



BSI Standards Publication

Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW

Part 6: Calculation of seasonal
performances

National foreword

This British Standard is the UK implementation of EN 12309-6:2014. Together with BS EN 12309-1:2014, BS EN 12309-3:2014, BS EN 12309-4:2014, BS EN 12309-5:2014 and BS EN 12309-7:2014, it supersedes BS EN 12309-2:2000, which is withdrawn.

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English Version

**Gas-fired sorption appliances for heating and/or cooling with a
net heat input not exceeding 70 kW - Part 6: Calculation of
seasonal performances**

Appareils à sorption fonctionnant au gaz pour le chauffage
et/ou le refroidissement de débit calorifique sur PCI inférieur
ou égal à 70 kW - Partie 6 : Calcul des performances
saisonnnières

Gasbefeuerte Sorptions-Geräte für Heizung und/oder
Kühlung mit einer Nennwärmebelastung nicht über 70 kW -
Teil 6: Berechnung der saisonalen Effizienzkennzahlen

This European Standard was approved by CEN on 18 October 2014.

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Foreword

This document (EN 12309-6:2014) 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of an identical text or by endorsement, at the latest by June 2015, and conflicting national standards shall be withdrawn at the latest by June 2015.

This document supersedes EN 12309-2:2000.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] 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 sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW*:

- *Part 1: Terms and definitions;*
- *Part 2: Safety;*
- *Part 3: Test conditions;*
- *Part 4: Test methods;*
- *Part 5: Requirements;*
- *Part 6: Calculation of seasonal performances;*
- *Part 7: Specific provisions for hybrid appliances;*
- *Part 8: Environmental aspects.*

EN 12309-1 and EN 12309-2 supersede EN 12309-1:1999, whereas EN 12309-1, EN 12309-3, EN 12309-4, EN 12309-5, EN 12309-6, and EN 12309-7 supersede EN 12309-2:2000.

EN 12309-1, EN 12309-2, EN 12309-3, EN 12309-4, EN 12309-5, EN 12309-6, and EN 12309-7 have been prepared to address the essential requirements of the European Directive 2009/142/EC relating to appliances burning gaseous fuels (see Annex ZA of prEN 12309-2:2013 for safety aspects and Annex ZA of EN 12309-5:2014 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/495 (see EN 12309-3:2014, Annex ZA; EN 12309-4:2014, Annex ZA; EN 12309-6:2014, Annex ZA and EN 12309-7:2014, Annex ZA and prEN 12309-2:2013, Annex ZB and EN 12309-5:2014, Annex ZB).

These documents will be reviewed whenever new mandates could apply.

EN 12309-8 ("Environmental aspects") deals with the incorporation of the Resolution BT 27/2008 regarding CEN approach on addressing environmental issues in product and service standards.

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

1 Scope

1.1 Scope of EN 12309

Appliances covered by this standard include one or a combination of the following:

- gas-fired sorption chiller;
- gas-fired sorption chiller/heater;
- gas-fired sorption heat pump.

This European Standard applies to appliances designed to be used for space heating or cooling or refrigeration with or without heat recovery.

This European Standard applies to appliances having flue gas systems of type B and type C (according to CEN/TR 1749) and to appliances designed for outdoor installations. EN 12309 does not apply to air conditioners, it only applies to appliances having:

- integral burners under the control of fully automatic burner control systems,
- closed system refrigerant circuits in which the refrigerant does not come into direct contact with the water or air to be cooled or heated,
- mechanical means to assist transportation of the combustion air and/or the flue gas.

The above appliances can have one or more primary or secondary functions (i.e. heat recovery - see definitions in EN 12309-1:2014).

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

The appliances having their condenser cooled by air and by the evaporation of external additional water are not covered by EN 12309.

Installations used for heating and/or cooling of industrial processes are not within the scope of EN 12309.

All the symbols given in this text should be used regardless of the language used.

1.2 Scope of this Part 6 to EN 12309

This part of EN 12309 specifies the calculation methods of seasonal performances for gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW. It deals in particular with the calculation methods of reference seasonal performances in cooling and heating mode for monovalent and bivalent appliances.

