generation

The basic energy balance of the generation sub-system is given by:

$$E_{\mathrm{H,gen,in}} = Q_{\mathrm{H,gen\ out}} - Q_{\mathrm{H,gen\ aux,rvd}} + Q_{\mathrm{H,gen\ ls}} \tag{1}$$

where

$E_{\mathrm{H,gen,in}}$ is the heat requirement of the generation sub-system (fuel input);

$Q_{\mathrm{H,gen\ out}}$ is the heat supplied to the distribution or emission sub-systems (space heating);

$Q_{\mathrm{H,gen\ aux,rvd}}$ is the auxiliary energy recovered by the generation sub-system (i.e. burner fan, valve, burner control, etc.);

$Q_{\mathrm{H,gen\ ls}}$ is the total losses of the generation sub-system (through the chimney, generator envelope, etc.).

NOTE $Q_{\mathrm{H,gen\ ls}}$ takes into account flue gas and generator envelope losses, part of which may be recoverable according to location.

4.3 Auxiliary energy W_{gen}

Auxiliary energy is the energy, other than fuel, required for operation of the burner, the burner fan and any equipment whose operation is related to operation of the heat generation sub-system. Auxiliary energy is counted in the generation part as long as no transport energy from the auxiliary equipment is transferred to the distribution sub-system (example: zero-pressure distribution array). Such auxiliary equipment can be (but need not be) an integral part of the generator.

For some heating appliances (radiant luminous and radiant tube heaters, warm air heaters, directly fired and located inside the heated space) heat generation sub-system and heat emission sub-system are included in one appliance. Auxiliary energy of these appliances has to be calculated only in this European Standard. For information part of the auxiliary energy data of these appliances is also listed in EN 15316-2-1, but shall not be accounted as an additional energy requirement there.

Auxiliary energy, normally in the form of electrical energy, may partially be recovered as heat for space heating or for the generation sub-system.

EXAMPLE 1 Examples of recoverable auxiliary energy:

- part of the electrical energy for the burner fan, valve, control.

EXAMPLE 2 Example of non-recoverable auxiliary energy:

- electrical energy for electric panel auxiliary circuits, if the generator is installed outside the heated space.

4.4 Recoverable, recovered and unrecoverable heat loss

Not all of the calculated system heat losses are lost. Some of the losses are recoverable and part of the recoverable system heat losses are actually recovered. The generation losses recovered by the generation sub-system are directly taken into account in the generation performance (e.g. combustion air preheating by flue gas losses). The part of the recovered system heat losses for space heating depends on the location of the generator and the utilisation factor (gain/loss ratio, see EN ISO 13790).

EXAMPLE 1 Example of recoverable heat losses:

- heat losses through the envelope of a generator installed within the heated space.

EXAMPLE 2 Examples of non-recoverable heat losses:

- heat losses through the envelope of a generator installed outside the heated space;
- heat losses through the chimney.

4.5 Calculation steps

The objective of the calculation is to determine the energy input of the heating generation sub-system for the entire calculation period (usually one year). This may be done in one of the following two different ways:

- by using average (usually yearly) data for the entire calculation period;
- by dividing the calculation period into a number of calculation steps (e.g. months, weeks, bins, operation modes as defined in EN ISO 13790) and perform the calculations for each step using step-dependent values and adding up the results for all the steps over the calculation period.

NOTE Generation efficiency is strongly dependent on the load factor and this relationship is not linear. To achieve a good precision, the calculation steps should not be longer than 1 month.

5 Generation system calculation

5.1 Principle of the method

This calculation method is based on the following principles.

The operation time of the generator (total time the generator system is available to supply heat as demanded by the temperature control) is divided in two parts:

The total time of operation of the generator is:

$$t_{\mathrm{gen}} = t_{\mathrm{on}} + t_{\mathrm{off}}.$$

where

t_{gen} is the total time of generator operation (available to supply heat as demanded by the control);

t_{on} is the time with the burner on (fuel valve open, pre- and post-ventilation are not considered);

t_{off} is the time with the burner off.

Heat losses are taken into account separately for these two periods of time.

Where applicable, the following heat losses are taken into account during burner on operation only:

- heat of flue gas with burner on: $Q_{\mathrm{ch,on}}$;
- heat losses due to ventilation finalised to exhaust flue gases $Q_{\mathrm{vent,on}}$ (type A appliances);
- heat losses through the generator envelope: $Q_{\mathrm{gen,env,on}}$.

Where applicable, the following heat losses are taken into account during burner off time only:

- heat of air flow to the chimney $Q_{\mathrm{ch,off}}$;
- heat losses by a permanent pilot burner operation $Q_{\mathrm{plt,off}}$.

Auxiliary energy is considered separately for devices that are directly related to the combustion function (t_{on}) and possible additional devices (i.e. system blowers or recirculation blowers) that are related to the entire operation time t_{gen}.

- W_{br} is the auxiliary energy required by components and devices directly related to the combustion function (typically. burner fan, burner control and fuel valve, main blower);

NOTE 1 These components and devices are running only when the burner is on, i.e. during t_{on}.

- W_{blw} is the auxiliary energy required by additional components and devices that are after the combustion chamber following the energy path (e.g. recirculation blower of large tube heaters);

NOTE 2 These components and devices are running during the entire operation period of the heat generator, i.e. during:

$$t_{gen} = t_{on} + t_{off}$$

k_{blw} and k_{br} express the fractions of the auxiliary energy for these appliances recovered to the heating medium. Therefore:

- $Q_{br} = k_{br} \cdot W_{br}$ is the auxiliary energy recovered from appliances directly related to the combustion function;
- $Q_{blw} = k_{blw} \cdot W_{blw}$ is the auxiliary energy recovered from additional devices (after the heat generator).

Auxiliary energy transformed into heat and emitted to the heated space may be considered separately and is added to the recoverable heat losses.

Heat losses at test conditions are expressed as a percentage ($\alpha_{ch,on}$, α_{plt} … $\alpha_{gen,env}$) of nominal combustion power Φ_{cmb}.

The heat generator is characterised by the following values:

- Φ_{cmb} combustion power of the generator, which is the reference power for losses factors α_{xxn};
- $\alpha_{ch,on}$, α_{plt} … $\alpha_{gen,env}$ heat loss factors at test conditions (according to the type of heater);
- P_{br} electrical power of auxiliary appliances directly related to the burner;
- k_{br} recovery factor of P_{br};
- P_{blw} electrical power of additional auxiliary appliances ;
- k_{blw} recovery factor of P_{blw};

For multistage or modulating heaters, the following additional data is required:

- $\Phi_{cmb,min}$ minimum combustion power of the generator;
- $\alpha_{ch,on,min}$ heat loss factor $\alpha_{ch,on}$ at minimum combustion power ($\Phi_{cmb,min}$);
- $P_{br,min}$ electrical power of auxiliary appliances (directly related to the combustion function) at minimum combustion power $\Phi_{cmb,min}$.

For condensing boilers, the following additional data is required:

— θ_{fg} flue gas temperature at nominal output;

— $X_{\mathrm{O2,fg,dry}}$ dry flue gas oxygen contents;

or

— η_{cmb} combustion efficiency on basis fuel net calorific value.

