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BSI Standards Publication

Gas-fired endothermic engine driven heat pumps

Part 5: Calculation of seasonal performances in heating and cooling mode

bsi.

National foreword

This British Standard is the UK implementation of EN 16905-5:2017.

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A list of organizations represented on this committee can be obtained on request to its secretary.

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Gasbefeuerte endothermische Motor-Wärmepumpen - Teil 5: Berechnung der saisonalen Effizienzkennzahlen im Heiz- und Kühlmodus

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European foreword

This document (EN 16905-5:2017) has been prepared by Technical Committee CEN/TC 299 "Gas-fired sorption appliances, indirect fired sorption appliances, gas-fired endothermic engine heat pumps and domestic gas-fired washing and drying appliances", the secretariat of which is held by UNI.

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of an identical text or by endorsement, at the latest by September 2017, and conflicting national standards shall be withdrawn at the latest by September 2017.

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

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative Annex ZA and Annex ZB, which are integral parts of this document.

This standard comprises the following parts under the general title, *Gas-fired endothermic engine driven heat pumps:*

— *Part 1: Terms and definitions*;

— *Part 2: Safety* (WI 00299025; currently in preparation);

— *Part 3: Test conditions*;

— *Part 4: Test methods*;

— *Part 5: Calculation of seasonal performances in heating and cooling mode*.

EN 16905-1, prEN 16905-2, EN 16905-3, EN 16905-4 and EN 16905-5 have been prepared to address the essential requirements of the European Directive 2009/142/EC relating to appliances burning gaseous fuels (see prEN 16905-2:201X, Annex ZA for safety aspects and EN 16905-5:2017, Annex ZA for rational use of energy aspects).

These documents are linked to the Energy Related Products Directive (2009/125/EC) in terms of tests conditions, tests methods and seasonal performances calculation methods under Mandate M/535; (see EN 16905-3:2017, Annex ZA, EN 16905-4:2017, Annex ZA, EN 16905-5:2017, Annex ZA and prEN 16905-2:201X, Annex ZB).

These documents will be reviewed whenever new mandates could apply.

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

1 Scope

1.1 Scope of EN 16905 series

This European Standard specifies the requirements, test methods and test conditions for the rating and performance calculation of air conditioners and heat pumps using either air, water or brine as heat transfer media, with gas-fired endothermic engine driven compressors when used for space heating, cooling and refrigeration, hereafter referred to as "GEHP appliance".

This European Standard only applies to appliances with a maximum heat input (based on net calorific value) not exceeding 70 kW at standard rating conditions.

This European Standard only applies to appliances under categories I_{2H}, I_{2E}, I_{2Er}, I_{2R}, $I_{2E(S)B}$, I_{2L}, I_{2LL}, I_{2ELL}, $I_{2E(R)B}$, I_{2ESi}, $I_{2E(R)}$, I_{3P}, I_{3B}, $I_{3B/P}$, II_{2H3+}, II_{2Er3+}, $II_{2H3B/P}$, $II_{2L3B/P}$, $II_{2E3B/P}$, $II_{2ELL3B/P}$, II_{2L3P}, II_{2H3P}, II_{2E3P} and II_{2Er3P} according to EN 437.

This European Standard only applies to appliances having:

a) gas fired endothermic engines under the control of fully automatic control systems;

b) closed system refrigerant circuits in which the refrigerant does not come into direct contact with the fluid to be cooled or heated;

c) where the temperature of the heat transfer fluid of the heating system (heating water circuit) does not exceed 105 °C during normal operation;

d) where the maximum operating pressure in the:

   1) heating water circuit (if installed) does not exceed 6 bar,

   2) domestic hot water circuit (if installed) does not exceed 10 bar.

This European Standard applies to appliances only when used for space heating or space cooling or for refrigeration, with or without heat recovery.

The appliances having their condenser cooled by air and by the evaporation of external additional water are not covered by this European Standard.

Packaged units, single split and multisplit systems are covered by this European Standard. Single duct and double duct units are covered by this European Standard.

The above appliances can have one or more primary or secondary functions.

This European Standard is applicable to appliances that are intended to be type tested. Requirements for appliances that are not type tested would need to be subject to further consideration.

In the case of packaged units (consisting of several parts), this European Standard applies only to those designed and supplied as a complete package.

NOTE All the symbols given in this text are used regardless of the language used.

1.2 Scope of EN 16905-5

This part of the EN 16905 series specifies the calculation of seasonal performance factor for gas-fired endothermic engine driven heat pumps for heating and/or cooling mode including the engine heat recovery.

2 Normative references

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

EN 16905-1, *Gas-fired endothermic engine driven heat pumps — Part 1: Terms and definitions*

EN 16905-4:2017, *Gas-fired endothermic engine driven heat pumps — Part 4: Test methods*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 16905-1 apply.

4 Part load conditions in cooling mode

4.1 General

For the purpose of calculation of application $SGUE_c$, $SAEF_c$, $SEHREgas_c$, $SEHREelec_c$ and reference $SGUE_c$, $SAEF_c$, $SEHREgas_c$, $SEHREelec_c$ as explained in Clauses 6 and 7, the part load ratios mentioned below shall be based on the part load ratio Formulae (1)st column of Tables 1 to 2) and not on the rounded figures as mentioned in the 2nd column of these tables. The calculation of $SGUE_c$, $SAEF_c$, $SEHREgas_c$, $SEHREelec_c$ and reference $SGUE_c$, $SAEF_c$, $SEHREgas_c$, $SEHREelec_c$ is determined via linear interpolation of the respective part load values at the reference part load conditions mentioned below (A, B, C, D).

4.2 Air-to-air units

The part load conditions for determining the reference $SGUE_c$ (Formula (2)), $SAEF_c$ (Formula (4)), $SEHREgas_c$ (Formula (7)), $SEHREelec_c$ (Formula (8)) are given in the following table:

Table 1 — Part load conditions of air to air units and air-cooled multisplit systems in cooling mode

	Part load ratio	Part load ratio %	Outdoor air dry bulb temperature °C	Indoor air dry bulb (wet bulb) temperatures °C
A	(35–16)/(Tdesignc-16)	100	35	27(19)
B	(30–16)/(Tdesignc-16)	74	30	27(19)
C	(25–16)/(Tdesignc-16)	47	25	27(19)
D	(20–16)/(Tdesignc-16)	21	20	27(19)

4.3 Water-to-air and brine to air units

The part load conditions for determining the reference $SGUE_c$ (Formula (2)), $SAEF_c$ (Formula (4)), $SEHREgas_c$ (Formula (7)), $SEHREelec_c$ (Formula (8)) are given in the following table:

Table 2 — Part load conditions of water-to-air and brine-to-air units in cooling mode

	Part load ratio	Part load ratio %	Outdoor heat exchanger			Indoor heat exchanger
			Cooling tower [b] or water loop application Inlet/outlet water temperatures °C	Ground coupled application (water or brine) Inlet/outlet water temperatures °C	Dry cooler application Inlet/outlet water temperatures °C	Air dry bulb (wet bulb) temperatures °C
A	(35–16)/(Tdesignc-16)	100	30/35	10/15	50/45	27(19)
B	(30–16)/(Tdesignc-16)	74	26/[a]	10/[a]	45/[a]	27(19)
C	(25–16)/(Tdesignc-16)	47	22/[a]	10/[a]	40/[a]	27(19)
D	(20–16)/(Tdesignc-16)	21	18/[a]	10/[a]	35/[a]	27(19)

[a] With the water flow rate as determined during the "A" test.

[b] If a cooling tower and a water-to-air unit are sold as a matched assembly, they shall be tested as an air-to-air unit.

4.4 Air-to-water units

For each application, units either allowing or not allowing a variation of the outlet water temperature with the outdoor temperature are considered. The variable outlet temperature shall only be applied when the control provides a regulation of outlet water temperature that considers the outdoor temperature.

The part load conditions for determining the reference $SGUE_c$ (Formula (2)), $SAEF_c$ (Formula (4)), $SEHREgas_c$ (Formula (7)), $SEHREelec_c$ (Formula (8)) are given in the following table:

Table 3 — Part load conditions of air-to-water units in cooling mode

	Part load ratio	Part load ratio %	Outdoor heat exchanger	Indoor heat exchanger		
			Air dry bulb temperature °C	Fan coil application Inlet/outlet water temperatures		Cooling floor application Inlet/outlet water temperatures °C
				Fixed outlet °C	Variable outlet °C	
A	(35–16)/(Tdesignc-16)	100	35	12/7	12/7	23/18
B	(30–16)/(Tdesignc-16)	74	30	[a]/7	[a]/8,5	[a]/18
C	(25–16)/(Tdesignc-16)	47	25	[a]/7	[a]/10	[a]/18
D	(20–16)/(Tdesignc-16)	21	20	[a]/7	[a]/11,5	[a]/18

[a] With the water flow rate as determined during "A" test for units with a fixed water flow rate or with a fixed delta T of 5 K for units with a variable water flow rate.

4.5 Water-to-water and brine-to-water units

For each application, units either allowing or not allowing a variation of the outlet water temperature with the outdoor temperature are considered. The variable outlet temperature shall only be applied when the control provides a regulation of outlet water temperature that considers the outdoor temperature.