NOTE This European Standard serves as an input for the calculation of the system energy efficiency in heating mode of specific heat pump systems in buildings, as stipulated in EN 15316-4-2.

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 12309-1:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 1: Terms and definitions*

EN 12309-4:2014, *Gas-fired sorption appliances for heating and/or cooling with a net heat input not exceeding 70 kW — Part 4: Test methods*

EN 15502-1, *Gas-fired heating boilers — Part 1: General requirements and tests*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN 12309-1:2014 apply.

4 Calculation methods for reference *SGUE* and *SAEF* in cooling mode

4.1 General

The calculation of the reference Seasonal Gas Utilization Efficiency ratio in cooling mode (*SGUE_c*) and reference Seasonal Auxiliary Energy factor in cooling mode (*SAEF_c*) follows from the application of the bin method, where the part load Gas Utilization Efficiency ratio in cooling mode (*GUE_c*) and Auxiliary Energy Factor in cooling mode (*AEF_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 T_j is defined according to Formula (1):

$$PLR_c(T_j) = (T_j - 16) / (35 - 16) \quad (1)$$

At part load condition A, the declared capacity of the appliance is assumed equal to the building load (i.e. capacity ratio = 100 %).

At part load conditions B, C and D, the declared capacity of the appliance is higher than the building load. The capacity ratio (CR), i.e. the ratio of the cooling load (P_c) over the declared capacity (DC) of the appliance at the same temperature conditions, is lower than one. In such conditions, the *GUE_c* and *AEF_c* are affected by both temperature test conditions and capacity ratio. The methods for the determination of *GUE_c* and *AEF_c* are defined in EN 12309-4:2014.

4.2 Part load conditions

4.2.1 General

For the indoor heat exchanger both fan coil and floor cooling applications are considered.

For the fan coil application, appliances which do, and do not, allow variations of the outlet water temperature with the outdoor temperature are considered. Variable outlet temperatures shall only be applied when the programming unit provides an outdoor air temperature dependant modification of the outlet temperature.

4.2.2 Air-to-water appliances

Table 1 — Part load conditions for the seasonal performance calculation in cooling mode of air-to-water appliances

	Part load ratio	Outdoor heat exchanger	Indoor heat exchanger		
		Air dry bulb temperature °C	Fan coil application Inlet / outlet water temperatures °C		Floor cooling application Inlet / outlet water temperatures °C
			Fixed outlet	Variable outlet	
A	1	35	12 / 7	12 / 7	23 / 18
B	(30–16) / (35–16)	30	^a / 7	^a / 8,5	^a / 18
C	(25–16) / (35–16)	25	^a / 7	^a / 10	^a / 18
D	(20–16) / (35–16)	20	^a / 7	^a / 11,5	^a / 18

^a With the water flow rate as determined during standard rating test with a fixed water flow rate.

4.2.3 Water-to-water and brine-to-water appliances

Table 2 — Part load conditions for the seasonal performance calculation in cooling mode of water-to-water appliances and brine to water appliances

	Part load ratio	Outdoor heat exchanger			Indoor heat exchanger		
		Cooling tower application Inlet/outlet water temperatures °C	Ground couple d application (water or brine) Inlet/outlet water temperatures °C	Dry cooler application Inlet/outlet water temperatures °C	Fan coil application Inlet/outlet water temperatures °C		Floor cooling application Inlet/outlet water temperatures °C
					Fixed outlet	Variable outlet	
A	1	30 / 35	10 / 15	50 / 55	12 / 7	12 / 7	23 / 18
B	(30–16) / (35–16)	26 / ^a	10 / ^a	45 / ^a	^a / 7	^a / 8,5	^a / 18
C	(25–16) / (35–16)	22 / ^a	10 / ^a	40 / ^a	^a / 7	^a / 10	^a / 18
D	(20–16) / (35–16)	18 / ^a	10 / ^a	35 / ^a	^a / 7	^a / 11,5	^a / 18

^a With the water flow rate as determined during standard rating test with a fixed water flow rate.