For condensing multistage or modulating heaters, the following additional data is required;

— $\theta_{\mathrm{fg,min}}$ flue gas temperature at minimum combustion power;

— $X_{\mathrm{O2,fg,dry,min}}$ flue gas oxygen contents at minimum combustion power;

or

— $\eta_{\mathrm{cmb,min}}$ combustion efficiency on gas net (lower) calorific value at minimum combustion power.

Actual operation conditions are characterised by the following values:

— $Q_{\mathrm{H,gen,out}}$ heat output to the heat distribution or heat emission sub-system(s);

— $\theta_{\mathrm{gen,air}}$ generator ambient temperature, room temperature if the appliance is located within the heated space, outside temperature if the appliance is located outside;

— $k_{\mathrm{gen,env,rvd}}$ reduction factor taking into account recovery of heat losses through the generator envelope depending on location of the generator;

— β_{cmb} load factor.

NOTE 3 All powers and the load factor β_{cmb} are referred to generator input (combustion power).

Data should be declared by the manufacturer or measured, where applicable. If no declared or measured data is available data shall be found in a relevant national annex. If no national annex is available, default values can be found in informative Annex A.

5.2 Load factor

The load factor β_{cmb} is the ratio between the time with the burner on and the total time the generator is available to supply heat as demanded by the system control (running and stand-by):

$$\beta_{\mathrm{cmb}} = \frac{t_{\mathrm{on}}}{t_{\mathrm{gen}}} = \frac{t_{\mathrm{on}}}{t_{\mathrm{on}} + t_{\mathrm{off}}} \tag{2}$$

and also

$$t_{\mathrm{on}} = \beta_{\mathrm{cmb}} \cdot (t_{\mathrm{on}} + t_{\mathrm{off}}) = \beta_{\mathrm{cmb}} \cdot t_{\mathrm{gen}} \tag{3}$$

where

t_{gen} total time of generator operation (available to supply heat as demanded by the control);

t_{on} time with the burner on (fuel valve open, pre- and post-ventilation are not considered);

t_{off} time with the burner off;

β_{cmb} load factor (see calculation in 5.6).

5.3 Specific heat losses

5.3.1 General

Specific heat losses of the generator are given at standard test conditions.

Test values shall be adjusted according to actual operation conditions. This applies both to standard test values and to field test measurements.

For the design and calculation of new systems the values of specific losses are declared by the manufacturer according to certified measurements. Default values are given in informative Annex A.

For existing installations field measurements of different losses have to be determined in accordance with European standards EN 416-1, EN 419-1, EN 621, EN 777-1, EN 777-2, EN 777-3, EN 777-4, EN 778, EN 1020, EN 1196, EN 1319 and in accordance with relevant national rules in law. Average default values for older appliances are also given in informative Annex A.

5.3.2 Heat losses through the chimney with burner on ($\alpha_{\mathrm{ch,on}}$)

$\alpha_{\mathrm{ch,on}}$ is the heat loss to the flue in unit time, when the appliance is in operation at full load, expressed as a percentage of nominal heat input.

For the design of new systems, $\alpha_{\mathrm{ch,on}}$ is the value declared by the manufacturer.

Default values are given in **Annex A, Table A.1**.

Actual specific heat losses through the chimney with the burner on $\alpha_{\mathrm{ch,on,corr}}$ are given by:

$$\alpha_{\mathrm{ch,on,corr}} = \left[\alpha_{\mathrm{ch,on}} + \left(\theta_{\mathrm{gen,air}} - \theta_{\mathrm{gen,air,test}}\right)\cdot f_{\mathrm{corr,ch,on}}\right]\cdot \beta_{\mathrm{cmb}}^{n_{\mathrm{ch,on}}} \tag{4}$$

$\theta_{\mathrm{gen,air,test}}$ room temperature when test has been conducted (usually 20 °C). For the design of new systems, $\theta_{\mathrm{gen,air,test}}$ is the value declared by the manufacturer. For existing systems, $\theta_{\mathrm{gen,air,test}}$ is measured together with combustion efficiency. If no data is available, default values are given in Annex A, Table A.1. The source of data shall be clearly stated in the calculation report.

$\theta_{\mathrm{gen,air}}$ air temperature of the room where the appliance is located for radiant heaters (room set temperature) or air temperature supply to the main blower for an air heater. For air heaters located in the heated room, $\theta_{\mathrm{gen,air}}$ is the room set temperature. When different room temperatures occur within the calculation time, calculation may be done for each temperature, or with an average temperature.

$f_{\mathrm{corr,ch,on}}$ correction factor for $\alpha_{\mathrm{ch,on}}$. Default values for this factor are given in **Annex A, Table A.1**.

$n_{\mathrm{ch,on}}$ exponent for the load factor β_{cmb}. Default values for this exponent are given in **Annex A, Table A.1**. β_{cmb} raised to $n_{\mathrm{ch,on}}$ takes into account the reduction of losses with high intermittencies, due to a lower average temperature of the flue gas (higher efficiency at start). An increasing value of $n_{\mathrm{ch,on}}$ corresponds to a higher value of $c_{\mathrm{mass,on}}$, defined as the specific mass of the heat exchange surface between flue gas and air per kW nominal power.

5.3.3 Induced ventilation heat losses (α_{vent})

Appliances type A require specific ventilation to supply combustion air and to evacuate flue gases.

α_{vent} is the specific ventilation loss in unit time, when the appliance is in operation at nominal load, expressed as a percentage of nominal heat input.

The amount of ventilation heat loss is given by:

$$\Phi_{\text{vent}} = V_{\text{vent}} \cdot \Phi_{\text{cmb}} \cdot c_{\text{P}} \cdot (\theta_{\text{exh}} - \theta_{\text{e}}) \tag{5}$$

where

Φ_{vent} is the actual specific ventilation loss (kW);

Φ_{cmb} is the total nominal combustion power of the generator system (kW);

V_{vent} is the amount of specific ventilation required (m^3/h per kW installed) according to EN 13410;

θ_{exh} is the average temperature of the ventilation air exiting the building (°C);

θ_{e} is the average (monthly) external air temperature (°C);

c_{P} is the specific heat capacity of the air exiting the building (kWh/m^3 K).

Calculation for ventilation losses should be done in monthly steps.

Specific ventilation losses expressed as a percentage of the nominal heat input are given by:

$$\alpha_{\text{vent}} = \frac{\Phi_{\text{vent}}}{\Phi_{\text{cmb}}} \tag{6}$$

For standard systems with ventilation provided by fans which are interlocked to the burner(s):

$$\alpha_{\text{vent,on}} = \alpha_{\text{vent}} \tag{7}$$

$$\alpha_{\text{vent,off}} = 0 \tag{8}$$

If no data is available from the manufacturer, default values are given in **Annex A, Table A.4**.

NOTE The induces ventilation rate is assumed constant for on/off appliances, high-low appliances and modulating appliances.

5.3.4 Losses through the generator envelope ($\alpha_{\text{gen,env}}$)

$\alpha_{\text{gen,env}}$ is the heat loss from the appliance envelope in unit time when the appliance is in operation, expressed as a percentage of the combustion power Φ_{cmb}.

If no data is available from the manufacturer, default value are given in **Annex A, Table A.6**.

NOTE The assumption is made that the heat capacity of heaters is low and envelope losses during t_{off} are negligible.