The part load conditions for determining the reference $SGUE_c$ (Formula (2)), $SAEF_c$ (Formula (4)), $SEHREgas_c$ (Formula (7)), $SEHREelec_c$ (Formula (8)) are given in the following table:

Table 4 — Part load conditions of water to-water units and brine to-water units in cooling mode

	Part load ratio	Part load ratio %	Outdoor heat exchanger			Indoor heat exchanger		
			Cooling tower[b] application Inlet/outlet water temperatures °C	Ground coupled application (water or brine) Inlet/outlet water temperatures °C	Dry cooler application Inlet/outlet water temperatures °C	Fan coil application Inlet/outlet water temperatures		Cooling floor application Inlet/outlet water temperatures °C
						Fixed outlet °C	Variable outlet °C	
A	(35–1 6) / (Tdesignc-16)	100	30/35	10/15	50/45	12/7	12/7	23/18
B	(30–1 6) / (Tdesignc-16)	74	26/[a]	10/[a]	45/[a]	[a]/7	[a]/8,5	[a]/18
C	(25–1 6) / (Tdesignc-16)	47	22/[a]	10/[a]	40/[a]	[a]/7	[a]/10	[a]/18
D	(20–1 6) / (Tdesignc-16)	21	18/[a]	10/[a]	35/[a]	[a]/7	[a]/11,5	[a]/18

[a] With the water flow rate as determined during "A" test for units with a fixed water flow rate or with a fixed delta T of 5 K for units with a variable water flow rate.

[b] If a cooling tower and water-to-air unit are sold as a matched assembly, they shall be tested as an air-to-air unit.

5 Part load conditions in heating mode

5.1 General

For the purpose of calculation of application $SGUE_h$, $SAEF_h$, $SEHREgas_h$, $SEHREelec_h$ and reference $SGUE_h$, $SAEF_h$, $SEHREgas_h$, $SEHREelec_h$ the part load ratios mentioned below should be based on the part load ratio Formulae (1)st column of Tables 4 to 22) and not on the rounded figures as mentioned in the 2nd column of these tables. The calculation of $SGUE_h$, $SAEF_h$, $SEHREgas_h$, $SEHREelec_h$ and reference $SGUE_h$, $SAEF_h$, $SEHREgas_h$, $SEHREelec_h$ is determined via linear interpolation of the respective part load values at the reference part load conditions mentioned below (A, B, C, D). For the purpose of reference $SGUE_h$, $SAEF_h$, $SEHREgas_h$, $SEHREelec_h$ there are three reference conditions: average(A), warmer (W) and colder (C).

The relevant $Tdesign_h$ values are defined as follows:

— Tdesign "average" dry bulb temperature conditions at – 10 °C (– 11 °C wet bulb) outdoor temperature and 20 °C indoor temperature;

— Tdesign "colder" dry bulb temperature conditions at – 22 °C (– 23 °C wet bulb) outdoor temperature and 20 °C indoor temperature

— Tdesign "warmer" dry bulb temperature conditions at + 2 °C (1 °C wet bulb) outdoor temperature and 20 °C indoor temperature

and the relevant Tbivalent is defined as follows:

— for the average heating season, the dry bulb bivalent temperature is + 2 °C or lower;

— for the colder heating season, the dry bulb bivalent temperature is − 7 °C or lower;

— for the warmer heating season, the dry bulb bivalent temperature is + 7 °C or lower.

NOTE If the declared TOL is lower than the $Tdesign_h$ of the considered climate, then it is assumed that TOL is equal to $Tdesign_h$. For Tbivalent and TOL higher or equal to − 7 °C the wet bulb temperature equals the dry bulb temperature minus 1 °C. For Tbivalent and TOL below − 7 °C, the wet bulb temperature is not defined. At any other part load conditions, the declared capacity of the appliance is larger than the building load.

5.2 Air-to-air units

The part load conditions for determining the reference $SGUE_h$ (Formula (11)), $SAEF_h$ (Formula (13)), $SEHREgas_h$ (Formula (16)), $SEHREelec_h$ (Formula (17)) are given in the following tables:

Table 5 — Part load conditions of air-to-air units and air-cooled multisplit systems in heating mode for the reference heating season "A" = average

	A		Outdoor air dry bulb (wet bulb) temperatures °C	Indoor air dry bulb temperature °C
	Part load ratio	Part load ratio %		
A	(−7–16)/(Tdesignh-16)	88	−7(−8)	20
B	(+2–16)/(Tdesignh-16)	54	2(1)	20
C	(+7–16)/(Tdesignh-16)	35	7(6)	20
D	(+12–16)/(Tdesignh-16)	15	12(11)	20
E	(TOL-16)/(Tdesignh-16)		TOL	20
F	(Tbivalent-16)/(Tdesignh −16)		Tbivalent	20

Table 6 — Part load conditions of air-to-air units and air-cooled multisplit systems in heating mode for the reference heating season "W" = warmer

	W		Outdoor air dry bulb (wet bulb) temperatures °C	Indoor air dry bulb temperature °C
	Part load ratio	Part load ratio %		
A	(not applicable)			
B	(+2–16)/(Tdesignh-16)	100	2(1)	20
C	(+7–16)/(Tdesignh-16)	64	7(6)	20
D	(+12–16)/(Tdesignh-16)	29	12(11)	20
E	(TOL-16)/(Tdesignh-16)		TOL	20
F	(Tbivalent-16)/(Tdesignh −16)		Tbivalent	20

Table 7 — Part load conditions of air-to-air units and air-cooled multisplit systems in heating mode for the reference heating season "C" = colder

	C		Outdoor air dry bulb (wet bulb) temperatures °C	Indoor air dry bulb temperature °C
	Part load ratio	Part load ratio %		
A	(−7–16)/(Tdesignh-16)	61	−7(−8)	20
B	(+2–16)/(Tdesignh-16)	37	2(1)	20
C	(+7–16)/(Tdesignh-16)	24	7(6)	20
D	(+12–16)/(Tdesignh-16)	11	12(11)	20
E	(TOL-16)/(Tdesignh-16)		TOL	20
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	20
G[a]	(−15–16)/(Tdesignh-16)	82	−15	20

[a] Condition G is performed in case TOL is below −20 °C.

5.3 Water-to-air units and brine to air units

The part load conditions for determining the reference $SGUE_h$ (Formula (11)), $SAEF_h$ (Formula (13)), $SEHREgas_h$ (Formula (16)), $SEHREelec_h$ (Formula (17)) are given in the following tables:

Table 8 — Part load conditions of water-to-air and brine-to-air units in heating mode for the reference heating season "A" = average

	A		Outdoor heat exchanger		Indoor heat exchanger
	Part load ratio	Part load ratio %	Ground water	Brine	Indoor air
			Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Inlet dry bulb temperature °C
A	(−7–16)/(Tdesignh-16)	88	10/a	0/a	20
B	(+2–16)/(Tdesignh-16)	54	10/a	0/a	20
C	(+7–16)/(Tdesignh-16)	35	10/a	0/a	20
D	(+12–16)/(Tdesignh-16)	15	10/a	0/a	20
F	(Tbivalent-16)/(Tdesignh-16)		10/a	0/a	20
a The water flow rate as determined at the standard rating conditions.					

Table 9 — Part load conditions of water-to-air and brine-to-air units in heating mode for the reference heating season "W" = warmer

	W		Outdoor heat exchanger		Indoor heat exchanger
	Part load ratio	Part load ratio %	Ground water	Brine	Indoor air
			Inlet/outlet temperatures °C	Inlet/outlet temperatures ° C	Indoor temperatures dry bulb °C
A	Not applicable				
B	(+2–16)/(Tdesignh-16)	100	10/a	0/a	20
C	(+7–16)/(Tdesignh-16)	64	10/a	0/a	20
D	(+12–16)/(Tdesignh-16)	29	10/a	0/a	20
F	(Tbivalent-16)/(Tdesignh-16)		10/a	0/a	20
a The water flow rate as determined at the standard rating conditions of fixed capacity heat pumps.					

Table 10 — Part load conditions of water-to-air and brine-to-air units in heating mode or the reference heating season "C" = colder

	C		Outdoor heat exchanger		Indoor heat exchanger
			Ground water	Brine	Indoor air
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures ° C	Indoor temperatures dry bulb °C
A	(−7–16)/(Tdesignh-16)	61	10/a	0/a	20
B	(+2–16)/(Tdesignh-16)	37	10/a	0/a	20
C	(+7–16)/(Tdesignh-16)	24	10/a	0/a	20
D	(+12–16)/(Tdesignh-16)	11	10/a	0/a	20
F	(Tbivalent-16)/(Tdesignh-16)		10/a	0/a	20

a The water flow rate as determined at the standard rating conditions of fixed capacity heat pumps.

5.4 Air-to-water units

5.4.1 General

For each application, units either allowing or not allowing a variation of the outlet water temperature with the outdoor temperature are considered. The variable outlet temperature shall only be applied when the control provides a regulation of outlet water temperature that considers the outdoor temperature.

The part load conditions for determining the reference $SGUE_h$ (Formula (11)), $SAEF_h$ (Formula (13)), $SEHREgas_h$ (Formula (16)), $SEHREelec_h$ (Formula (17)) are given in the following tables.