4.3 Calculation of reference *SGUEc*

The calculation of the reference Seasonal Gas Utilization Efficiency ratio in cooling mode (*SGUEc*) that applies to all types of appliances is given by Formula (2):

$$SGUEc = \frac{\sum_{j=1}^n h_j \times f_{on} \times Pc(T_j)}{\sum_{j=1}^n h_j \times f_{on} \times \left(\frac{Pc(T_j)}{GUEc(T_j)} \right)} \quad (2)$$

where

- T_j is the bin temperature;
- j is the bin number;
- n is the number of bins;
- $Pc(T_j)$ is the cooling load of the building not exceeding the appliance declared capacity at the corresponding temperature T_j ;
- h_j is the number of bin hours occurring at the corresponding temperature T_j ;
- f_{on} is the fraction of the bin hours during which the appliance is active;
- $GUEc(T_j)$ is the $GUEc$ of the appliance for the corresponding temperature T_j .

The values to be used for j , T_j and h_j are determined in Table 3.

Table 3 — bin number j , outdoor bin temperature T_j in °C and number of hours per bin h_j 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
T_j (°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
h_j (h)	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 value of f_{on} can be found in Annex C.

The cooling load that is not exceeding the appliance declared capacity is determined by multiplying the full load value ($P_{designc}$) with the part load ratio $PLRc(T_j)$ of the corresponding bin:

$$Pc(T_j) = P_{designc} \times PLRc(T_j) \quad (3)$$

where $PLRc(T_j)$ is:

- defined according to Formula (1) for T_j less than or equal to 35 °C;
- always 1 for T_j greater than 35 °C.

The $GUEc$ values at each bin are determined via interpolation of the $GUEc$ values at part load conditions A, B, C and D as defined in 4.1.

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

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

4.4 Calculation of reference SAEFc

The calculation of the reference Seasonal Auxiliary Energy Factor in cooling mode ($SAEFc$) 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.

$$SAEFc = \frac{Q_{refc}}{\frac{Q_{refc}}{SAEFc_{on}} + H_{TO} \times P_{TO} + H_{SB} \times P_{SB} + H_{OFF} \times P_{OFF}} \quad (4)$$

where

- Q_{refc} is the reference annual cooling demand, expressed in kWh, as defined in 4.5;
- $SAEFc_{on}$ is the Seasonal Auxiliary Energy Factor in cooling mode and active mode, as defined in 4.6;
- H_{TO}, H_{SB}, H_{OFF} are the number of hours the appliance is considered to work in respectively thermostat off mode, standby mode and off mode. The number of hours to be used for cooling is indicated in Annex C;
- 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 12309-4:2014.

4.5 Calculation of reference annual cooling demand (Q_{refc})

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

$$Q_{refc} = P_{designc} \times H_{ec} \quad (5)$$

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

4.6 Calculation of reference $SAEFc_{on}$

The reference $SAEFc_{on}$ is determined as follows:

$$SAEFc_{on} = \frac{\sum_{j=1}^n hj \times f_{on} \times Pc(Tj)}{\sum_{j=1}^n hj \times f_{on} \times \left(\frac{Pc(Tj)}{AEFc(Tj)} \right)} \quad (6)$$

where

- Tj is the bin temperature;
- j is the bin number;
- n is the number of bin;
- $Pc(Tj)$ 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 ;
- f_{on} is the fraction of the bin hours during which the appliance is active;
- $AEFc(Tj)$ 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 3.

The value of f_{on} can be found in Annex C.

The cooling load $P_c(T_j)$ shall be determined according to Formula (3).

The $AEFc$ values at each bin are determined via interpolation of the $AEFc$ values at part load conditions A, B, C and D as defined in 4.1.

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

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

4.7 Procedures for the determination of $GUEc$ / $AEFc$ values

In part load condition A (full load), the declared capacity of an appliance is considered equal to the cooling load ($P_{designc}$). Accordingly, the test methods at full capacity shall be used, as defined in EN 12309-4:2014.