Corrected envelope losses $\alpha_{\text{gen,env}}$ take into account the location of the generator:

$$\alpha_{\text{gen,env,corr}} = k_{\text{gen,env}} \cdot \alpha_{\text{gen,env}} \tag{9}$$

Default values for $k_{\text{gen,env}}$ are given in **Annex A, Table A.6**.

5.3.5 Pilot flame losses (α_{plt})

α_{plt} is the heat loss to the flue by a permanent pilot flame in unit time when the burner is switched off, expressed as a percentage of nominal heat input .

Where the pilot heat input is unknown default values are given in Annex A, Table A.7 For heaters without permanent pilot flame $\alpha_{\text{plt}} = 0$.

5.3.6 Heat recovery from condensation (α_{cond})

For new projects heat recovery from condensation is calculated by:

$$\alpha_{\text{cond}} = \eta_{\text{cmb}} - 100 + \alpha_{\text{ch,on,corr}} \tag{10}$$

where

η_{cmb} is the combustion efficiency calculated on the net caloric value of the fuel

and $\eta_{\text{cmb}} > 100$

if $\eta_{\text{cmb}} \leq 100$ then $\alpha_{\text{cond}} = 0$

η_{cmb} is a manufacturer declared value.

Default values are given in **Annex A, Table A.8**.

For existing sites:

Calculate α_{cond} according to EN 15316-4-1 based on actual measurements on site or take average default values of installed heaters in informative **Annex A**.

5.4 Total heat losses

5.4.1 Burner ON losses (α_{on})

α_{on} are total losses when the burner is ON

$$\alpha_{\text{on}} = \alpha_{\text{ch,on,corr}} + \alpha_{\text{vent,on}} + \alpha_{\text{gen,env,corr}} - \alpha_{\text{cond}} \tag{11}$$

NOTE 1 For standard flued heaters (not condensing) installed inside the heated space (overhead radiant tube heaters and air heaters): $\alpha_{\text{on}} = \alpha_{\text{ch,on,corr}}$ ($\alpha_{\text{vent,on}} = 0$; $\alpha_{\text{gen,env,corr}} = 0$; $\alpha_{\text{cond}} = 0$).

NOTE 2 For unflued heaters (overhead luminous heaters and overhead radiant tube heaters) installed inside the heated space: $\alpha_{\text{on}} = \alpha_{\text{vent,on}}$ ($\alpha_{\text{ch,on,corr}} = 0$; $\alpha_{\text{gen,env,corr}} = 0$; $\alpha_{\text{cond}} = 0$).

5.4.2 Burner OFF Losses (α_{off})

α_{off} are total losses when the burner is OFF

$$\alpha_{\text{off}} = \alpha_{\text{plt}} + \alpha_{\text{vent,off}} \tag{12}$$

NOTE 1 except for heaters with permanent pilot flame $\alpha_{\text{plt}} = 0$

NOTE 2 for all standard unflued heaters with ventilation of air/flue interlocked with the burner $\alpha_{\text{vent,off}} = 0$

5.5 Auxiliary energy

5.5.1 Auxiliary energy related to time burner on

The auxiliary energy for the generator related to burner on W_{br} is calculated by:

$$W_{\text{br}} = P_{\text{aux,br}} \cdot t_{\text{on}} \tag{13}$$

where

$P_{\text{aux,br}}$ is the electrical power of the auxiliary equipment. Data will be supplied by the manufacturer. If no data is available from the manufacturer, default values are given in **Annex A, Table A.3**.

The auxiliary power relative to the combustion power $\beta_{\text{aux,br}}$ is given by:

$$\beta_{\text{aux,br}} = \frac{P_{\text{aux,br}}}{\Phi_{\text{cmb}}} \tag{14}$$

The recovered auxiliary energy related to burner on Q_{br} is given by:

$$Q_{\text{br}} = W_{\text{br}} \cdot k_{\text{br}} \tag{15}$$

where

k_{br} is the Part of burner auxiliary energy recovered by the generation sub-system (e.g. burner fan). Default values of k_{br} are given in **Annex A, Table A.9.**

5.5.2 Auxiliary energy of additional devices (after the burner)

The auxiliary energy of additional devices after the burner (related to t_{gen}) W_{blw} is calculated by:

$$W_{\text{blw}} = P_{\text{aux,blw}} \cdot t_{\text{gen}} \tag{16}$$

where

$P_{\text{aux,blw}}$ is the electrical power of the auxiliary equipment after the burner. Data will be supplied by the manufacturer. If no data is available from the manufacturer, default values are given in **Annex A, Table A.3**.

t_{gen} is the operation time of these auxiliaries ($t_{\text{on}} + t_{\text{off}}$).

The auxiliary power relative to the combustion power $\beta_{\text{aux,blw}}$ is given by:

$$\beta_{\text{aux,blw}} = \frac{P_{\text{aux,blw}}}{\Phi_{\text{cmb}}} \tag{17}$$

The recovered auxiliary energy related to t_{gen} Q_{blw} is given by:

$$Q_{\text{blw}} = W_{\text{blw}} \cdot k_{\text{blw}} \tag{18}$$

where

k_{blw} is the part of auxiliary energy recovered by the generation sub-system (e.g. blower) Default values of k_{blw} are given in **Annex A, Table A.9**.

5.6 Calculation procedure

5.6.1 Calculation procedure for on-off generators

1) Get $Q_{\text{H,gen,out}}$ (heat to be supplied by the generator) from previous calculations.

2) Set $t_{\text{on}} = 0{,}5\ t_{\text{gen}}$.

3) Determine α_{on} and α_{off} according to Equation (11) and Equation (12).

4) Determine Q_{blw} and Q_{br} according to Equation (15) and Equation (18).

5) Calculate the load factor β_{cmb} according to:

$$\beta_{\text{cmb}} = \frac{100 \cdot \dfrac{Q_{\text{H,gen,out}} - Q_{\text{blw}}}{\Phi_{\text{cmb}} \cdot t_{\text{gen}}} + \alpha_{\text{OFF}}}{100 + k_{\text{br}} \cdot \beta_{\text{aux,br}} - \alpha_{\text{ON}} + \alpha_{\text{ON}}} \tag{19}$$

6) Calculate a new t_{on} with:

$$t_{\text{on}} = t_{\text{gen}} \cdot \beta_{\text{cmb}} \tag{20}$$

7) If any of the values in Equation (19) is dependent on t_{on}, repeat the calculation from step 3 until old and new β_{cmb} present a difference in absolute value lower than 0,001.

8) Calculate the fuel input $E_{\text{H,gen,in}}$ according to:

$$E_{\text{H,gen,in}} = t_{\text{on}}\ \ \Phi_{\text{cmb}} \tag{21}$$

9) Calculate the auxiliary energy input with:

$$W_{\text{H,gen,aux}} = t_{\text{on}}\ \ \Phi_{\text{br}} + t_{\text{gen}}\ \ \Phi_{\text{blw}} \tag{22}$$

10) There are no recoverable losses because recovered losses are taken into account as reduction of losses.

11) Calculate total losses with:

$$E_{\text{H,gen,ds}} = E_{\text{H,gen,in}} - Q_{\text{H,gen,out}} + Q_{\text{blw}} + Q_{\text{br}} \tag{23}$$

5.6.2 Calculation procedure for modulating or multistage generators

5.6.2.1 General

A multistage or modulating generator is characterised by 3 states:

1) burner off;

2) burner on at minimum power;

3) burner on at maximum power.