5.4.2 Low temperature application

Table 11 — Part load conditions of air-to-water units in heating mode, *for low temperature application*, for the reference heating season "A" = average

	A		Outdoor heat exchanger [b]	Indoor heat exchanger	
	Part load ratio	Part load ratio %	Outdoor air	Inlet/outlet temperatures	
			Inlet dry bulb (wet bulb) temperature °C	Fixed outlet °C	Variable outlet °C
A	(−7–16)/(Tdesignh-16)	88	−7(−8)	[a] /35	[a] /34
B	(+2–16)/(Tdesignh-16)	54	2(1)	[a] /35	[a] /30
C	(+7–16)/(Tdesignh-16)	35	7(6)	[a] /35	3/27
D	(+12–16)/(Tdesignh-16)	15	12(11)	[a] /35	[a] /24
E	(TOL-16)/(Tdesignh-16)		TOL	[a] /35	Variable outlet shall be calculated by interpolation or extrapolation from the temperatures which are closest to the TOL [a]
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	[a] /35	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water flow rate as determined at the standard rating conditions at 30/35 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A - F are performed with an outdoor heat exchanger condition according to EN 16905–4.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 12 — Part load conditions of air-to-water units in heating mode, for *low temperature application*, for the reference heating season "W" = warmer

	W		Outdoor heat exchanger [b]	Indoor heat exchanger	
			Outdoor air	Inlet/outlet	
	Part load ratio	Part load ratio %	Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
A	Not applicable		−7(−8)		
B	(+2–16)/(Tdesignh-16)	100	2(1)	[a] /35	[a] /35
C	(+7–16)/(Tdesignh-16)	64	7(6)	[a] /35	[a] /31
D	(+12–16)/(Tdesignh-16)	29	12(11)	[a] /35	[a] /26
F	(Tbivalent-16)/(Tdesignh-16) [c]		Tbivalent	[a] /35	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 30/35 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A - F are performed with an outdoor heat exchanger condition according to EN 16905–4.

[c] Not applicable if Tbivalent is equal or lower than temperature of B condition.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 13 — Part load conditions of air-to-water units in heating mode, *for low temperature application*, for the reference heating season "C" = colder

	C		Outdoor heat exchanger [b]	Indoor heat exchanger	
	Part load ratio	Part load ratio %	Outdoor air	Inlet/outlet	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
A	(−7–16)/(Tdesignh-16)	61	−7(−8)	[a]/35	[a]/30
B	(+2–16)/(Tdesignh-16)	37	2(1)	[a]/35	[a]/27
C	(+7–16)/(Tdesignh-16)	24	7(6)	[a]/35	[a]/25
D	(+12–16)/(Tdesignh-16)	11	12(11)	[a]/35	[a]/24
E	(TOL-16)/(Tdesignh-16)		TOL	[a]/35	Variable outlet shall be calculated by interpolation or extrapolation from the temperatures which are closest to the TOL [a]
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	[a]/35	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature
G	(−15–16)/(Tdesignh-16)	82	−15(−16)	[a]/35	[a]/32

[a] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 30/35 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A - F are performed with an outdoor heat exchanger condition according to EN 16905–4.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

5.4.3 Medium temperature application

The part load conditions for determining the reference $SGUE_h$ (Formula (11)), $SAEF_h$ (Formula (13)), $SEHREgas_h$ (Formula (16)), $SEHREelec_h$ (Formula (17)) are given in the following tables:

Table 14 — Part load conditions of air-to-water units in heating mode, for *medium temperature application*, for the reference heating season "A" = average

	A		Outdoor heat exchanger [b]	Indoor heat exchanger	
	Part load ratio	Part load ratio %	Outdoor air	Inlet/outlet temperatures	
			Inlet dry bulb (wet bulb) temperature °C	Fixed outlet °C	Variable outlet °C
A	(−7−16)/(Tdesignh-16)	88	−7(−8)	[a]/45	[a]/43
B	(+2−16)/(Tdesignh-16)	54	2(1)	[a]/45	[a]/37
C	(+7−16)/(Tdesignh-16)	35	7(6)	[a]/45	[a]/33
D	(+12−16)/(Tdesignh-16)	15	12(11)	[a]/45	[a]/28
E	(TOL-16)/(Tdesignh-16)		TOL	[a]/45	Variable outlet shall be calculated by interpolation or extrapolation from the temperatures which are closest to the TOL [a]
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	[a] /45	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A - F are performed with an outdoor heat exchanger condition according to EN 16905−4.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 15 — Part load conditions of air-to-water units in heating mode, for *medium temperature application*, for the reference heating season "W" = warmer

	W		Outdoor heat exchanger [b]	Indoor heat exchanger	
	Part load ratio	Part load ratio %	Outdoor air	Inlet/outlet	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
A	Not applicable		−7(−8)		
B	(+2–16)/(Tdesignh-16)	100	2(1)	a/45	a/45
C	(+7–16)/(Tdesignh-16)	64	7(6)	a/45	a/39
D	(+12–16)/(Tdesignh-16)	29	12(11)	a/45	a/31
E	(TOL-16)/(Tdesignh-16)		TOL	a/45	Variable outlet shall be calculated by interpolation or extrapolation from the temperatures which are closest to the TOL [a]
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	a/45	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A - F are performed with an outdoor heat exchanger condition according to EN 16905–4.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 16 — Part load conditions of air-to-water units in heating mode, *for medium temperature application*, for the reference heating season "C" = colder

	C		Outdoor heat exchanger [b]	Indoor heat exchanger	
	Part load ratio	Part load ratio %	Outdoor air	Inlet/outlet	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
A	(−7–16)/(Tdesignh-16)	61	−7(−8)	[a]/45	[a]/38
B	(+2–16)/(Tdesignh-16)	37	2(1)	[a]/45	[a]/33
C	(+7–16)/(Tdesignh-16)	24	7(6)	[a]/45	[a]/30
D	(+12–16)/(Tdesignh-16)	11	12(11)	[a]/45	[a]/26
E	(TOL-16)/(Tdesignh-16)		TOL	[a]/45	Variable outlet shall be calculated by interpolation or extrapolation from the temperatures which are closest to the TOL [a]
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	[a]/45	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature
G	(−15–16)/(Tdesignh-16)	82	−15	[a]/45	[a]/41

[a] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A – F are performed with an outdoor heat exchanger condition according to EN 16905–4.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

5.4.4 High temperature application

The part load conditions for determining the reference $SGUE_h$ (Formula (11)), $SAEF_h$ (Formula (13)), $SEHREgas_h$ (Formula (16)), $SEHREelec_h$ (Formula (17)) are given in the following tables:

Table 17 — Part load conditions of air-to-water units in heating mode, for *high temperature application*, for the reference heating season "A" = average

	A		Outdoor heat exchanger [b]	Indoor heat exchanger	
	Part load ratio	Part load ratio %	Outdoor air	Inlet/outlet temperatures	
			Inlet dry bulb (wet bulb) temperature °C	Fixed outlet °C	Variable outlet °C
A	(−7–16)/(Tdesignh-16)	88	−7(−8)	[a]/55	[a]/52
B	(+2–16)/(Tdesignh-16)	54	2(1)	[a] /55	[a]/42
C	(+7–16)/(Tdesignh-16)	35	7(6)	[a]/55	[a]/36
D	(+12–16)/(Tdesignh-16)	15	12(11)	[a]/55	[a]/30
E	(TOL-16)/(Tdesignh-16)		TOL	[a]/55	Variable outlet shall be calculated by interpolation or extrapolation from the temperatures which are closest to the TOL [a]
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	[a]/55	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions for units with a fixed water flow rate, and with a fixed delta T of 8 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A – F are performed with an outdoor heat exchanger condition according to EN 16905–4.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 18 — Part load conditions of air-to-water units in heating mode, for *high temperature application*, for the reference heating season "W" = warmer

	W		Outdoor heat exchanger [b]	Indoor heat exchanger	
	Part load ratio	Part load ratio %	Outdoor air	Inlet/outlet	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
A	Not applicable		−7(−8)		
B	(+2–16)/(Tdesignh-16)	100	2(1)	[a]/55	[a]/55
C	(+7–16)/(Tdesignh-16)	64	7(6)	[a]/55	[a]/46
D	(+12–16)/(Tdesignh-16)	29	12(11)	[a]/55	[a]/34
E	(TOL-16)/(Tdesignh-16)		TOL	[a]/55	Variable outlet shall be calculated by interpolation or extrapolation from the temperatures which are closest to the TOL [a]
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	[a]/55	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions for units with a fixed water flow rate, and with a fixed delta T of 8 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A – F are performed with an outdoor heat exchanger condition according to EN 16905–4.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 19 — Part load conditions of air-to-water units in heating mode, *for high temperature application*, for the reference heating season "C" = colder

	C		Outdoor heat exchanger [b]	Indoor heat exchanger	
	Part load ratio	Part load ratio %	Outdoor air	Inlet/outlet	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
A	(−7–16)/(Tdesignh-16)	61	−7(−8)	[a]/55	[a]/44
B	(+2–16)/(Tdesignh-16)	37	2(1)	[a]/55	[a]/37
C	(+7–16)/(Tdesignh-16)	24	7(6)	[a]/55	[a]/32
D	(+12–16)/(Tdesignh-16)	11	12(11)	[a]/55	[a]/28
E	(TOL-16)/(Tdesignh-16)		TOL	[a]/55	Variable outlet shall be calculated by interpolation or extrapolation from the temperatures which are closest to the TOL [a]
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	[a]/55	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature
G	(−15–16)/(Tdesignh-16)	82	−15	[a]/55	[a]/49

[a] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions for units with a fixed water flow rate, and with a fixed delta T of 8 K for units with a variable flow rate.

[b] For exhaust air heat pumps part load tests A - F are performed with an outdoor heat exchanger condition according to EN 16905–4.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

5.5 Water-to-water and brine-to-water units

5.5.1 General

For each application, units either allowing or not allowing a variation of the outlet water temperature with the outdoor temperature are considered. The variable outlet temperature shall only be applied when the control provides a regulation of outlet water temperature that considers the outdoor temperature.