In part load conditions B, C, D, the test methods at reduced capacity shall be used, as defined in EN 12309-4:2014.

5 Calculation methods for reference seasonal performance in heating mode

5.1 General

For the purpose of calculating the reference seasonal performance in heating mode, three reference climatic conditions are defined: average (A), warmer (W) and colder (C).

The relevant reference design outdoor temperature for heating ($T_{designh}$) and bivalent temperature ($T_{bivalent}$) values are set as follows:

Table 4 — Design temperature and bivalent temperature upper limit for the different reference heating seasons

Reference Heating Season	Dry bulb temperature conditions	
	$T_{designh}$	$T_{bivalent}$ upper limit
Average (A)	−10 °C	2 °C
Warmer (W)	+2 °C	+7 °C
Colder (C)	−22 °C	−7 °C

For bivalent appliances, $T_{bivalent}$ can be any value between $T_{designh}$ and the $T_{bivalent}$ upper limit. Once $T_{bivalent}$ is defined in dry bulb, the corresponding wet bulb temperature shall be calculated as dry bulb temperature minus 1 K. For monovalent appliances, $T_{bivalent}$ shall be assumed equal to $T_{designh}$.

For air to water appliances, the declared Operation Limit Temperature (TOL) of the heat pump appliance shall also be considered. TOL higher than $T_{designh}$ is an acceptable condition only for bivalent appliances. If TOL is lower than $T_{designh}$, TOL can be assumed equal to $T_{designh}$.

The calculation of the seasonal performance follows from the application of the bin method, where the part load Gas Utilization Efficiency ratio in heating mode ($GUEh$) and Auxiliary Energy Factor in heating mode ($AEFh$) at each bin temperature is determined via linear interpolation of the respective part load values at the reference part load conditions O, A, B, C, D, E and F.

The part load conditions O, A, B, C and D provide the part load ratios and the temperature test conditions at four reference outdoor air dry bulb temperatures: −15 °C, −7 °C, +2 °C, +7 °C and +12 °C.

The part load conditions E and F provide the part load ratios and temperature test conditions at the appliance operation limit outdoor temperature (TOL) and at the appliance bivalent outdoor temperature (T_{bivalent}), respectively.

The part load ratio corresponding to a given outdoor temperature T_j is defined according to Formula (7):

$$PLRh(T_j) = (T_j - 16) / (T_{\text{designh}} - 16) \quad (7)$$

At part load conditions for which the outdoor temperature is lower than or equal to the defined T_{bivalent} temperature, the appliance declared capacity is lower than or equal to the requested heating load. In this condition, the appliance operates at its maximum capacity and that the gap between heating load and appliance declared capacity is covered by an auxiliary gas boiler. The $GUEh$ and $AEFh$ at full capacity are to be used.

At the T_{bivalent} part load condition (F), the appliance's declared capacity is equal to the requested heating load. In this condition, the appliance operates at its maximum capacity and that auxiliary gas-fired heating system (if any) is turned off. The $GUEh$ and $AEFh$ at full capacity are to be used.

At any other part load conditions, the declared capacity of the appliance is larger than the building load. Accordingly, the auxiliary gas-fired heating system (if any) is turned off and the appliance capacity ratio (CR), i.e. the ratio of the heating load (Ph) over the declared capacity (DC) of the appliance at the same temperature conditions, is lower than 1. The $GUEh$ and $AEFh$ are affected by both temperature test conditions and capacity ratio. The methods for the determination of $GUEh$ and $AEFh$ are defined in EN 12309-4:2014.

5.2 Part load conditions

5.2.1 General

The part load conditions for each type of appliance (air-to-water, water-to-water and brine-to water), reference heating season (average, warmer, colder) and application temperatures (low temperature, medium temperature, high temperature, very high temperature) are given in the following tables. The table of tables for part load conditions in heating mode is provided in Annex F.

Appliances which either allow a variation of the outlet water temperature with the outdoor temperature or do not are both considered. The variable outlet temperature test point scheme in the following tables shall only be applied when the programming unit provides an outdoor air temperature dependant modification of the outlet temperature.