It is assumed that only two situations are possible:

4) the generator is operating intermittently as a single stage generator at minimum power;

5) the generator is operating at a constant average power between minimum and maximum power.

5.6.2.2 Additional data required

The following additional data are required to characterise a multistage or modulating generator:

— $\Phi_{\text{cmb,min}}$ minimum combustion power of the generator;

or

— $k_{\text{cmb,min}}$ ratio of minimum power to nominal (maximum) power

— $\alpha_{\text{ch,on,min}}$ heat loss factor $\alpha_{\text{ch,on}}$ at minimum combustion power $\Phi_{\text{cmb,min}}$, as a fraction of $\Phi_{\text{cmb,min}}$;

— $P_{\text{br,min}}$ electrical power of auxiliaries related directly to the burner at minimum combustion power. It is assumed that differences between nominal and minimum power are negligible $P_{\text{br,min}} = P_{\text{br}}$.

If $\Phi_{\text{cmb,min}}$ is known, then $k_{\text{cmb,min}}$ is given by:

$$k_{\text{cmb,min}} = \frac{\Phi_{\text{cmb,min}}}{\Phi_{\text{cmb}}} \tag{24}$$

otherwise, if $k_{\text{cmb,min}}$ is known then $\Phi_{\text{cmb,min}}$ is given by:

$$\Phi_{\text{cmb,min}} = k_{\text{cmb,min}} \cdot \Phi_{\text{cmb}} \tag{25}$$

If data from the manufacturer or default values from a national annex are not available, default values are calculated according to Annex A.

It is assumed that nominal values correspond to maximum power output, therefore:

— $\Phi_{\text{cmb,max}} = \Phi_{\text{cmb}}$ maximum combustion power of the generator;

— $\alpha_{\text{ch,on,max}} = \alpha_{\text{ch,on}}$ heat loss factor at maximum combustion power $\Phi_{\text{cmb,max}}$.

5.6.2.3 Calculation procedure (for multistage or modulating generators)

The procedure begins following a method similar to that described in 5.6.1 for single on-off generators:

1) Get the total heat output $Q_{\text{H,gen,out}}$ of the generation sub-system, which is equal to $Q_{\text{H,dis,in}}$, total heat to be supplied to the distribution sub-system in the calculation period.

2) Set $\beta_{\text{cmb,min}} = 0{,}5$.

3) Calculate Q_{blw} according to Equation (18).

4) Calculate $\alpha_{\text{ch,on,min,corr}}$ according to Equation (4) using $\alpha_{\text{ch,on,min}}$ instead of $\alpha_{\text{ch,on}}$ and $\beta_{\text{cmb,min}}$ instead of β_{cmb}.

5) Calculate $\alpha_{\text{on,min}}$ and $\alpha_{\text{off,min}}$ according to:

$$\alpha_{\text{ON,min}} = \alpha_{\text{ch,on,min,corr}} - \alpha_{\text{cond}} + \frac{\alpha_{\text{gen,env,corr}} + \alpha_{\text{vent,on}}}{k_{\text{cmb,min}}} \tag{26}$$

$$\alpha_{\text{OFF,min}} = \frac{\alpha_{\text{plt}} + \alpha_{\text{vent,off}}}{k_{\text{cmb,min}}} \tag{27}$$

6) Calculate a new $\beta_{\text{cmb,min}}$ using:

$$\beta_{\text{cmb,min}} = \frac{100 \cdot \dfrac{Q_{\text{H,gen,out}} - Q_{\text{blw}}}{\Phi_{\text{cmb,min}} \cdot t_{\text{gen}}} + \alpha_{\text{OFF,min}}}{100 + k_{\text{br}} \cdot \beta_{\text{aux,br}} - \alpha_{\text{ON,min}} + \alpha_{\text{OFF,min}}} \tag{28}$$

7) Calculate a new t_{on} with:

$$t_{\text{on}} = t_{\text{gen}} \cdot \beta_{\text{cmb,min}} \tag{29}$$

8) If any of the values in Equation (28) is dependent on t_{on}, repeat the calculation from step 4 until old and new β_{cmb} present a difference in absolute value lower than 0,001.

If the load factor $\beta_{\text{cmb,min}}$ converges to a value which is not greater than 1 (generator will operate with two possible states: burner off or burner at minimum power), then:

- the fuel input $E_{\text{H,gen,in}}$ is given by:

$$E_{\text{H,gen,in}} = t_{\text{on}} \cdot \Phi_{\text{cmb,min}} \tag{30}$$

- the auxiliary energy input $W_{\text{H,gen,aux}}$ is given by:

$$W_{\text{H,gen,aux}} = t_{\text{on}} \cdot \Phi_{\text{br,min}} + t_{\text{gen}} \cdot \Phi_{\text{blw}} \tag{31}$$

If the load factor β_{cmb} converges to a value greater than 1 (generator will operate between two possible states: burner at minimum power or burner at maximum power), then $t_{\text{on}} = t_{\text{gen}}$ and the average combustion power $\Phi_{\text{Pcmb,avg}}$ is calculated as follows:

9) Get the total heat output $Q_{\text{H,gen,out}}$ of the generation sub-system, which is equal to $Q_{\text{H,dis,in}}$, total heat to be supplied to the distribution sub-system in the calculation period.

10) Calculate $\alpha_{\text{ch,on,corr}}$ according to Equation (4) using 1 instead of β_{cmb}.

11) Calculate $\alpha_{\text{ch,on,min,corr}}$ according to Equation (4) using $\alpha_{\text{ch,on,min}}$ instead of $\alpha_{\text{ch,on}}$ and 1 instead of β_{cmb}.

12) Calculate α_{ch} with:

$$\alpha_{\text{ch}} = \alpha_{\text{ch,on,corr}} - \alpha_{\text{cond}} \tag{32}$$

13) Calculate $\alpha_{\text{ch,min}}$ with:

$$\alpha_{\text{ch,min}} = \alpha_{\text{ch,on,corr,min}} - \alpha_{\text{cond,min}} \tag{33}$$

14) Calculate Q_{br} and $Q_{\mathrm{br,min}}$ according to Equation (15).

15) Calculate Q_{blw} according to Equation (18)

    (i.e. $Q_{\mathrm{blw}} = P_{\mathrm{blw}} \cdot k_{\mathrm{blw}} \cdot t_{\mathrm{gen}}$).

16) Set $\Phi_{\mathrm{cmb,avg}} = \Phi_{\mathrm{cmb,min}}$.

17) Calculate k_{mod} with:

$$k_{\mathrm{mod}} = \frac{\Phi_{\mathrm{cmb,avg}} - \Phi_{\mathrm{cmb,min}}}{\Phi_{\mathrm{cmb,max}} - \Phi_{\mathrm{cmb,min}}} \tag{34}$$

18) Calculate $\alpha_{\mathrm{on,avg}}$ with:

$$\alpha_{\mathrm{on,avg}} = \alpha_{\mathrm{ch,min}} + \left(\alpha_{\mathrm{ch}} - \alpha_{\mathrm{ch,min}}\right) \cdot k_{\mathrm{mod}} + \left(\alpha_{\mathrm{gen,env,corr}} + \alpha_{\mathrm{vent,on}}\right) \cdot \frac{\Phi_{\mathrm{cmb,max}}}{\Phi_{\mathrm{cmb,avg}}} \tag{35}$$

19) Calculate a new $\Phi_{\mathrm{cmb,avg}}$ with:

$$\Phi_{\mathrm{cmb,avg}} = \frac{Q_{\mathrm{H,gen,out}} - Q_{\mathrm{blw}} - Q_{\mathrm{br}}}{t_{\mathrm{gen}} \cdot \left(1 - \frac{\alpha_{\mathrm{on,avg}}}{100}\right)} \tag{36}$$

20) Repeat steps 9, 10, 11 and 12 until $\Phi_{\mathrm{cmb,avg}}$ converges with an absolute variation between old and new value lower than 0,2 % in absolute value.