The part load conditions for determining the reference $SGUE_h$ (Formula (11)), $SAEF_h$ (Formula (13)), $SEHREgas_h$ (Formula (16)), $SEHREelec_h$ (Formula (17)) are given in the following tables:

5.5.2 Low temperature application

Table 20 — Part load conditions of water/brine-to-water units in heating mode, *for low temperature application*, for the reference heating season "A" = average

	A		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	(–7–16)/(Tdesignh-16)	88	10/[a]	0/[a]	[b] /35	[b]/34
B	(+2–16)/(Tdesignh-16)	54	10/[a]	0/[a]	[b]/35	[b]/30
C	(+7–16)/(Tdesignh-16)	35	10/[a]	0/[a]	[b]/35	[b]/27
D	(+12–16)/(Tdesignh-16)	15	10/[a]	0/[a]	[b]/35	[b]/24
E	(Tdesignh-16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/35	[b]/35
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/35	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 30/35 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 30/35 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 21 — Part load conditions of water/brine-to-water units in heating mode, *for low temperature application*, for the reference heating season "W" = warmer

	W		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	Not applicable					
B	(+2–16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/35	[b]/35
C	(+7–16)/(Tdesignh-16)	64	10/[a]	0/[a]	[b]/35	[b]/31
D	(+12–16)/(Tdesignh-16)	29	10/[a]	0/[a]	[b]/35	[b]/26
E	(Tdesignh-16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/35	[b]/35
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/35	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 30/35 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 30/35 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 22 — Part load conditions of water/brine-to-water units in heating mode, *for low temperature application*, for the reference heating season "C" = colder

	C		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	(−7−16)/(Tdesignh-16)	61	10/[a]	0/[a]	[b]/35	[b]/30
B	(+2−16)/(Tdesignh-16)	37	10/[a]	0/[a]	[b]/35	[b]/27
C	(+7−16)/(Tdesignh −16)	24	10/[a]	0/[a]	[b]/35	[b]/25
D	(+12−16)/(Tdesignh-16)	11	10/[a]	0/[a]	[b]/35	[b]/24
E	(Tdesignh-16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/35	[b]/35
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/35	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 30/35 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 30/35 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be be fixed according to EN 16905-4.

5.5.3 Medium temperature application

The part load conditions for determining the reference $SGUE_h$ (Formula (11)), $SAEF_h$ (Formula (13)), $SEHREgas_h$ (Formula (16)), $SEHREelec_h$ (Formula (17)) are given in the following tables:

Table 23 — Part load conditions of water/brine-to-water units in heating mode, *for medium temperature application*, for the reference heating season "A" = average

	A		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	(−7–16)/(Tdesignh-16)	88	10/[a]	0/[a]	[b]/45	[b]/43
B	(+2–16)/(Tdesignh-16)	54	10/[a]	0/[a]	[b]/45	[b]/37
C	(+7–16)/(Tdesignh-16)	35	10/[a]	0/[a]	[b]/45	[b]/33
D	(+12–16)/(Tdesignh-16)	15	10/[a]	0/[a]	[b]/45	[b]/28
E	(Tdesignh-16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/45	[b]/45
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/45	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 24 — Part load conditions of water/brine-to-water units in heating mode, *for medium temperature application,* for the reference heating season "W" = warmer

	W		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	Not applicable					
B	(+2–16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/45	[b]/45
C	(+7–16)/(Tdesignh-16)	64	10/[a]	0/[a]	[b]/45	[b]/39
D	(+12–16)/(Tdesignh-16)	29	10/[a]	0/[a]	[b]/45	[b]/31
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/45	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 25 — Part load conditions of water/brine-to-water units in heating mode, *for medium temperature application*, for the reference heating season "C" = colder

	C		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	(−7−16)/(Tdesignh-16)	61	10/[a]	0/[a]	[b]/45	[b]/38
B	(+2−16)/(Tdesignh-16)	37	10/[a]	0/[a]	[b]/45	[b]/33
C	(+7−16)/(Tdesignh-16)	24	10/[a]	0/[a]	[b]/45	[b]/30
D	(+12−16)/(Tdesignh-16)	11	10/[a]	0/[a]	[b]/45	[b] 26
E	(Tdesignh-16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/45	[b]/45
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/45	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature.

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 40/45 conditions for units with a fixed water flow rate, and with a fixed delta T of 5 K for units with a variable flow rate.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

5.5.4 High temperature application

The part load conditions for determining the reference $SGUE_h$ (Formula (11)), $SAEF_h$ (Formula (13)), $SEHREgas_h$ (Formula (16)), $SEHREelec_h$ (Formula (17)) are given in the following tables:

Table 26 — Part load conditions of water/brine-to-water units in heating mode, *for high temperature application*, for the reference heating season "A" = average

	A		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	(−7–16)/(Tdesignh-16)	88	10/[a]	0/[a]	[b]/55	[b]/52
B	(+2–16)/(Tdesignh-16)	54	10/[a]	0/[a]	[b]/55	[b]/42
C	(+7–16)/(Tdesignh-16)	35	10/[a]	0/[a]	[b]/55	[b]/36
D	(+12–16)/(Tdesignh-16)	15	10/[a]	0/[a]	[b]/55	[b]/30
E	(Tdesignh-16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/55	[b]/55
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/55	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions for units with a fixed water flow rate, and with a fixed delta T of 8 K for units with a variable flow rate.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 27 — Part load conditions of water/brine-to-water units in heating mode, *for high temperature application*, for the reference heating season "W" = warmer

	W		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	Not applicable					
B	(+2–16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/55	[b]/55
C	(+7–16)/(Tdesignh-16)	64	10/[a]	0/[a]	[b]/55	[b]/46
D	(+12–16)/(Tdesignh-16)	29	10/[a]	0/[a]	[b]/55	[b]/34
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/55	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions for units with a fixed water flow rate, and with a fixed delta T of 8 K for units with a variable flow rate.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

Table 28 — Part load conditions of water/brine-to-water units in heating mode, *for high temperature application*, for the reference heating season "C" = colder

	C		Outdoor heat exchanger		Indoor heat exchanger	
			Ground water	Brine	Inlet/outlet temperatures	
	Part load ratio	Part load ratio %	Inlet/outlet temperatures °C	Inlet/outlet temperatures °C	Fixed outlet °C	Variable outlet °C
A	(−7–16)/(Tdesignh-16)	61	10/[a]	0/[a]	[b]/55	[b]/44
B	(+2–16)/(Tdesignh-16)	37	10/[a]	0/[a]	[b]/55	[b]/37
C	(+7–16)/(Tdesignh-16)	24	10/[a]	0/[a]	[b]/55	[b]/32
D	(+12–16)/(Tdesignh-16)	11	10/[a]	0/[a]	[b]/55	[b]/28
E	(Tdesignh-16)/(Tdesignh-16)	100	10/[a]	0/[a]	[b]/55	[b]/55
F	(Tbivalent-16)/(Tdesignh-16)		10/[a]	0/[a]	[b]/55	Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature

[a] With the water/brine flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions.

[b] With the water flow rate as determined at the standard rating conditions of fixed capacity heat pumps at 47/55 conditions for units with a fixed water flow rate, and with a fixed delta T of 8 K for units with a variable flow rate.

For units that have to cycle on/off to reach the required part load ratio or part load condition below Tbivalent, the inlet temperature of the indoor heat exchanger should be fixed according to EN 16905-4.

6 Calculation methods for reference SPERc

6.1 General

The calculation of the seasonal performance follows from the application of the bin method, where the part load GUE_c, AEF_c and $EHREgas_c$ and $EHREelec_c$ at each bin temperature is determined via linear interpolation of the respective part load values at the reference part load conditions A, B, C and D.

The part load conditions A, B, C, D provide the part load ratios and the temperature test conditions at four reference outdoor air dry bulb temperatures: 35 °C, 30 °C, 25 °C and 20 °C.

The part load ratio corresponding to a given outdoor temperature is defined according to Formula (1):

$$PLR_c\left(T_{outdoor}\right) = T_{outdoor} - 16 / 35 - 16 \quad (1)$$

6.2 General formula for calculation of GUE_c and AEF_c

The calculation of the reference GUE_c that applies to all types of units is given by the formula included in EN 16905-4:2017, 4.2.5.

The calculation of the reference AEF_c that applies to all types of units is given by the formula included in EN 16905-4:2017, 4.2.6.

6.3 General formula for calculation of $EHREgas_c$ and $EHREelec_c$

The calculation of the reference $EHREgas_c$ that applies to all types of units is given by the formula included in EN 16905-4:2017, 4.2.7.

The calculation of the reference $EHRelec_c$ that applies to all types of units is given by the formula included in EN 16905-4:2017, 4.2.7.

6.4 General formula for calculation of reference $SGUE_c$

The calculation of the reference $SGUE_c$ that applies to all types of units is given by the following Formula (2):

$$SGUE_c = \frac{\sum_{j=1}^{n} hjPc(Tj)}{\sum_{j=1}^{n} hj\left(\frac{Pc(Tj)}{GUEc_{PL}(Tj)}\right)} \quad (2)$$

where

Tj is the bin temperature;

j is the bin number;

n is the number of bins;

Pc(Tj) is the cooling load of the building for the corresponding temperature Tj;

hj is the number of bin hours occurring at the corresponding temperature Tj;

$GUEc_{PL}(Tj)$ is the part load GUEc values of the appliance for the corresponding temperature Tj

Table 29 — Bin number j, outdoor temperature Tj in °C and number of hours per bin hj corresponding to the reference cooling season

j	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Tj °C	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
hj	205	227	225	225	216	215	218	197	178	158	137	109	88	63	39	31	24	17	13	9	4	3	1	0

The cooling load Pc (Tj) can be determined by multiplying the full load value ($Pdesign_c$) with the part load ratio PLRc (Tj) of the corresponding bin:

$$Pc(Tj) = Pdesign_c \times PLRc(Tj) \quad (3)$$

where

PLRc (Tj) is defined according to Formula (1).