5.2.2 Air-to-water appliances

5.2.2.1 Low temperature application

Table 5 — Part load conditions for reference seasonal performance calculation in heating mode of air to-water appliances for low temperature application for the reference heating season (A) = average

	(A)		Outdoor heat exchanger	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	$(-7-16) / (T_{\text{designh}}-16)$	88	-7(-8)	^a / 35	^a / 34
B	$(+2-16) / (T_{\text{designh}}-16)$	54	2(1)	^a / 35	^a / 30
C	$(+7-16) / (T_{\text{designh}}-16)$	35	7(6)	^a / 35	^a / 27
D	$(+12-16) / (T_{\text{designh}}-16)$	15	12(11)	^a / 35	^a / 24
E	$(\text{TOL}-16) / (T_{\text{designh}}-16)$		TOL	^a / 35	^a / $34-(-7-\text{TOL})/(-7-2)\times(34-30)$
F	$(T_{\text{bivalent}}-16) / (T_{\text{designh}}-16)$		T_{bivalent}	^a / 35	^a / ^b
^a With the water flow rate as determined at standard rating test conditions for low temperature applications given in EN 12309-3:2014 for appliances with a fixed water flow rate, or with the flow rate defined and set by the appliance controller for an appliance using a variable water flow rate.					
^b Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature.					

Table 6 — Part load conditions for reference seasonal performance calculation in heating mode of air to-water appliances for low temperature application for the reference heating season (W) = warmer

	(W)		Outdoor Heat Exchanger	Indoor Heat Exchanger	
	Part load ratio	Part load ratio %	Outdoor Air	Inlet/Outlet temperatures	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
A	Not applicable		-7(-8)		
B	$(+2-16) / (T_{\text{designh}}-16)$	100	2(1)	^a / 35	^a / 35
C	$(+7-16) / (T_{\text{designh}}-16)$	64	7(6)	^a / 35	^a / 31
D	$(+12-16) / (T_{\text{designh}}-16)$	29	12(11)	^a / 35	^a / 26
F	$(T_{\text{bivalent}}-16) / (T_{\text{designh}}-16)$		T_{bivalent}	^a / 35	^a / ^b
^a With the water flow rate as determined at standard rating test conditions for low temperature applications given in EN 12309-3:2014 for appliances with a fixed water flow rate, or with the flow rate defined and set by the appliance controller for an appliance using a variable water flow rate.					
^b Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature.					

Table 7 — Part load conditions for reference seasonal performance calculation in heating mode of air to-water appliances for low temperature application for the reference heating season (C) = colder

	(C)		Outdoor Heat Exchanger	Indoor Heat Exchanger	
	Part load ratio	Part load ratio %	Outdoor Air	Inlet/Outlet temperatures	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
O	$(-15-16) / (T_{\text{designh}}-16)$	82	-15(-16)	^a / 35	^a / 32
A	$(-7-16) / (T_{\text{designh}}-16)$	61	-7(-8)	^a / 35	^a / 30
B	$(+2-16) / (T_{\text{designh}}-16)$	37	2(1)	^a / 35	^a / 27
C	$(+7-16) / (T_{\text{designh}}-16)$	24	7(6)	^a / 35	^a / 25
D	$(+12-16) / (T_{\text{designh}}-16)$	11	12(11)	^a / 35	^a / 24
E	$(\text{TOL}-16) / (T_{\text{designh}}-16)$		TOL	^a / 35	^a / $30 - (-7 - \text{TOL}) / (-7 - 2) \times (30 - 27)$
F	$(T_{\text{bivalent}}-16) / (T_{\text{designh}}-16)$		T_{bivalent}	^a / 35	^a / ^b

^a With the water flow rate as determined at standard rating test conditions for low temperature applications given in EN 12309-3:2014 for appliances with a fixed water flow rate, or with the flow rate defined and set by the appliance controller for an appliance using a variable water flow rate.

^b Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature.