21) Calculate the energy to be supplied by the fuel with:

$$E_{\mathrm{H,gen,in}} = \Phi_{\mathrm{cmb,avg}} \cdot t_{\mathrm{gen}} \tag{37}$$

22) Calculate total auxiliary energy $W_{\mathrm{H,gen,aux}}$ with:

$$W_{\mathrm{H,gen,aux}} = \frac{Q_{\mathrm{br,avg}}}{k_{\mathrm{br}}} + \frac{Q_{\mathrm{blw}}}{k_{\mathrm{blw}}} \tag{38}$$

23) Calculate total heat losses by:

$$Q_{\mathrm{H,gen,ls}} = E_{\mathrm{H,gen,in}} - Q_{\mathrm{H,gen,out}} + Q_{\mathrm{br,avg}} + Q_{\mathrm{blw}} \tag{39}$$

24) There are no recoverable heat losses, since recovery has been taken into account as a reduction of heat losses through the generator envelope:

$$Q_{\mathrm{H,gen,ls,rbl}} = 0 \tag{40}$$

Annex A
(informative)

Default values

A.1 Default values for ($\alpha_{\text{ch,on}}$)

Default data for heat losses through the chimney with burner on and auxiliary power for appliances of different manufacturing date are given in Tables A.1, A.2 and A.3.

Table A.1 — Default values of $\theta_{\text{gen,air,test}}$, $f_{\text{corr,ch,on}}$ and $\alpha_{\text{ch,on}}$

Type of appliance			**Manufacturing date**		
			after 2005	**1990 - 2005**	**before 1990**
Description	$\theta_{\text{gen,air,test}}$ °C	$f_{\text{corr,ch,on}}$ –	$\alpha_{\text{ch,on}}$ %	$\alpha_{\text{ch,on}}$ %	$\alpha_{\text{ch,on}}$ %
Overhead luminous radiant heater	20	0	0	0	0
Overhead radiant tube heater unflued	20	0	0	0	0
Overhead radiant tube heater flued	20	0,25	10	13	16
Air heater with natural draught burner	20	0,18	13	15	18
Air heater with forced draught burner	20	0,18	10	13	16
Air heater modulating output	20	0,18	8	10	n.A.
Condensing air heater	20	0,18	5	n.A.	n.A.

Table A.2 — Additional default values for multistage or modulating appliances $\alpha_{\text{ch,on,min}}$

Type of appliance		**Manufacturing date**		
		after 2005	**1990 - 2005**	**before 1990**
Description	$K_{\text{cmb, min}}$ %	$\alpha_{\text{ch,on,min}}$ %	$\alpha_{\text{ch,on,min}}$ %	$\alpha_{\text{ch,on,min}}$ %
Overhead luminous radiant heater	0,5	0	0	0
Overhead radiant tube heater unflued	0,7	0	0	0
Overhead radiant tube heater flued	0,7	8	10	13
Air heater modulating output and combustion air	0,7	6	8	10
Air heater modulating output and not combustion air	0,7	12	14	n.A.
Modulating condensing air heater	0,3	3	n.A.	n.A

Table A.3 — Default values of exponent $n_{\text{ch,on}}$ and $P_{\text{aux,blw}}$, $P_{\text{aux,br}}$

Description	$c_{\text{mass,on}}$ kg/kW	$n_{\text{ch,on}}$ –	$y_{\text{aux,blw}}$ % of Φ_{cmb}	$y_{\text{aux,br}}$ % of Φ_{cmb}
Overhead luminous radiant heater (unflued)	NA	NA	0	0,18
Overhead radiant tube heater ≤ 60 kW (see NOTE 3)	1 to 2	0,1	0	0,25
Air heater (axial blowing)	1 to 2	0,1	0	0,9
Air heater (centrifugal blowing)	1 to 2	0,1	0	1,7
Overhead radiant tube heater > 60 kW (see NOTE 4)	> 2	0,15	2	0,3

Calculate auxiliary power by:

$$P_{\text{aux,blw}} = y_{\text{aux,blw}} \cdot \Phi_{\text{cmb}} \tag{A.1}$$

$$P_{\text{aux,br}} = y_{\text{aux,br}} \cdot \Phi_{\text{cmb}} \tag{A.2}$$

NOTE 1 $c_{\text{mass,ch,on}}$ is the ratio between the mass of the heat exchange surface between flue gas and air and nominal combustion power in kg/kW.

NOTE 2 $y_{\text{aux,blw}}$ is the power factor of additional auxiliary equipment (after the burner), expressed as a percentage of the nominal heat input of the generator (system).

NOTE 3 Standard radiant tube heater, tube diameter < 105 mm, input range 10 kW to 60 kW, flue gases not recirculating inside the tube system, generator installed inside the heated space.

NOTE 4 Large tube heater, tube diameter 105 mm – 400 mm, input range mainly > 60 kW, flue gases partly recirculating in the tube system by secondary fan, generator installed inside or outside the heated space.

NOTE 5 Value for auxiliary power $y_{\text{aux,br}}$ factor for radiant luminous heaters (0,18) includes the power for the fan(s) installed in upper area of the walls or in the roof for indirect evacuation of the combustion products of the appliances together with room air according to EN 13410.

A.2 Default values for (α_{vent})

Default data for specific ventilation heat losses with burner on (only type A appliances) are given in Table A.4.

Table A.4 — Default values

Parameter	Description	Default value	Unit
V_{vent}	Amount of specific ventilation required to evacuate the flue gases	10	m^3/h per kW
c_{p}	Specific heat capacity of the flue/air-mixture exiting the building	0,34 · 10^3	kWh/m^{3}K
θ_{exh}	Temperature of the flue/air-mixture exiting the building	See Equation (A.3)	°C
θ_{e}	Average (monthly) external air temperature	(see national data)	°C
θ_{i}	Internal design temperature of the building Temperature difference inside the building	18	°C
$\Delta\theta_{\text{rad}}$	between room (set-point) and air temperature (building heated with radiant heaters)	2,5	K
H	Height of the building	(see project data)	m
$Gradient$	Gradient of air temperature for buildings heated with radiant heaters between air entrance (bottom) and exit (top) of the building	0,3	K/m

The temperature of the air/flue-mixture exiting the building near the roof is given by:

$$\theta_{\text{exh}} = \theta_{\text{i}} - \Delta\theta_{\text{rad}} + H \cdot Gradient \qquad \text{(A.3)}$$

NOTE Equation (A.3) takes into account the specific temperature stratification of high buildings heated by radiant heaters (see EN 15316-2-1). The air temperature near the floor (area where people are staying or working) is typically lower (-2,5 K) than the demanded room temperature. The temperature gradiant over the height has a characteristic value depending on the heating system (0,3 K/m) for radiant heaters (see EN 15316-2-1).