The $GUEc_{PL}$ values at each bin are determined via interpolation of the GUE_c values at part load conditions A, B, C and D as defined in 6.1.

For part load conditions above part load condition A, the same GUE_c values as for condition A shall be used.

For part load conditions below part load condition D, the same GUE_c values as for condition D shall be used.

6.5 Calculation of reference $SAEF_c$

The calculation of the reference $SAEF_c$ that applies to all types of appliances is given by reference annual cooling demand divided by the annual electricity consumption.

The annual electricity consumption includes the power consumption during active mode, thermostat off mode, standby mode and off mode:

$$SAEF_c = \frac{Q_{ref,c}}{\frac{Q_{ref,c}}{SAEF_{cON}} + H_{TO} \times P_{TO} + H_{SB} \times P_{SB} + H_{CK} \times P_{CK} + H_{OFF} \times P_{OFF}} \quad (4)$$

where

$Q_{ref,c}$ is the reference annual cooling demand, expressed in kWh, as defined in 6.6;

$SAEF_{cON}$ is the seasonal auxiliary energy factor in cooling mode and active mode, as defined in 6.7;

H_{TO}, H_{SB}, H_{CK}, H_{OFF} are the number of hours the appliance is considered to work in respectively thermostat off mode, standby mode, crankcase heather mode and off mode. The number of hours to be used for cooling is indicated in Annex A;

P_{TO}, P_{SB}, P_{CK}, P_{OFF} are the electricity consumption during respectively thermostat off mode, standby mode, crank case heather mode and off mode, expressed in kW. The measurement of P_{TO}, P_{SB}, P_{CK}, P_{OFF} shall be made according to EN 16905–4.

6.6 Calculation of reference annual cooling demand ($Q_{ref,c}$)

The reference annual cooling demand is expressed in kWh and can be calculated as the design cooling load ($Pdesign_c$) multiplied by the number of equivalent cooling hours (H_{ec}):

$$Q_{refC} = Pdesign_c \times H_{ec} \quad (5)$$

The number of equivalent cooling hours (H_{ec}) can be found in Annex A.

6.7 Calculation of reference $SAEF_{cON}$

The reference $SAEF_{cON}$ is determined as follows:

$$SAEF_{cON} = \frac{\sum_{j=1}^{n} hjP_c(Tj)}{\sum_{j=1}^{n} hj\left(\frac{P_c(Tj)}{AEF_{CPL}(Tj)}\right)} \quad (6)$$

where

Tj	is the bin temperature;
j	is the bin number;
n	is the amount of bins;
$P_c(Tj)$	is the cooling demand of the building for the corresponding temperature Tj;
hj	is the number of bin hours occurring at the corresponding temperature Tj;
$AEF_{CPL}(Tj)$	is the AEFc values of the appliance for the corresponding temperature Tj.

The values to be used for j, Tj and hj are determined in Table 29. The cooling load P_C (Tj) shall be determined according to Formula (3).

The AEF_{cPL} values at each bin are determined via interpolation of the AEF_c values at part load conditions A, B, C and D as defined in 6.1.

For part load conditions above part load condition A, the same AEF_c values as for condition A shall be used.

For part load conditions below part load condition D, the same AEF_c values as for condition D shall be used.

6.8 Calculation of reference $SEHREgas_c$

The calculation of the reference $SEHREgas_c$ that applies to all types of units is given by the following Formula (7):

$$SEHREgas_c = \frac{\sum_{j=1}^{n} hjP_c(Tj)}{\sum_{j=1}^{n} hj\left(\frac{P_c(Tj)}{EHREgas_{cPL}(Tj)}\right)} \quad (7)$$

where

Tj	is the bin temperature;
j	is the bin number;
n	is the number of bins;
$P_c(Tj)$	is the cooling load of the building for the corresponding temperature Tj;
hj	is the number of bin hours occurring at the corresponding temperature Tj;
$EHREgas_{cPL}(Tj)$	is the part load $EHREgas_c$ values of the appliance for the corresponding temperature Tj.

The values to be used for j, Tj and hj are determined in Table 29.

The $EHREgas_{cPL}$ values at each bin are determined via interpolation of the $EHREgas_c$ values at part load conditions A, B, C and D as defined in 6.1.

For part load conditions above part load condition A, the same $EHREgas_c$ values as for condition A shall be used.

For part load conditions below part load condition D, the same $EHREgas_c$ values as for condition D shall be used.

6.9 Calculation of reference $SEHREelec_c$

The calculation of the reference $SEHREelec_c$ that applies to all types of units is given by the following Formula (8):

$$SEHREelec_c = \frac{\sum_{j=1}^{n} hjP_c(Tj)}{\sum_{j=1}^{n} hj\left(\frac{P_c(Tj)}{EHREelec_{cPL}(Tj)}\right)} \quad (8)$$

where

Tj	is the bin temperature;
j	is the bin number;
n	is the number of bins;
$P_c(Tj)$	is the cooling load of the building for the corresponding temperature Tj;
hj	is the number of bin hours occurring at the corresponding temperature Tj;
$EHREelec_{cPL}(Tj)$	is the part load $EHREelec_c$ values of the appliance for the corresponding temperature Tj.

The values to be used for j, Tj and hj are determined in Table 29.

The $EHREelec_{cPL}$ values at each bin are determined via interpolation of the $EHREelec_c$ values at part load conditions A, B, C and D as defined in 6.1.

For part load conditions above part load condition A, the same $EHREelec_c$ values as for condition A shall be used.

For part load conditions below part load condition D, the same $EHREelec_c$ values as for condition D shall be used.

6.10 Procedures for the determination of GUE_{cPL} / AEF_{cPL} values

In part load condition A (full load), the declared capacity of an appliance is considered equal to the cooling load ($Pdesign_c$). Accordingly, the GUE_{cDC} / AEF_{cDC} shall be used.

In part load conditions B, C, D, the test methods at part load shall be used in order to measure GUE_{cPL} / AEF_{cPL}, as defined in EN 16905-4.

6.11 Procedures for the determination of $EHREgas_{cPL}$ / $EHREelec_{cPL}$ values

In part load condition A (full load), the declared capacity of an appliance is considered equal to the cooling load ($Pdesign_c$). Accordingly, the $EHREgas_{cDC}$ / $EHREelec_{cDC}$ shall be used.

In part load conditions B, C, D, the test methods at part load shall be used in order to measure $EHREgas_{cPL}$ / $EHREelec_{cPL}$ as defined in EN 16905-4.

6.12 Calculation of reference $SPER_c$

The seasonal primary energy ratio $SPER_c$ is determined according to Formula (9):

$$SPER_c = \frac{1}{\frac{Prim_{gas}}{SGUE_c} + \frac{Prim_{elec}}{SAEF_c}} + \frac{1}{\frac{Prim_{gas}}{SEHREgas_c} + \frac{Prim_{elec}}{SEHREelec_c}} \quad (9)$$

where

$Prim_{gas}$ is the primary energy factor for gas, value based on ErP Directive (2009/125/EC) or by default equal to 1 on GCV;

$Prim_{elec}$ is the primary energy factor for electricity, value based on ErP Directive (2009/125/EC) or by default equal to 2,5;

$SGUE_c$ is the seasonal gas utilization efficiency in cooling mode, as defined in 6.4;

$SAEF_c$ is the seasonal auxiliary energy factor in cooling mode, as defined in 6.5;

$SEHREgas_c$ is the seasonal engine heat recovery efficiency gas in cooling mode as defined in 6.8

$SEHREelec_c$ is the seasonal engine heat recovery efficiency electricity in cooling mode as defined in 6.9.

7 Calculation methods for reference $SPER_h$

7.1 General

The calculation of the seasonal performance follows from the application of the bin method, where the part load GUE_h, AEF_h, $EHREgas_h$ and $EHREelec_h$ at each bin temperature is determined via linear interpolation of the respective part load values at the reference part load conditions A, B, C, D, and in some cases E and F.

The part load conditions A, B, C, D, E and F provide the part load ratios and the temperature test conditions at six reference outdoor air dry bulb temperatures: – 7 °C, 2 °C, 7 °C, 12 °C, TOL and Tbivalent.

The part load ratio corresponding to a given outdoor temperature is defined according to Formula (10):

$$PLR_h\left(T_{outdoor}\right) = \left(T_{outdoor} - 16\right) / \left(T_{design} - 16\right) \quad (10)$$

7.2 General formula for calculation of GUE_h and AEF_h

The calculation of the reference GUE_h that applies to all types of units is given by the formula included into EN 16905-4:2017, 4.2.5.

The calculation of the reference AEF_h that applies to all types of units is given by the formula included into EN 16905-4:2017, 4.2.6.

7.3 General formula for calculation of $EHREgas_h$

The calculation of the reference $EHREgas_h$ that applies to all types of units is given by the formula included into EN 16905-4:2017, 4.2.7.

The calculation of the reference $EHREelec_h$ that applies to all types of units is given by the formula included into EN 16905-4:2017, 4.2.7.

7.4 General formula for calculation of reference $SGUE_h$

The calculation of the reference $SGUE_h$ that applies to all types of units is given by the following Formula (11):

$$SGUE_h = \frac{\sum_{j=1}^{n} hjPh(Tj)}{\sum_{j=1}^{n} hj\left(\frac{Ph(Tj)}{GUE_{hPL}(Tj)}\right)} \quad (11)$$

where

Tj is the bin temperature;

j is the bin number;

n is the number of bins;

Ph(Tj) is the heating load of the building for the corresponding temperature Tj;

hj is the number of bin hours occurring at the corresponding temperature Tj;

GUE_{hPL} *(Tj)* is the part load GUE_h values of the appliance for the corresponding temperature Tj.