5.2.2.2 Medium temperature application

Table 8 — Part load conditions for reference seasonal performance calculation in heating mode of air-to-water appliances for medium temperature application for the reference heating season (A) = average

	(A)		Outdoor heat exchanger	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	$(-7-16) / (T_{\text{designh}}-16)$	88	-7(-8)	^a / 45	^a / 43
B	$(+2-16) / (T_{\text{designh}}-16)$	54	2(1)	^a / 45	^a / 37
C	$(+7-16) / (T_{\text{designh}}-16)$	35	7(6)	^a / 45	^a / 33
D	$(+12-16) / (T_{\text{designh}}-16)$	15	12(11)	^a / 45	^a / 28
E	$(\text{TOL}-16) / (T_{\text{designh}}-16)$		TOL	^a / 45	^a / $43 - (-7 - \text{TOL}) / (-7 - 2) \times (43 - 37)$
F	$(T_{\text{bivalent}}-16) / (T_{\text{designh}}-16)$		T_{bivalent}	^a / 45	^a / ^b

^a With the water flow rate as determined at standard rating test conditions for medium temperature applications given in EN 12309-3:2014 for appliances with a fixed water flow rate, or with the flow rate defined and set by the appliance controller for an appliance using a variable water flow rate.

^b Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature.

**Table 9 — Part load conditions for reference seasonal performance calculation in heating mode of air-to-water appliances for medium temperature application for the reference heating season
(W) = warmer**

	(W)		Outdoor Heat Exchanger	Indoor Heat Exchanger	
	Part load ratio	Part load ratio %	Outdoor Air	Inlet/Outlet temperatures	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
A	Not applicable		-7(-8)		
B	$(+2-16) / (T_{\text{designh}}-16)$	100	2(1)	^a / 45	^a / 45
C	$(+7-16) / (T_{\text{designh}}-16)$	64	7(6)	^a / 45	^a / 39
D	$(+12-16) / (T_{\text{designh}}-16)$	29	12(11)	^a / 45	^a / 31
F	$(T_{\text{bivalent}}-16) / (T_{\text{designh}}-16)$		T_{bivalent}	^a / 45	^a / ^b
^a With the water flow rate as determined at standard rating test conditions for medium temperature applications given in EN 12309-3:2014 for appliances with a fixed water flow rate, or with the flow rate defined and set by the appliance controller for an appliance using a variable water flow rate.					
^b Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature.					

**Table 10 — Part load conditions for reference seasonal performance calculation in heating mode of air-to-water appliances for medium temperature application for the reference heating season
(C) = colder**

	(C)		Outdoor Heat Exchanger	Indoor Heat Exchanger	
	Part load ratio	Part load ratio %	Outdoor Air	Inlet/Outlet temperatures	
			Inlet dry (wet) bulb °C	Fixed outlet °C	Variable outlet °C
O	$(-15-16) / (T_{\text{designh}}-16)$	82	-15(-16)	^a / 45	^a / 41
A	$(-7-16) / (T_{\text{designh}}-16)$	61	-7(-8)	^a / 45	^a / 38
B	$(+2-16) / (T_{\text{designh}}-16)$	37	2(1)	^a / 45	^a / 33
C	$(+7-16) / (T_{\text{designh}}-16)$	24	7(6)	^a / 45	^a / 30
D	$(+12-16) / (T_{\text{designh}}-16)$	11	12(11)	^a / 45	^a / 26
E	$(\text{TOL}-16) / (T_{\text{designh}}-16)$		TOL	^a / 45	^a / $38-(-7-\text{TOL})/(-7-2)\times(38-33)$
F	$(T_{\text{bivalent}}-16) / (T_{\text{designh}}-16)$		T_{bivalent}	^a / 45	^a / ^b
^a With the water flow rate as determined at standard rating test conditions for medium temperature applications given in EN 12309-3:2014 for appliances with a fixed water flow rate, or with the flow rate defined and set by the appliance controller for an appliance using a variable water flow rate.					
^b Variable outlet shall be calculated by interpolation between the upper and lower temperatures which are closest to the bivalent temperature.					