A.3 Default values for ($\alpha_{\text{gen,env}}$)

Default data for heat losses through the envelope with burner on are given in Tables A.5 and A.6. The default losses through the burner envelope $\alpha_{\text{gen,env}}$ are given by:

$$\alpha_{\text{gen,env}} = c_1 - c_2 \cdot \log\left(\frac{\Phi_{\text{cmb}}}{1000\,W}\right) \qquad \text{(A.4)}$$

where

c_1, c_2 are the parameters given in Table A.5;

Φ_{cmb} Heater nominal combustion power.

Table A.5 — Default values of parameters c_1 and c_2

Heaters insulation type	c_1 %	c_2 %
Well insulated, high efficiency new appliance	1,72	0,44
Well insulated and maintained	3,45	0,88
Old unit with average insulation	6,90	1,76
Old unit, poor insulation	8,36	2,2
No insulation	10,35	2,64

Table A.6 — Default values for corrected envelope losses $k_{\text{gen,env}}$

Heater type and location	$k_{\text{gen,env}}$ –
Heater installed within the heated space without direct contact with wall or roof	0
Heater installed within the heated space with direct contact with wall or roof	0,1
Heater installed within a boiler room	0,7
Heater installed under the roof, outside the heated space	0,8
Heater installed outdoors	1,0

A.4 Default values for (α_{plt})

Default data for heat losses by permanent pilot flame with burner off are given in Table A.7.

Table A.7 — Default value of α_{plt}

Description	α_{plt} %
Heater with permanent pilot flame	2
Heater without permanent pilot flame	0

A.5 Default values for (α_{cond})

Default data for heat recovery by condensation with burner on are given in Table A.8.

Table A.8 — Default values for combustion efficiency on fuel net calorific value, condensing appliances manufactured after 2005

Description	η_{cmb} %	$\eta_{\mathrm{cmb,min}}$ %
On-Off appliances	104	
Multi-stage or modulating appliances with modulated combustion air flow	94	104
Multi-stage or modulating appliances without modulated combustion air flow	102	90

A.6 Default values for auxiliary energy

Default data for auxiliary energy and recovered auxiliary energy are given in Table A.9.

Table A.9 — Default values for auxiliary energy

Description	k_{br}
Heater located within the heated space	1
Heater located outside the heated space	0,8

Annex B
(informative)

Examples of use of the calculation

B.1 Calculation example 1 - Overhead radiant tube heating system

Heating system consisting of 3 on/off radiant tube heaters, 60kW, flued, non-condensing, manufactured 2007

$\theta_{\text{gen, air, test}} = 20$, $\theta_{\text{gen, air}} = 20$

Heaters located within the heated space

$Q_{\text{H,gen,out}} = 50\ 000$ kWh

Nominal combustion power of the generators: 42 KW · 3 units = 126 kW

$t_{\text{gen}} = 720$ h (1 month)

Set $t_{\text{on}} = 0{,}5\ t_{\text{gen}}$

$t_{\text{on}} = 360$, $\beta_{\text{cmb}} = 0{,}5$

Calculate $\alpha_{\text{on}} = \alpha_{\text{ch,on,corr}} + \alpha_{\text{vent,on}} + \alpha_{\text{gen,env,corr}} - \alpha_{\text{cond}}$

$$\alpha_{\text{ch,on,corr}} = \left[\alpha_{\text{ch,on}} + \left(\theta_{\text{gen,air}} - \theta_{\text{gen,air,test}}\right)\cdot f_{\text{corr,ch,on}}\right]\cdot \beta_{\text{cmb}}^{n_{\text{ch,on}}} \qquad \text{Equation (4)}$$

$\alpha_{\text{ch,on,corr}} = (10 + 0) \cdot 0{,}5$ puissance $0{,}1 = 9{,}33\%$

$\alpha_{\text{vent,on}} = 0$ (flued system)

$\alpha_{\text{gen,env,corr}} = k_{\text{gen,env}} \cdot \alpha_{\text{gen,env}} = 0$, Equation (9)

as heaters are installed within the heated space without direct contact with wall or roof

$\alpha_{\text{cond}} = 0$, as heaters are non condensing

$\alpha_{\text{on}} = \alpha_{\text{ch,on,corr}} + \alpha_{\text{vent,on}} + \alpha_{\text{gen,env,corr}} - \alpha_{\text{cond}}$ Equation (11)

$\alpha_{\text{off}} = \alpha_{\text{plt}} + \alpha_{\text{vent,off}} = 0$ (no pilot) + 0 (flued system) Equation (12)

$Q_{\text{blw}} = W_{\text{blw}} \cdot k_{\text{blw}}$ with $W_{\text{blw}} = P_{\text{aux,blw}} \cdot t_{\text{gen}}$ Equation (18)

as $P_{\text{aux,blw}} = 0$ (see Table A.3), $Q_{\text{blw}} = 0$

$Q_{\text{br}} = W_{\text{br}} \cdot k_{\text{br}}$ with $W_{\text{br}} = P_{\text{aux,br}} \cdot t_{\text{on}}$ Equation (15)

= 0,002 5 (see Table A.3) · 42 kW · 3 units · 720 h · 0,5 = 113 kWh

As $k_{\mathrm{br}} = 1$ (see Table A.9), $Q_{\mathrm{br}} = 113$ kWh

Calculate the load factor:

$$\beta_{\mathrm{cmb}} = \frac{100 \times \dfrac{Q_{\mathrm{H,gen,out}} - Q_{\mathrm{blw}}}{\Phi_{\mathrm{cmb}} \cdot t_{\mathrm{gen}}} + \alpha_{\mathrm{OFF}}}{100 + k_{\mathrm{br}} \cdot \beta_{\mathrm{aux,br}} - \alpha_{\mathrm{ON}} + \alpha_{\mathrm{OFF}}} \qquad \text{Equation (19)}$$

$\beta_{\mathrm{cmb}} = (100 \cdot ((50\,000 - 0)/42 \cdot 3 \cdot 720) + 0) / (100 + 1 \cdot 0{,}25 - 9{,}33 + 0) = 60{,}61$ %

Recalculate (Iteration 1):

$\alpha_{\mathrm{ch,on,corr}} = (10 + 0) \cdot 0{,}606$ puissance $0{,}1 = 9{,}51$ % Equation (4)

$\alpha_{\mathrm{on}} = \alpha_{\mathrm{ch,on,corr}} + \alpha_{\mathrm{vent,on}} + \alpha_{\mathrm{gen,env,corr}} - \alpha_{\mathrm{cond}} = 9{,}51 + 0 + 0 - 0 = 9{,}51$ % Equation (11)

$\alpha_{\mathrm{off}} = \alpha_{\mathrm{plt}} + \alpha_{\mathrm{vent,off}} = 0$ (no pilot) $+ 0$ (flued system) (unchanged) Equation (12)

$Q_{\mathrm{blw}} = W_{\mathrm{blw}} \cdot k_{\mathrm{blw}}$ with $W_{\mathrm{blw}} = P_{\mathrm{aux,blw}} \cdot t_{\mathrm{gen}}$. as $P_{\mathrm{aux,blw}} = 0$ (see Table A.3), $Q_{\mathrm{blw}} = 0$ (unchanged)