The values to be used for j, Tj and hj are determined in Table 30.

Table 30 — Bin number j, outdoor temperature Tj in °C and number of hours per bin hj corresponding to the reference heating season "warmer", "average", "colder"

j	Tj °C	Warmer (W) hj W h	Average (A) hj A h	Colder (C) hj C h
1 to 8	−30 to −23	0	0	0
9	−22	0	0	1
10	−21	0	0	6
11	−20	0	0	13
12	−19	0	0	17
13	−18	0	0	19
14	−17	0	0	26
15	−16	0	0	39
16	−15	0	0	41
17	−14	0	0	35
18	−13	0	0	52
19	−12	0	0	37

j	Tj °C	Warmer (W) hj W h	Average (A) hj A h	Colder (C) hj C h
20	−11	0	0	41
21	−10	0	1	43
22	−9	0	25	54
23	−8	0	23	90
24	−7	0	24	125
25	−6	0	27	169
26	−5	0	68	195
27	−4	0	91	278
28	−3	0	89	306
29	−2	0	165	454
30	−1	0	173	385
31	0	0	240	490
32	1	0	280	533
33	2	3	320	380
34	3	22	357	228
35	4	63	356	261
36	5	63	303	279
37	6	175	330	229
38	7	162	326	269
39	8	259	348	233
40	9	360	335	230
41	10	428	315	243
42	11	430	215	191
43	12	503	169	146
44	13	444	151	150
45	14	384	105	97
46	15	294	74	61
	Total	3 590	4 910	6 446

The heating load Ph(Tj) can be determined by multiplying the full load value ($Pdesign_h$) with the part load ratio $PLR_h(Tj)$ of each corresponding bin.

$$Ph(Tj) = Pdesign_h \times PLR_h(Tj) \tag{12}$$

In Formula (12) above, the part load ratio $PLR_h(Tj)$ is defined according to Formula (10), i.e.

— for the average climate: (Tj-16) / (−10-16);

— for the warmer climate: (Tj-16) / (+2-16);

— for the colder climate: (Tj-16) / (−22-16).

The GUE_{hPL} values and capacity values at each bin are determined via interpolation of the GUE_h and capacity values at part load conditions A, B, C, D and in some cases also E, F. Interpolation is done between the GUE_h and capacities of the two closest part load conditions.

The GUE_{hPL} and values and capacity values for part load conditions above D are extrapolated from the GUE_h and values and capacity values at part load conditions C and D.

7.5 Calculation of reference $SAEF_h$

The calculation of the reference $SAEF_h$ that applies to all types of appliances is given by reference annual heating demand divided by the annual electricity consumption.

The annual electricity consumption includes the power consumption during active mode, thermostat off mode, standby mode and off mode:

$$SAEF_h = \frac{Q_{ref,h}}{\frac{Q_{ref,h}}{SEAF_{hON}} + H_{TO} \times P_{TO} + H_{SB} \times P_{SB} + H_{CK} \times P_{CK} + H_{OFF} \times P_{OFF}} \tag{13}$$

where

$Q_{ref,h}$ is the reference annual heating demand, expressed in kWh, as defined in 7.6;

$SAEF_{hON}$ is the seasonal auxiliary energy factor in heating mode and active mode, as defined in 7.7;

H_{TO}, H_{SB}, H_{CK}, H_{OFF} are the number of hours the appliance is considered to work in respectively thermostat off mode, standby mode, crankcase heater and off mode. The number of hours to be used for cooling is indicated in Annex A;

P_{TO}, P_{SB}, P_{OFF} are the electricity consumption during respectively thermostat off mode, standby mode and off mode, expressed in kW. The measurement of P_{TO}, P_{SB}, P_{OFF} shall be made according to EN 16905–4.

7.6 Calculation of reference annual heating demand (Q_{refh})

The reference annual heating demand is expressed in kWh and can be calculated as the design heating load (Pdesignh) multiplied by the number of equivalent heating hours (H_{eh}):

$$Q_{ref,h} = Pdesign_h \times H_{eh} \tag{14}$$

The number of equivalent heating hours (H_{eh}) for the average, warmer and colder reference heating season can be found in Annex A.

7.7 Calculation of reference $SAEF_{hON}$

The reference $SAEF_{hON}$ is determined as follows:

$$SAEF_{hON} = \frac{\sum_{j=1}^{n} hjP_h(Tj)}{\sum_{j=1}^{n} hj\left(\frac{P_h(Tj)}{AEF_{hPL}(Tj)}\right)} \quad (15)$$

where

Tj is the bin temperature;

j is the bin number;

n is the amount of bins;

Ph(Tj) is the heating demand of the building for the corresponding temperature Tj;

hj is the number of bin hours occurring at the corresponding temperature Tj;

AEF_{hPL} *(Tj)* is the AEF_h values of the appliance for the corresponding temperature Tj.

The values to be used for j, Tj and hj are determined in Table 30.

The heating load Ph(Tj) can be determined according to Formula (12).

The AEF_{hPL} values and capacity values at each bin are determined via interpolation of the AEF_{hPL} and capacity values at part load conditions A, B, C, D and in some cases also E, F. Interpolation is done between the AEF_{hPL} and capacities values of the 2 closest part load conditions.

The AEF_{hPL} values and capacity values for part load conditions above D are extrapolated from the AEF_{hPL} values and capacity values at part load conditions C and D.

7.8 Calculation of reference $SEHREgas_h$

The calculation of the reference $SEHREgas_h$ that applies to all types of units is given by the following Formula (16):

$$SEHREgas_h = \frac{\sum_{j=1}^{n} hjPh(Tj)}{\sum_{j=1}^{n} hj\left(\frac{Ph(Tj)}{EHREgash_{PL}(Tj)}\right)} \quad (16)$$

where

Tj is the bin temperature;

j is the bin number;

n is the number of bins;

Ph(Tj) is the heating load of the building for the corresponding temperature Tj;

hj is the number of bin hours occurring at the corresponding temperature Tj;

$EHREgas_{hPL}$ *(Tj)* is the part load $EHREgas_h$ values of the appliance for the corresponding temperature Tj.

The values to be used for j, Tj and hj are determined in Table 30.

The $EHREgas_{hPL}$ values at each bin are determined via interpolation of the $EHREgas_h$ values at part load conditions A, B, C and D as defined in 7.1.

The $EHREgas_{hPL}$ values and capacity values at each bin are determined via interpolation of the $EHREgas_{hPL}$ and capacity values at part load conditions A, B, C, D and in some cases also E, F. Interpolation is done between the $EHREgas_{hPL}$ and capacities values of the 2 closest part load conditions.

The $EHREgas_{hPL}$ values and capacity values for part load conditions above D are extrapolated from the $EHREgas_{hPL}$ values and capacity values at part load conditions C and D.

7.9 Calculation of reference $SEHREelec_h$

The calculation of the reference $SEHREelec_h$ that applies to all types of units is given by the following Formula (17):

$$SEHREelec_h = \frac{\sum_{j=1}^{n} hjPh(Tj)}{\sum_{j=1}^{n} hj\left(\frac{Ph(Tj)}{EHREelec_{hPL}(Tj)}\right)} \quad (17)$$

where

Tj	is the bin temperature;
j	is the bin number;
n	is the number of bins;
$P_h(Tj)$	is the heating load of the building for the corresponding temperature Tj;
hj	is the number of bin hours occurring at the corresponding temperature Tj;
$EHREelec_{hPL}(Tj)$	is the part load $EHREelec_h$ values of the appliance for the corresponding temperature Tj.

The values to be used for j, Tj and hj are determined in Table 30.

The $EHREelec_{hPL}$ values at each bin are determined via interpolation of the $EHREelec_h$ values at part load conditions A, B, C and D as defined in 7.1.

The $EHREelec_{hPL}$ values and capacity values at each bin are determined via interpolation of the $EHREelec_{hPL}$ and capacity values at part load conditions A, B, C, D and in some cases also E, F. Interpolation is done between the $EHREelec_{hPL}$ and capacities values of the 2 closest part load conditions.

The $EHREelec_{hPL}$ values and capacity values for part load conditions above D are extrapolated from the $EHREelec_{hPL}$ values and capacity values at part load conditions C and D.

7.10 Procedures for the determination of GUE_{hPL} / AEF_{hPL} values

In part load condition A (full load), the declared capacity of an appliance is considered equal to the heating load ($Pdesign_h$). Accordingly, the GUE_{hDC} / AEF_{hDC} shall be used.

In part load conditions B, C, D, the test methods at part load shall be used in order to measure GUE_{hPL} / AEF_{hPL} as defined in EN 16905-4.

7.11 Procedures for the determination of $SEHREgas_{hPL}$ / $SEHREelec_{hPL}$ values

In part load condition A (full load), the declared capacity of an appliance is considered equal to the heating load ($Pdesign_h$). Accordingly, the $SEHREgas_{hDC}$ / $SEHREelec_{hDC}$ shall be used.

In part load conditions B, C, D, the test methods at part load shall be used in order to measure $SEHREgas_{hPL}$ / $SEHREelec_{hPL}$ as defined in EN 16905-4.

7.12 Calculation of reference $SPER_h$

The seasonal primary energy ratio $SPER_h$ is determined according to Formula (18):

$$SPER_h = \frac{1}{\frac{Prim_{gas}}{SGUE_h} + \frac{Prim_{elec}}{SAEF_h}} + \frac{1}{\frac{Prim_{gas}}{SEHREgas_h} + \frac{Prim_{elec}}{SEHREelec_h}} \quad (18)$$

where

$Prim_{gas}$ is the primary energy factor for gas, value based on ErP Directive (2009/125/EC) or by default equal to 1 on GCV;

$Prim_{elec}$ is the primary energy factor for electricity, value based on ErP Directive (2009/125/EC) or by default equal to 2,5;

$SGUE_h$ is the seasonal gas utilization efficiency in heating mode, as defined in 7.4;

$SAEF_h$ is the seasonal auxiliary energy factor in heating mode, as defined in 7.5;

$SEHREgas_h$ is the seasonal engine heat recovery efficiency gas in heating mode as defined in 7.8;

$SEHREelec_h$ is the seasonal engine heat recovery efficiency electricity in heating mode as defined in 7.9.