$Q_{\mathrm{br}} = W_{\mathrm{br}} \cdot k_{\mathrm{br}}$ with $W_{\mathrm{br}} = P_{\mathrm{aux,br}} \cdot t_{\mathrm{on}} =$ 0,002 5 (see Table A.3) · 42 kW · 3 units · 720h · 0,606 1 = 137 kWh

As $k_{\mathrm{br}} = 1$ (see Table A.9), $\boldsymbol{Q_{\mathrm{br}} = 137}$ **kWh**

Recalculate the load factor:

$$\beta_{\mathrm{cmb}} = \frac{100 \cdot \dfrac{Q_{\mathrm{H,gen,out}} - Q_{\mathrm{blw}}}{\Phi_{\mathrm{cmb}} \cdot t_{\mathrm{gen}}} + \alpha_{\mathrm{OFF}}}{100 + k_{\mathrm{br}} \cdot \beta_{\mathrm{aux,br}} - \alpha_{\mathrm{ON}} + \alpha_{\mathrm{OFF}}} \qquad \text{Equation (19)}$$

$\beta_{\mathrm{cmb}} = (100 \cdot ((50\,000 - 0) / 42 \cdot 3 \cdot 720) + 0) / (100 + 1 \cdot 0{,}25 - 9{,}51 + 0) = 0{,}60740$

The next iteration gives 0,60742. As the difference is less than 0,001, iteration is converged.

Calculate the fuel input $E_{\mathrm{H,gen,in}}$ according to:

$\boldsymbol{E_{\mathrm{H,gen,in}} = 42 \cdot 3 \cdot 720 \cdot 0{,}60740 = 55\,105}$ **kWh** Equation (21)

Calculate the auxiliary energy input with

$\boldsymbol{W_{\mathrm{H,gen,aux}} = 720 \cdot 0{,}60740 \cdot 0{,}25 \cdot 42 \cdot 3 = 138}$ **kWh** Equation (22)

end of calculation

B.2 Calculation example 2 — Overhead luminous radiant heating system

Heating system consisting of 6 on/off overhead luminous radiant heaters manufactured 2007, unflued, mechanical ventilation is interelocked with the burners, building height is 10 m, internal design temperature 20 °C.

$\theta_{\text{gen,air,test}} = 20$, $\theta_{\text{gen,air}} = 20$

Heaters located within the heated space $Q_{\text{H,gen,out}} = 50\,000$ kWh

Nominal combustion power of the generators: 21 KW · 6 units = 126 kW

$\theta_{\text{e}} = 2°\text{C}$, $\theta_{\text{i}} = 20°\text{C}$

$t_{\text{gen}} = 720$ h (1 month)

Set $t_{\text{on}} = 0{,}5\ t_{\text{gen}}$

$t_{\text{on}} = 360$, $\beta_{\text{cmb}} = 0{,}5$

Calculate $\alpha_{\text{on}} = \alpha_{\text{ch,on,corr}} + \alpha_{\text{vent,on}} + \alpha_{\text{gen,env,corr}} - \alpha_{\text{cond}}$

$\alpha_{\text{ch,on,corr}} = [\alpha_{\text{ch,on}} + (\theta_{\text{gen,air}} - \theta_{\text{gen,air,test}}) \cdot f_{\text{corr,ch,on}}] \cdot \beta_{\text{cmb}}^{n_{\text{ch,on}}}$ Equation (4)

$\alpha_{\text{ch,on,corr}} = (0 + 0) \cdot 0{,}5$ puissance $0{,}05 = 0\ \%$

$\theta_{\text{exh}} = \theta_{\text{i}} - \Delta\theta_{\text{rad}} + H \cdot Gradiant = 20 - 2{,}5 + 10 \cdot 0{,}3 = 20{,}5\ °\text{C}$ Equation (A.3)

$\alpha_{\text{vent,on}} = (10^{-3} \cdot 21 \cdot 6 \cdot 10 \cdot 0{,}34 \cdot (20{,}5 - 2)) / 21 \cdot 6 = 6{,}3\ \%$ Equations (7) (6) (5)

$\alpha_{\text{gen,env,corr}} = k_{\text{gen,env}} \cdot \alpha_{\text{gen,env}} = 0,$ Equation (9)

as heaters are installed within the heated space without direct contact with wall or roof

$\alpha_{\text{cond}} = 0$, as heaters are non condensing Equation (10)

$\alpha_{\text{on}} = \alpha_{\text{ch,on,corr}} + \alpha_{\text{vent,on}} + \alpha_{\text{gen,env,corr}} - \alpha_{\text{cond}} = 0 + 6{,}3 + 0 - 0 = 6{,}3\ \%$ Equation (11)

$\alpha_{\text{off}} = \alpha_{\text{plt}} + \alpha_{\text{vent,off}} = 0$ (no pilot) + 0 (burner interlocked with ventilation) Equation (12)

$Q_{\text{blw}} = 0$

$Q_{\text{br}} = W_{\text{br}} \cdot k_{\text{br}}$ with $W_{\text{br}} = P_{\text{aux,br}} \cdot t_{\text{on}} = 0{,}001\,8$ (see Table A.3) · 21 kW · 6 units · 360 h = 82 kWh Equation (15)

$$\beta_{\text{cmd}} = \frac{100\dfrac{Q_{\text{H,gen,out}} - Q_{\text{blw}}}{\Phi_{\text{cmb}} \times t_{\text{gen}}} + \alpha_{\text{OFF}}}{100 + k_{\text{br}} \times \beta_{\text{aux,br}} - \alpha_{\text{ON}} + \alpha_{\text{OFF}}}$$ Equation (19)

$\beta_{\text{cmb}} = (100 \cdot ((50\,000 - 0) / 21 \cdot 6 \cdot 720) + 0) / (100 + 1 \cdot 0{,}18 - 6{,}3 + 0) = 0{,}5871$

Therefore new $t_{\text{on}} = 0{,}5871 \cdot 720 = 423$ h Equation (3)

As there is no impact of β_{cmb} on α_{on} no further iteration is required

Calculate the fuel input $E_{\mathrm{H,gen,in}}$ according to:

$$\boldsymbol{E_{\mathrm{H,gen,in}} = 21 \cdot 6 \cdot 423 = 53259\ \mathrm{kWh}}$$ Equation (21)

Equation (19)

Calculate the auxiliary energy input with

$$\boldsymbol{W_{\mathrm{H,gen,aux}} = 423 \cdot 0{,}18 \cdot 21 \cdot 6 = 95\ \mathrm{kWh}}$$ Equation (22)

end of calculation

B.3 Calculation example 3 — Condensing air heating system

Installation consists of 2 modulating condensing unit heaters, manufactured 2007, heaters are modulating the combustion air, heaters installed within the heated space, wall mounted with brackets (i.e. without wall contact)

$\theta_{\mathrm{gen,air,test}} = 20,\ \theta_{\mathrm{gen,air}} = 20$

$Q_{\mathrm{H,gen,out}} = 50\ 000$ kWh

Nominal combustion power of the generator: 63 KW · 2 units

$t_{\mathrm{gen}} = 720$ h (1 month)