Annex A
(normative)

Determination of reference annual cooling/heating demands and determination of hours for active mode, thermostat off, standby, off mode and crankcase heater mode for reference $SAEF_c$ and $SAEF_h$ calculation

Table A.1 — Number of hours used for calculation of reference $SAEF_c$

		Reversible **h**
A	**Total hours per year**	8760
B	**Off mode (Hoff)**	0
C	**Hours for the reference cooling season, of which:**	3672
D	**Thermostat off (HTO)**	221
E	**Standby(HSB)**	2142
F	**Difference (C-D-E) = Active mode hours without setback correction**	1309
G	**Setback correction**	355
H	**Difference (F-G) = (or F x 73 %) = Active mode hours corrected for setback impact**	954
I	**Equivalent active hours for cooling (H_{ec})**	350

Table A.2 — Number of hours used for calculation of reference $SAEF_h$

	Reversible		
	"A" **h**	**"W"** **h**	**"C"** **h**
Off mode (H_{OFF})	0	0	0
Thermostat off (H_{OFF})	179	755	131
Stand by (H_{SB})	0	0	0
Equivalent active for heating (H_{EH})	1400	1400	2100

Table A.3 — Crankcase heather mode hours used for calculation of reference $SAEF_c$

	Reversible **h**
Crankcase heather mode (H_{CK})	2672

Table A.4 — Crankcase heather mode hours used for calculation of reference $SAEF_h$

	Reversible		
	"A" **h**	**"W"** **h**	**"C"** **h**
Crankcase heather mode (H_{CK})	179	755	131

Annex B
(informative)

Calculation example for reference $SGUE_c$, $SAEF_c$, $SEHREgas_c$, $SEHREelec_c$ and $SPER_c$

For an air to air appliance the following design parameters are given:

— P_{design} = 50 kW

— Declared capacity at T_{design} (35 C) = 50 kW

From Table 1 in 4.2 the outdoor temperature, partial load ratio and indoor air temperature may be determined. Correspondingly, the cooling load is calculating according to the Formula (4). GUE_c and AEF_c are determined by test according to EN 16905-4 (see Table B.1) and $EHREgas_c$ and $EHREelec_c$ are determined by test according to EN 16905-4 (see Table B.1).

Table B.1 — Data for GUE_c and AEF_c and $EHREgas_c$ and $EHREelec_c$

	Part load ratio	Part load ratio %	Outdoor air dry bulb temperature °C	Indoor air dry bulb (wet bulb) temperatures °C	Cooling Load kW	GUE_c	$EHREgas_c$	AEF_c	$EHREelec_c$
A	(35–16)/(Tdesignc-16)	100	35	27(19)	50	1,15	0,46	48,54	19,42
B	(30–16)/(Tdesignc-16)	74	30	27(19)	36,8	1,26	0,55	48,47	21,19
C	(25–16)/(Tdesignc-16)	47	25	27(19)	23,7	1,72	0,94	31,01	16,87
D	(20–16)/(Tdesignc-16)	21	20	27(19)	10,59	1,18	0,00	13,80	0,00

The bin calculation is shown in Table B.2. The columns (A), (B), (C) are derived from Table 29. For each bin, the cooling load (D) is calculated according to Formula (3). GUE_c (E) and AEF_c (G) are obtained according to 6.2. Cooling demand (I) = fon x (C) x (D); gas energy input (H) = (G) / (E); electricity input (K) = (I) / (F). $SGUE_c$, $SAEF_{cON}$ $SEHREgas_c$ and $SEHREelec_c$ can be derived from total values (M), (N), (O), (P):

$SGUE_c$ = (M)/(N) = 1,39

$SAEF_{cON}$ = (M)/(O) = 27,10

$SEHREgas_c$ = (P)/(N) = 0,54

$SEHREelec_c$ = (P)/(O) = 10,42

The reference annual cooling demand $Q_{ref,c}$ is calculated according to Formula (5).

$Q_{ref,c}$ = 50 kW x 350 h = 17 500 kWh

The measured power consumptions in thermostat off, stand by, crank case and off mode are respectively 0,03 kW, 0,03 kW, 0,05 kW and 0,01 kW.

Finally $SAEF_c$ is calculated according to Formula (4).

$SAEF_c$ = 17 500 kWh / (17 500 kWh / 27,10 + 221 h x 0,03 kW + 2142 h x 0,03 kW + 2672 h x 0,05 kW + 0 h x 0,01 kW) = 20,58

Finally $SPER_c$ is calculated according to Formula (9):

$SPER_c$ = (1 / (1 / 1,39 + 2,5 / 20,58)) + (1/(1 / 0,54 + 2,5 / 10,42)) = 1,67

Table B.2 — Bin calculation of cooling load

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)
Bin	**Outdoor air temp. °C**	**Bin hours hj**	**Pc(Tj) kW**	**GUE_c kW/kW**	**AEF_c kW/kW**	**$EHREgas_c$ kW/kW**	**$EHREelec_c$ kW/kW**	**Cooling demand kWh**	**Gas energy input kWh**	**Electricity input kWh**	**Energy recovery from engine (Qhr) kWh**
1	17	205	2,63	1,18	13,80	0,00	0,00	539	457	39	0
2	18	227	5,26	1,18	13,80	0,00	0,00	1195	1012	87	0
3	19	225	7,89	1,18	13,80	0,00	0,00	1776	1505	129	0
4	20	225	10,53	1,18	13,80	0,00	0,00	2368	2009	172	0
5	21	216	13,16	1,29	17,24	0,19	3,37	2842	2208	165	556
6	22	215	15,79	1,40	20,69	0,37	6,75	3395	2432	164	1108
7	23	218	18,42	1,50	24,13	0,56	10,12	4016	2669	166	1685
8	24	197	21,05	1,61	27,57	0,75	13,49	4147	2571	150	2030
9	25	178	23,68	1,72	31,01	0,94	16,87	4216	2449	136	2293
10	26	158	26,32	1,63	34,51	0,86	17,73	4158	2553	121	2137
11	27	137	28,95	1,54	38,00	0,78	18,59	3966	2582	104	1941
12	28	109	31,58	1,44	41,49	0,70	19,46	3442	2386	83	1615
13	29	88	34,21	1,35	44,98	0,63	20,32	3011	2230	67	1360
14	30	63	36,84	1,26	48,47	0,55	21,19	2321	1847	48	1014
15	31	39	39,47	1,24	48,49	0,53	20,83	1539	1246	32	658
16	32	31	42,11	1,21	48,50	0,51	20,48	1305	1075	27	547
17	33	24	44,74	1,19	48,52	0,50	20,12	1074	900	22	443
18	34	17	47,37	1,17	48,53	0,48	19,77	805	688	17	327
19	35	13	50,00	1,15	48,54	0,46	19,42	650	566	13	260
20	36	9	52,63	1,15	48,54	0,46	19,42	474	412	10	187
21	37	4	55,26	1,15	48,54	0,46	19,42	221	192	5	86
22	38	3	57,89	1,15	48,54	0,46	19,42	174	151	4	67
23	39	1	60,53	1,15	48,54	0,46	19,42	61	53	1	23
24	40	0	63,16	1,15	48,54	0,46	19,42	0	0	0	0

(M)	(N)	(O)	(P)
47 695	34 194	1 760	18 337

Annex C
(informative)

Calculation example for reference $SGUE_h$, $SAEF_h$, $SEHREgas_h$, $SEHREelec_h$ and $SPER_h$

For an air to air appliance the following design parameters are given:

— P_{design} = 50 kW

— Declared capacity at T_{design} (−10° C) = 50 kW

— T bivalent = −10° C

From Table 5 in 5.2 the outdoor temperature, partial load ratio and indoor air temperature may be determined. Correspondingly, the heating load is calculating according to Formula (12) and GUE_h and AEF_h are determined by test according to EN 16905-4 and $EHREgas_h$ and $EHREelec_h$ are determined by test according to EN 16905-4 (see Table C.1).

Table C.1 — Data for GUE_h and AEF_h and $EHREgas_h$ and $EHREelec_h$

	Part load ratio	Part load ratio %	Outdoor air dry bulb (wet bulb) temperatures °C	Indoor air dry bulb temperatures °C	Heating Load kW	GUE_h	$EHREgas_h$	AEF_h	$EHREelec_h$
A	(−7–16)/(Tdesignh-16)	88	−7(−8)	20	44,23	1,10	0	58,20	0
B	(+2–16)/(Tdesignh-16)	54	2 (1)	20	26,92	1,28	0,09	35,42	2,37
C	(+7–16)/(Tdesignh-16)	35	7 (6)	20	17,31	1,54	0,72	22,73	10,65
D	(+12–16)/(Tdesignh-16)	15	12 (11)	20	7,69	1,16	0,36	10,12	3,16
E	(TOL-16)/(Tdesignh-16)		TOL	20	50	1,06	0	65,78	0
F	(Tbivalent-16)/(Tdesignh-16)		Tbivalent	20	50	1,06	0	65,78	0

The bin calculation is shown in Table C.2. The columns (A), (B), (C) are derived from Table 30. For each bin, the heating load (D) is calculated according to Formula (13). GUE_h (E) and AEF_h (F) are obtained according to 7.2. Heating demand (I) = fon x (C) x (D); gas energy input (H) = (G) / (E); electricity input (K) = (I) / (F). $SGUE_h$, $SAEF_{hON}$ $SEHREgas_h$ and $SEHREelec_h$ can be derived from total values (M), (N), (O), (P):

$SGUE_h$ = (M)/(N) = 1,29

$SAEF_{hON}$ = (M)/(O) = 26,27

$SEHREgas_h$ = (P)/(N) = 0,23

$SEHREelec_h = (P)/(O) = 4,65$

The reference annual heating demand $Q_{ref,h}$ is calculated according to Formula (14).