Set $t_{\mathrm{on}} = 0{,}5\ t_{\mathrm{gen}}$

$t_{\mathrm{on}} = 360$, $\beta_{\mathrm{cmb}} = 0{,}5$ Calculate $\alpha_{\mathrm{on,min}}$ according to:

$$\alpha_{\mathrm{ON,min}} = \alpha_{\mathrm{ch,ON,min}} - \alpha_{\mathrm{cond}} + \frac{\alpha_{\mathrm{gen,env,corr}} + \alpha_{\mathrm{vent,on}}}{k_{\mathrm{cmb,min}}}$$ Equation (26)

$\alpha_{\mathrm{ch,on,min,corr}} = (0{,}5 + 0) \cdot 0{,}5$ puissance $0{,}1 = 4{,}665$ % Equation (4)

$\alpha_{\mathrm{vent,on,min}} = 0$ (air heater, flued)

$\alpha_{\mathrm{gen,env,corr,min}} = k_{\mathrm{gen,env}} \cdot \alpha_{\mathrm{gen,env}} = 0$, as heaters are installed within the heated Equation (9)

space without direct contact with wall or roof

$\alpha_{\mathrm{cond,min}} = 104 - 100 + 4{,}665 = 8{,}665$ Equation (10)

$\alpha_{\mathrm{on,min}} = \alpha_{\mathrm{ch,on,corr,min}} + \alpha_{\mathrm{vent,on,min}} + \alpha_{\mathrm{gen,env,corr,min}} - \alpha_{\mathrm{cond,min}} = -4$

(negative value possible as calculated on net calorific value of the fuel)

Calculate $\alpha_{\mathrm{off,min}}$ according to: $$\alpha_{\mathrm{OFF,min}} = \frac{\alpha_{\mathrm{plt}} + \alpha_{\mathrm{vent,off}}}{k_{\mathrm{cmb,min}}}$$ Equation (27)

$\alpha_{\mathrm{off,min}} = 0$, as $\alpha_{\mathrm{vent,off}} = 0$ and $\alpha_{\mathrm{plt+}} = 0$

Calculate a new $\beta_{\mathrm{cmb,min}}$

$\beta_{\mathrm{cmb,min}} = (100 \cdot ((50\,000 - 0) / 63 \cdot 0{,}3 \cdot 2 \cdot 720) + 0) / (100 + 1 \cdot 0{,}9 + 4 + 0) = 1{,}751$ Equation (19)

A new calculation of $\beta_{\mathrm{cmb,min}}$ gives identical results with less than 0,001 difference.

Therefore new $t_{\mathrm{on,min}} = 1{,}751 \cdot 720 = 1\,261$ h

As $\beta_{\mathrm{cmb,min}}$ is > 100 %, the unit will run over its minimal output capacity and $t_{\mathrm{on}} = t_{\mathrm{gen}}$.

Calculate now the average combustion power of the heater.

Calculate α_{ch} and $\alpha_{\mathrm{ch,min}}$ at a load factor 1:

$\alpha_{\mathrm{ch,min}} = (5 + 0) \cdot 1$ puissance $0{,}1 - (104 - 100 + 5) = -4$ Equation (33)

$\alpha_{\mathrm{ch}} = (6 + 0) \cdot 1$ puissance $0{,}1 - 0 = 6$ Equation (32)

as $\alpha_{\mathrm{acond,min}} = 0$, $\eta_{\mathrm{cmb,max}} \leq 100$ Equation (10)

$Q_{\mathrm{br}} = W_{\mathrm{br}} \cdot k_{\mathrm{br}}$ with $W_{\mathrm{br}} = P_{\mathrm{aux,br}} \cdot t_{\mathrm{on}} = 0{,}009$ (see Table A.3) $\cdot\ 1 \cdot 63$ kW $\cdot\ 2$ units $\cdot\ 720$h $= 816$ kWh

$Q_{\mathrm{blw}} = 0$ (see Table A.3)

Calculate $k_{\mathrm{mod}} = (0{,}3 \cdot 63 \cdot 2 - 0{,}3 \cdot 63 \cdot 2) / (1 \cdot 63 \cdot 2 - 0{,}3 \cdot 63 \cdot 2) = 0$ Equation (34)

$\alpha_{\mathrm{on,avg}} = -4 + (6 - -4) \cdot 0 + 0 = -4$ Equation (35)

$\Phi_{\mathrm{cmb,avg}} = ((50\,000 - 0 - 816) / (720 \cdot (1 - 0{,}04)) = 65{,}68$ kW Equation (36)

Recalculate $\alpha_{\mathrm{on,avg}}$ (Step 1)

Calculate $k_{\mathrm{mod}} = (65{,}68 - 0{,}3 \cdot 63 \cdot 2) / (1 \cdot 63 \cdot 2 - 0{,}3 \cdot 63 \cdot 2) = 0{,}316$ Equation (34)

$\alpha_{\mathrm{on,avg}} = -4 + (6 - -4) \cdot 0{,}316 = -0{,}839\,0$ Equation (35)

new $\Phi_{\mathrm{cmb,avg}} = ((50\,000 - 0 - 816) / (720 \cdot (1 - -0{,}008\,390)) = 67{,}74$ kW Equation (36)

Recalculate $\alpha_{\mathrm{on,avg}}$ (Step 2)

Calculate $k_{\mathrm{mod}} = (67{,}74 - 0{,}3 \cdot 63 \cdot 2) / (1 \cdot 63 \cdot 2 - 0{,}3 \cdot 63 \cdot 2) = 0{,}339$ Equation (34)

$\alpha_{\mathrm{on,avg}} = -4 + (6 - -4) \cdot 0{,}339) = -0{,}6052$ Equation (35)

new $\Phi_{\mathrm{cmb,avg}} = ((50\,000 - 0 - 816) / (720 \cdot (1 - -0{,}006\,052)) = 67{,}90$ kW Equation (36)

Recalculate $\alpha_{\mathrm{on,avg}}$ (Step 3)

Calculate $k_{\mathrm{mod}} = (67{,}90 - 0{,}3 \cdot 63 \cdot 2) / (1 \cdot 63 \cdot 2 - 0{,}3 \cdot 63 \cdot 2) = 0{,}341$ Equation (34)

$\alpha_{\mathrm{on,avg}} = -4 + (6 - -4) \cdot 0{,}341 -0{,}587\,3$ Equation (35)

new $\Phi_{\mathrm{cmb,avg}} = ((50\,000 - 0 - 816) / (720 \cdot (1 - -0{,}006\,052)) = 67{,}91$ kW Equation (36)

Convergence is obtained as $\left| 67{,}90 - 67{,}91 \right|$ / 67,91 < 0,2 %.

Calculate the fuel input $E_{\mathrm{H,gen,in}}$ according to:

$$E_{\mathbf{H,gen,in}} = \mathbf{67{,}91 \cdot 720 = 48\ 895\ kWh} \qquad \text{Equation (37)}$$

Calculate the auxiliary energy input with

$$W_{\mathbf{H,gen,aux}} = \mathbf{720 \cdot 0{,}9 \cdot 63 \cdot 2 = 816\ kWh} \qquad \text{Equation (38)}$$

end of calculation

Bibliography

[1] EN 15316-1:2007, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 1: General*

[2] EN 15316-4-7:2008, *Heating systems in buildings — Method for calculation of system energy requirements and system efficiencies — Part 4-7: Space heating generation systems, biomass combustion systems*

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