$Q_{ref,h}$ = 50 kW x 1400 h = 70 000 kWh

The measured power consumptions in thermostat off, stand by, crank case and off mode are respectively 0,03 kW, 0,03 kW, 0,05 kW and 0,01 kW.

Finally $SAEF_h$ is calculated according to Formula (13).

$SAEF_h$ = 70 000 kWh / (70 000 kWh / 26,27 + 0 h x 0,03 kW + 179 h x 0,03 kW + 179 h x 0,05 kW + 0 h x 0,01 kW) = 26,17

Finally $SPER_h$ is calculated according to Formula (19):

$SPER_h$ = (1 / (1 / 1,29 + 2,5 / 26,17)) + (1 / (1/ 0,23 + 2,5 / 4,65)) = 1,36

Table C.2 — Bin calculation of heating load

(A)	(B)	(C)	(D)	(E)	(F)	(G)	(H)	(I)	(J)	(K)	(L)
Bin	**Outdoor air temp. °C**	**Bin hours hj**	**Ph(Tj) kW**	**GUE_h kW/kW**	**AEF_h kW/kW**	**$EHREgas_h$ kW/kW**	**$EHREelec_h$ kW/kW**	**Heating demand kWh**	**Gas energy input kWh**	**Electricity input kWh**	**Energy recovery from engine (Qhr) kWh**
21	−10	1	50,00	1,06	59,95	0,00	0,00	50	47	1	0
22	−9	25	48,08	1,07	59,37	0,00	0,00	1 202	1 119	20	0
23	−8	23	46,15	1,09	58,78	0,00	0,00	1 062	977	18	0
24	−7	24	44,23	1,10	58,20	0,00	0,00	1 062	965	18	0
25	−6	27	42,31	1,12	55,67	0,01	0,26	1 142	1 020	21	5
26	−5	68	40,38	1,14	53,14	0,02	0,53	2 746	2 409	52	27
27	−4	91	38,46	1,16	50,61	0,03	0,79	3 500	3 017	69	55
28	−3	89	36,54	1,18	48,08	0,04	1,05	3 252	2 756	68	71
29	−2	165	34,62	1,20	45,54	0,05	1,32	5 712	4 760	125	165
30	−1	173	32,69	1,22	43,01	0,06	1,58	5 656	4 636	131	208
31	0	240	30,77	1,24	40,48	0,07	1,84	7 385	5 955	182	336
32	1	280	28,85	1,26	37,95	0,08	2,10	8 077	6 410	213	448
33	2	320	26,92	1,28	35,42	0,09	2,37	8 615	6 731	243	576
34	3	357	25,00	1,33	32,88	0,21	4,03	8 925	6 700	271	1093
35	4	356	23,08	1,38	30,34	0,34	5,68	8 215	5 936	271	1540
36	5	303	21,15	1,44	27,81	0,47	7,34	6 410	4 464	231	1693
37	6	330	19,23	1,49	25,27	0,59	9,00	6 346	4 265	251	2260
38	7	326	17,31	1,54	22,73	0,72	10,65	5 642	3 664	248	2645
39	8	348	15,38	1,46	20,21	0,65	9,15	5 354	3 657	265	2425
40	9	335	13,46	1,39	17,69	0,58	7,66	4 510	3 249	255	1952
41	10	315	11,54	1,31	15,16	0,51	6,16	3 635	2 770	240	1476
42	11	215	9,62	1,24	12,64	0,43	4,66	2 067	1 673	164	762
43	12	169	7,69	1,16	10,12	0,36	3,16	1 300	1 121	128	406
44	13	151	5,77	1,03	6,97	0,27	1,28	871	843	125	147
45	14	105	3,85	0,91	3,82	0,18	0,00	404	445	106	0
46	15	74	1,92	0,78	0,66	0,00	0,00	142	182	215	0

(M)	(N)	(O)	(P)
103 281	79 771	3 931	18 289

Annex D
(informative)

Adaption of water temperature for fixed capacity

For the adaptation of water temperature for fixed capacity, refer to EN 14825:2016, Annex D.

Annex E
(informative)

Compensation method for air to water and water to water units

For the compensation method for air to water and water to water units, refer to EN 14825:2016, Annex F.

Annex ZA
(informative)

Relationship between this European Standard and the ecodesign requirements of Commission Regulation (EU) No 813/2013 aimed to be covered

This European Standard has been prepared under a Commission's standardization request "M/535" to provide one voluntary means of conforming to the ecodesign requirements of Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2005/32/EC [1)] / 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters.

Once this standard is cited in the Official Journal of the European Union under that Regulation, compliance with the normative clauses of this standard given in Table ZA.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding ecodesign requirements of that Regulation and associated EFTA regulations.

1) The Directive was replaced by Directive 2009/125/EC.

Table ZA.1 — Correspondence between this European Standard and Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for space heaters and combination heaters and Commission's standardization request M/535

Ecodesign Requirements of Regulation (EU) No 813/2013	**Clause(s)/subclause(s) of this EN**	**Remarks/Notes**
Annex II.1 (a) and (b)	Not applicable	
Annex II.2 (a) and (b)	Not applicable	
Annex II.3	Not applicable	
Annex II.4	Not applicable	
Annex II.5 (a), (b) and (c)	Not applicable	
Annex II.1 Table 1	Not applicable	
Annex II.1 Table 2	Not applicable	
Annex III.2	Not applicable	
Annex III.3	Not applicable	
Annex III.4	Not applicable	
Annex III.5	Not applicable	
Annex III. Table 3	Not applicable	
Annex III. Table 4	Not applicable	
Annex III. Table 5	Not applicable	
Annex III. Table 6	Not applicable	
Annex III. Table 7	Not applicable	

WARNING 1 — Presumption of conformity stays valid only as long as a reference to this European Standard is maintained in the list published in the Official Journal of the European Union. Users of this standard should consult frequently the latest list published in the Official Journal of the European Union.

WARNING 2 — Other Union legislation may be applicable to the products falling within the scope of this standard.

Annex ZB
(informative)

Relationship between this European Standard and the energy labelling requirements of Commission Delegated Regulation (EU) No 811/2013 aimed to be covered

This European Standard has been prepared under a Commission's standardization request "M/535" to provide one voluntary means of conforming to the energy labelling requirements of Commission Delegated Regulation (EC) No 811/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling requirements for space heaters and combination heaters.

Once this standard is cited in the Official Journal of the European Union under that Regulation, compliance with the normative clauses of this standard given in Table ZB.1 confers, within the limits of the scope of this standard, a presumption of conformity with the corresponding energy labelling requirements of that Regulation and associated EFTA regulations.

Table ZB.1 — Correspondence between this European Standard and Commission Delegated Regulation (EU) No 811/2013 of 18 February 2013 supplementing Directive 2010/30/EU of the European Parliament and of the Council with regard to energy labelling of space heaters and combination heaters and Commission's standardization request M/535

Energy labelling requirements of Regulation (EU) No 811/2013	**Clause(s)/subclause(s) of this EN**	**Remarks/Notes**
Article 3, 1(a), Annex II, 1	6,7	Energy efficiency classes
Article 3, 1(a), Annex II, 2	Not applicable	Water heating energy classes
Article 3, 1(a), Annex III and IV	Not applicable	Sound power level
Article 3, 1(a), Annex III,1.1 and Annex III, 3	Not applicable	Tests conditions for measuring the rated heat output to be inserted in the Energy label for space heater
Article 3, 1(b), Annex IV,1 and Annex IV, 5	Not applicable	Tests conditions for measuring the data to be inserted in the product fiche for space heater
Article 3, 1(c), Annex IV,1	Not applicable	Technical documentation for space heater
Article 3, 2(a), Annex III, 2.1 and Annex III, 4	6,7	Energy label for combination heater
Article 3, 2(b), Annex IV, 2 and Annex IV, 6	6,7	Product fiche for combination space heater
Article 3, 2(c), Annex V, 2	Not applicable	Technical documentation for combination heater

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Bibliography

[1] EN 437, *Test gases — Test pressures — Appliance categories*

[2] EN 12309-1, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 1: Terms and definitions*

[3] EN 12309-2, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 2: Safety*

[4] EN 12309-3, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 3: Test conditions*

[5] EN 12309-4, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 4: Test methods*

[6] EN 12309-5, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW - Part 5: Requirements*

[7] EN 14511-1, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 1: Terms, definitions and classification*

[8] EN 14511-2, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 2: Test conditions*

[9] EN 14511-3, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 3: Test methods*

[10] EN 14511-4, *Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors for space heating and cooling - Part 4: Operating requirements, marking and instructions*

[11] EN 14825:2016, *Air conditioners, liquid chilling packages and heat pumps, with electrically driven compressors, for space heating and cooling - Testing and rating at part load conditions and calculation of seasonal performance*

[12] prEN 16905-2[2], *Gas-fired endothermic engine driven heat pumps — Part 2: Safety*

[13] EN 16905-3, *Gas-fired endothermic engine driven heat pumps — Part 3: Test conditions*

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